Three Essays on Democracy and Economic Development

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A dissertation
submitted in partial fulfillment of the
requirements for the degree of

Doctor of Philosophy

University of Washington

2023

Reading Committee:
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Program Authorized to Offer Degree:
Political Science

University of Washington

Abstract

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This project examines two related questions: how political regimes shape economic policies and, in turn, how and to what extent economic conditions consolidate or destabilize the democratic form of governance. The collection of three essays in this dissertation presents a new theory on democratic disadvantage in economic policy implementation and proposes two quantitative methods to reevaluate the effect of economic development on democratization. The first essay identifies the disadvantages of democratic governance in banking regulation and finds evidence that democratic countries are less likely to implement macroprudential banking policies. The second essay finds the temporal heterogeneity of the effect of income on democratization, using Bayesian time-dependent Probit models. The result shows the positive effect of income on democracy has gradually decreased since the beginning of the twenty century, and the effect no longer holds after the end of the Cold War. Lastly, the third essay proposes a method using quantile regression and the skewed t-distribution to examine the asymmetric effect of economic factors on the level of democracy. I reveal that while rising income inequality moderately increases the risk of democratic regression, it significantly decreases the probability of increasing the level of democracy.

To my wife, Ayaka

ACKNOWLEDGMENTS

This project could not have come together without the support and wisdom of wonderful individuals and academic communities. It is my genuine pleasure to acknowledge and thank them as much as possible.

Long before I arrived for graduate studies at the University of Washington, I had the good fortune to meet Frances McCall Rosenbluth. Without working with her as a research assistant, I would never have considered studying political science and pursuing a doctoral degree. She always asked me, "Where is politics" in my research and taught me to think of "big" issues. When I last met with her, she asked me, "Where is politics" again, which helped me greatly in framing the first article of this dissertation. Her leadership and mentorship will always stay with me.

As someone who wanted to study political economy, I was lucky to find a true intellectual home at the University of Washington. First and foremost, I owe a special debt of gratitude to Chris Adolph, my chair, for his belief in me and my project. Since Day One when we met together at Din Tai Fung, he has engaged me not only as the chair of my committee but as a hiring committee member, a lecturer of the methods sequence, for which I served as a teaching assistant, and a co-author. Thank you for investing your time in reviewing countless drafts and recognizing the significance of my research even more than I did. I would also like to extend my heartfelt appreciation for your flexibility and understanding regarding my family situation.

I am extremely grateful to the rest of my committee for their ongoing support and thoughtful feedback. Victor Menaldo always provided me with the framework of new institutional economics, which is a traditional approach in our department. All my work is

deeply influenced by his work on democracy and finance, and I could not have come up with these research ideas without his influence. Caitlin Ainsley shaped the development of the project, both in the examples of her own quantitative and formal model work and in her generous support and suggestions. Additionally, I am grateful to the numerous faculty members from whom I have learned in classrooms, talks, and through my experiences as a RA or TA, including but certainly not limited to Jeff Arnold, James A. Caporaso, Anthony Gill, Jake Grumbach, James Long, Christopher Parker, Aseem Prakash, Geoffrey Wallace, Susan Whiting, and John Wilkerson.

I would also like to acknowledge the faculty at Jackson School for their contributions to my academic growth. Robert J. Pekkanen invited me to write a book chapter about Japanese macroeconomic policies. Without his support, I would not have been able to proceed with my academic career. Saadia M. Pekkanen kindly accepted to serve as GSR, and Mark Metzler provided me with opportunities to work as a research assistant.

A network of faculty beyond the UW community supported me throughout the endeavor. I first want to thank Jouchi Nakajima for his friendship since we started our career together at the Bank of Japan and for his countless help. His fingerprints are everywhere in this project. He suggested using the IMF data for the first article, he collaborated with me on the second article, and he helped me understand the methodological details in the third article. I am so excited to write more papers in the coming years with you. I would like to thank Saori N. Katada and Masaaki Higashijima for coauthorship on the other projects. I would like to thank Charles Crabtree, Christina L. Davis, Yusaku Horiuchi, Phillip Lipscy, Mark Manger, Masaru Nishikawa, Yoshikuni Ono, and Daniel M. Smith for their mentorship and for welcoming me into Japanese politics.

Next, I want to recognize my fellow graduate students, who have been a constant source of inspiration and have made my academic journey enjoyable. A special shoutout goes to my peers from my cohort, Rutger Ceballos, Ryan Goehrung, Brian Leung, and Shihao Han. I

would like to give a special mention and thanks to Bree Bang-Jensen for her invaluable help, which has undoubtedly improved the quality of my writing. I echo you: we should have done a million more IPA/juice box/bottle play-dates. I always hope to resume the unfinished paper and start a new collaboration with you, Bree. I also want to thank my writing buddies, Yuki Atsusaka and Hikaru Yamagishi. Without your friendship and support, I could not have endured the long writing process. I would like to express my appreciation to all the graduate students I have met throughout the program and beyond, with a special emphasis on Ian Callison, Rachel Castellano, Megan Erickson, Calvin Garner, Jeffrey Grove, Zhaowen Guo, Trevor Incerti, Inhwan Ko, Beatrice Magistro, Sebastian Mayer, Austin M. Mitchell, Nela Mrchkovska, Christianna Marie Parr, Grace Reinke, Tomohiro Sasaki, Yusri Supiyan, Morgan Wack, Hanjie Wang, and Nicolas Wittstock.

Last but not least, I would like to express my deep gratitude to my family. My parents, Jun and Mieko Amano, have always believed in me and supported my intellectual interests and exploration, even though my direction is not their first preference. My parents-in-law, Hiromi and Chiaki Ishida, have also been extremely supportive throughout this academic journey, even though they thought their daughter married a central banker. My daughter Nina came to Seattle together with me but without her mom when she was one-year-half old. My memory of the first half of my graduate life was occupied by her development growth and a large-endless amount of reading assignments. Thank you for accompanying me and helping me grow as a father. My second daughter Sana was born in the quarter when I took my comprehensive exam. The quarter was the most challenging quarter I have ever had, and I always regret my decision to take the exam at that time. Even though her mom flew back to South Sudan when she turned to three-months-old on the day of my oral exam, Sana has been the happiest person in our family, which makes every day brighter. My final thanks are to my wife, Ayaka, whose support and love have sustained me since I aspired to join academia. She was the one who encouraged me to go to academia when I considered staying

at the Bank of Japan. Nevertheless, my best choice of graduate school was the worst choice for her because of visa and work eligibility issues. I owe a special debt to her for my decision. But, I have always been inspired that she developed her new career with her strong will and determination. Her dedication to making a better world is my source of inspiration to write a better paper.

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Chapter 1

INTRODUCTION

Scholars have long examined the relationship between democracy and economic development. On the one hand, they examine the advantages and disadvantages of democracy on economic and financial development, as well as banking crises (Barth, Caprio, and Levine 2005; Calomiris and Haber 2014; Menaldo and Yoo 2015). On the other hand, numerous studies explore the impact of economic conditions on political regimes, focusing on the level of income and income inequality (Lipset 1959; Boix 2011; Boix and Stokes 2003; Acemoglu and Robinson 2006). This dissertation project builds on and advances existing research by examining the disadvantage of democratic governance on financial regulation (Chapter 2), and by revisiting the effect of economic factors on political regimes (Chapter 3 and Chapter 4).

In the first essay in Chapter 2, **Democracy and Macroprudential Banking Regulation**, I investigate the conditions that exacerbate the democratic disadvantages of regulatory implementation. The study extends the growing debate about whether authoritarian or democratic governance best addresses contemporary global issues such as financial crises, contagious disease outbreaks, or climate change. Building on the existing literature on the short-termism of democratic decision-making and policy stagnation stemming from veto players, I argue that democratic governance limits the implementation of macroprudential regulation.

My theoretical contribution is to show how vertical and horizontal accountabilities of democratic governance do not yield better outcomes in areas such as macroprudential policies. Because macroprudential policies preemptively restrict credit expansion to reduce the risk and magnitude of banking crises, and because voters do not realize the policy benefits

without the occurrence of the crisis, the uncertainty in the future timing and magnitude of crises compounds the short-termism of democratic decision-making. I also argue that banking regulation increases the cost of veto bargaining in democracies. In particular, because the regulation creates a highly heterogeneous distribution of benefits, macroprudential regulation not only divides banks from veto players in other sectors but also leads to fragmented preferences over regulations within the financial sector. In contrast, authoritarian regimes more readily implement macroprudential regulation because avoiding banking crises is critical to long-term regime survival.

Empirically, using a panel dataset of macroprudential policies in 126 countries from 1990-2020, and event history and synthetic control models, I uncover that democracies are less likely to adopt macroprudential policies. The results of event history models confirm that, all else equal, advanced democratic regimes are 26 percent less likely to adopt macroprudential policies at any given time. Likewise, the synthetic control models, which compare countries that experienced democratization to synthetic countries without such a change, show that democratization causes the adoption of about one fewer policy out of nine possible macroprudential tools on average over ten years. I also explore case studies in the United States, China, and Hungary to corroborate the mechanisms behind this relationship. n Hungary and China, political leaders swiftly changed their economic institutions to implement macroprudential policies, whereas, in the liberal democracy of the United States, reform of prudential regulations remained marginal.

In the second essay in Chapter 3, **Estimating Waves of Temporal Heterogeneity: A Time-Varying Parameter Model Approach**, I revisit the canonical debate on the relationship between democracy and development, focusing on temporal heterogeneity. Because prior findings are contingent on the window of time selected for the study, such as the nineteenth century and the prewar period or the early 21st century, the causal association between economic development and democracy remains unsettled. To address this challenge, this article explores dynamic relationships between levels of income and democracy.

Recent methodological developments in changepoint models have successfully identified

structural changes in time-series cross-sectional data analysis. However, these models ignore gradual changes that happen over prolonged periods. To help researchers better analyze gradual changes, I propose the use of a Bayesian methodological strategy for time-varying parameter models to identify slow-moving structural changes. Specifically, I develop a time-varying parameter probit (TVPP) model, which estimates a time-varying relationship between a binary response (e.g., democratization) and explanatory variables (e.g., income). I illustrate the utility of the TVPP models using simulated data and examples drawn from two important debates in democratization studies: (i) the identification of shifting relationships between oil wealth and democratization and (ii) the effects of income on democratic transition and consolidation.

I find in the second application that the magnitude of the relationship between income and democracy gradually wanes over time, showing the gradual structural changes that occurred during the first and second reversals of democratization. Most strikingly, the relationship becomes statistically insignificant after the demise of the Soviet Union and the end of the Cold War. The empirical results partly support the theories in the previous democratization studies, in which change in the international system influences the democracy-income relationship (Boix 2011).

I also conducted a counterfactual analysis using the conditional posterior mean to assess the income effects on democratization. The analysis suggests that if the effect of GDP per capita on democratization had not changed after the Cold War, the number and proportion of democracies would have increased more rapidly. However, the decline in the number of democracies after 2007 can be attributed to the income shock during the Great Financial Crisis and the negative impact of the age effect on democratic transition and consolidation.

The third essay in Chapter 3, **Democracy-at-Risk: Estimating Resilience and Vulnerability of Democracy**, examines the asymmetric effect of economic factors on democracy. While qualitative studies have empirically tested the asymmetric relationships, quantitative empirical tools to adequately address them are limited because standard regression models rely on a *linear* assumption. To address asymmetric hypotheses, this article

proposes a method that estimates the conditional distribution, rather than just the mean, of the outcome variable as a function of explanatory variables using quantile regression and the skewed t-distribution. By focusing on conditional distribution, researchers can analyze the effects across the lower and upper tails of the probability distribution, capturing asymmetry through the empirical shape of the full distribution.

Using this new approach, I explore the risks of democratic vulnerability and resilience and their association with two economic drivers: income levels and income distribution. The literature distinguishes between theories of democratization, focusing on the probability of a transition to democracy, and theories of consolidation, focusing on the probability of democratic breakdown. Przeworski and Limongi (1997) distinguish the former as an "endogenous" theory and the latter as an "exogenous" theory in the relationship to the levels of income, and then they reject only the endogenous modernization theory, showing asymmetry between the two theories (Przeworski and Limongi 1997; Przeworski et al. 2000). Similarly, theories on income distribution and democracy challenge the linear assumption. While Boix and Stokes (2003) argues for a linear relationship, stating that reducing economic inequality strengthens democratization, Houle (2009) theorizes an asymmetry: inequality decreases democratic consolidation but has no net effect on democratization. I demonstrate how the proposed method can capture asymmetric assumptions embedded in these theories of democratic transition and consolidation.

To quantify the asymmetric risks from the conditional distribution, I estimate the probability of changing the level of democracy at a certain level. I describe such probabilities as Democracy-at-Risk (DaR). The downside Democracy-at-Risk, or countries at risk of becoming less democratic, is estimated from the lower end of the distribution. Likewise, the upside Democracy-at-Risk, or countries that may become more democratic, is estimated from the upper tail. Democracy-at-Risk represents not only the mean effect of explanatory variables but also integrates the uncertainty through variance and the asymmetry through skewness of both tails of the distribution. I find that when income level increases, the upside and downside democracy risks are symmetric, and regime stability increases with higher income across

all levels of democracy. However, the effect of income inequality is asymmetric: while rising income inequality moderately increases the risk of democratic regression, it significantly decreases the probability of increasing the level of democracy.

In conclusion, this dissertation project makes a significant contribution to the existing research on the relationship between democracy and economic development. The first article specifically focuses on the disadvantage of democratic governance on financial regulation, advancing the understanding of the drawbacks associated with democratic institutions. A considerable body of scholarly work has already explored the negative impact of democratic governance on various aspects such as economic stability (Lipscy 2019), trade (Kono 2006), migration (Breunig, Xun, and Luedtke 2012), capital formation (Dhillon, Pickering, and Sjö 2019), and financial crisis (Lipscy 2018). Additionally, there is a growing literature investigating the effectiveness of authoritarian and democratic governance in addressing contemporary challenges like climate change and pandemic response (Cheibub, Hong, and Przeworski 2020; Thomson and Ip 2020; Cepaluni, Dorsch, and Branyiczki 2022; von Stein 2022; Beeson 2018). My findings contribute to these broader debates surrounding 21st-century challenges, characterized by negative externalities, complex distributional effects, and challenges in a retrospective evaluation.

The two methodological approaches proposed in Chapter 3 and Chapter 4 provide new insights into the central debates in Comparative Political Economy by quantifying temporal heterogeneity and asymmetric assumptions discussed in these studies. Moreover, I believe that time-varying parameter models and the quantile regression approach provide a potential avenue to investigate political relationships beyond democracy. A slow, gradual institutional change is often ignored in empirical studies, so the theories in historical institutionalism have been tested mainly in qualitative analysis. Likewise, a wide range of political science theories, hypotheses, and data examines political relationships that are not *linearly* constructed. Therefore, the proposed methods contribute to exploring more nuanced and complex assumptions on political relationships.

Chapter 2

DEMOCRACY AND MACROPRUDENTIAL BANKING REGULATION

Kenya Amano

Abstract

Do democracies implement more banking regulations than authoritarian states? Existing studies examine the relationship between democracy, financial development, and banking crises, but we lack an understanding of how political regimes influence banking regulations. Through examining the increased global focus on macroprudential policy, which preemptively restricts credit expansion to decrease the risk and magnitude of banking crises, I argue that democratic governance limits regulatory implementation. Because the difficulty of retrospective evaluation of macroprudential policies exacerbates the short-termism of democratic decision-making, and the heterogeneous distributional effects of regulation increase the transaction costs of veto bargaining, democratic countries tend to resist reform and maintain status quo regulatory systems. Empirically, the analysis of a panel dataset of macroprudential policies in 126 countries from 1990-2020 and case studies of the United States, China, and Hungary indicate robust empirical support for the democratic disadvantage of macroprudential regulations.

2.1 Introduction

The economic and political consequences of the Great Financial Crisis (GFC) of 2007-2009 have led to increased interest in financial regulation, especially in macroprudential policies. Contrary to traditional banking regulations that aim to improve individual bank health, macroprudential policies regulate banking systems by restricting borrowers' credit access and mitigating the collective impact of banks' behavior on financial systems. Policymakers and economists expect this new regulatory framework to reduce the potential negative externalities of banking crises, thereby preventing political instability caused by banking crises, including regime change, terrorism, and the rise of political extremism (Walter, Ray, and Redeker 2020; Armingeon and Guthmann 2014; Bechtel, Hainmueller, and Margalit 2014; Fernández-Albertos and Kuo 2016). Despite this persuasive argument in the wake of the GFC, the adoption of macroprudential regulatory reform varies across countries. What explains this variation?

In this article, I examine how political regimes influence the implementation of macroprudential policies. A large literature demonstrates that democratic governance produces effective public policy, highlighting the role of democratic elements, including vertical accountability through competitive elections (Dixit and Londregan 1996; Grossman and Helpman 1996); horizontal accountability through executive constraints (North and Weingast 1989; Tsebelis 2011); and open access to markets (Eichengreen and Leblang 2008; Steinberg, Nelson, and Nguyen 2018; Milner and Kubota 2005). When it comes to finance, scholars largely agree that democratic countries have larger and more sophisticated financial systems than autocracies (Keefer 2007, 2008; Barth, Caprio, and Levine 2005; Calomiris and Haber 2014; Menaldo and Yoo 2015). However, not all public policies are equally responsive to democratic governance. Here, I explore mechanisms through which macroprudential policy may put democracies at a disadvantage.

I argue that democratic countries are less likely to adopt macroprudential policies because democratic governments tend to maintain status quo regulatory frameworks. Two theoretical

mechanisms anchor this argument. First, vertical accountability through elections encourages leaders to adopt a myopic time horizon due to shorter tenure and frequent elections. Because macroprudential policies impose preventative restrictions on the financial system as a whole, these measures are costly in the short term, so voters and political leaders seek to prevent short-term credit contractions. Moreover, the short-termism of democratic decision-making is further exacerbated in areas, such as macroprudential policy, where retrospective policy evaluation is difficult. Even if macroprudential policy successfully prevents a crisis, future retrospective voters may not realize the policy benefits as the crisis did not occur, cannot be easily measured by causal observers, and is easy to ignore. In this way, uncertainty in the future timing and magnitude of crises compounds the short-termism of democratic decision-making.

Second, democratic institutions impose more significant constraints on governments than autocratic regimes. The existence of multiple veto players limits regulatory action, leading to status quo bias in democracies. Moreover, banking regulation increases the cost of veto bargaining in democracies because special interest groups in financial industries are strong, employing ample resources for lobbying. In particular, macroprudential regulation not only divides banks from veto players in other sectors but also leads to fragmentation among financial sectors as regulation creates a heterogeneous distribution of benefits among banking sectors. On the other hand, in autocracies, power consolidation is more likely in the financial sector because political leaders tend to capture the banking sector to generate rents that help maintain their ruling coalitions (Calomiris and Haber 2014; Shih 2020). Discretion in the decision-making process means political transaction costs are internalized; therefore, as the power of authoritarian leaders is more consolidated, veto bargaining costs are greatly diminished.

To test the democratic disadvantage in macroprudential policy, I utilize three empirical approaches. First, using a panel dataset provided by the IMF that tracks the adoption of various types of macroprudential regulations from 1990 to 2020 in 126 countries, I employ event history models to estimate the timing of macroprudential policy implementation. The

results confirm that, all else equal, advanced democratic regimes are 26 percent (95% CI: 0.3% to 50.0%) less likely to adopt macroprudential policies at any given time. Second, exploiting democratization as a quasi-natural experiment, I estimate the effect of sharp changes in political regime on the cumulative number of policies adopted. I employ synthetic control methods to empirically construct a plausible counterfactual, comparing countries that experienced democratization to synthetic countries without such a change. The result shows that democratization causes adoption of about one (0.87, 95% CI: 0.05 to 1.7) fewer policy out of nine possible macroprudential tools on average over ten years. Finally, I take a closer look at the policy implementation processes in the United States, China, and Hungary to illustrate how different governance systems shape the implementation of macroprudential policies. Political leaders in the two non-liberal democracies swiftly changed their economic institutions to implement macroprudential policies, whereas in the United States, reform of prudential regulations remained marginal.

The findings contribute to our understanding of the politics of regulation. Scholarship on the political economy of regulation emphasizes that special interest groups shape regulation by capturing politicians to exploit the rents regulation creates (Stigler 1971; Becker 1983; Shleifer and Vishny 1998; Barth, Caprio, and Levine 2005; Kroszner and Strahan 2002; Demirguc-Kunt, Kane, and Laeven 2008). In comparative approaches to regulation, others argue that institutions matter since policymakers are constrained by electoral rules, and the degree of competition in the last election (Barth, Caprio, and Levine 2005; Rosenbluth and Schaap 2003). This article builds on this literature by exploring how democratic governance, contrasted with autocratic governance, limits macroprudential actions. Empirically, only a few scholars have tested the effect of political regime on the adoption of banking regulations, largely because of the difficulty in constructing a panel data for financial regulations (Barth, Caprio, and Levine 2005; Jones and Zeitz 2019; Demirguc-Kunt, Kane, and Laeven 2008). Using panel data of macroprudential policy that has not been used in previous research, this article is, to my knowledge, the first to estimate causal relationships between political regimes and banking regulation using time series data.

Finally, this article advances the literature on the disadvantages of democratic governance. A large body of scholarly work studies the negative influence of democratic institutions on economic stability (Lipscy 2019), trade (Kono 2006), migration (Breunig, Xun, and Luedtke 2012), capital formation (Dhillon, Pickering, and Sjö 2019), and financial crisis (Lipscy 2018). Moreover, a growing literature on climate change and pandemic response questions whether authoritarian or democratic governance better addresses contagious disease outbreaks and environmental issues (Cheibub, Hong, and Przeworski 2020; Thomson and Ip 2020; Cepaluni, Dorsch, and Branyiczki 2022; von Stein 2022; Beeson 2018). In line with these studies, the findings of this article speak to broader debates related to 21st-century challenges, which share the common features of negative externalities, highly heterogeneous distributional effects, and difficult retrospective evaluation.

2.2 Democracy and Financial Systems

A large literature in political economy has examined the relationship between democratic institutions and financial systems, including democracy's role in financial development and banking crises. However, the literature reaches a paradoxical conclusion on the question of democratic advantage, finding that democracy promotes financial development (Keefer 2007, 2008; Barth, Caprio, and Levine 2005; Calomiris and Haber 2014; Menaldo and Yoo 2015), but are less effective in preventing crises (Lipscy 2018; Rochet 2008; Gandrud and Hallerberg 2015; Woll 2014). Although banking regulation could be the key factor bridging the gap between financial development and stability, we have relatively little knowledge about the relationship between democracy and banking regulation.

Studies on financial development largely agree that democratic countries have larger and more sophisticated financial systems than autocratic countries. Because the median voter tends to have significant debts relative to assets, politicians are under electoral pressure to provide access to affordable credit (Calomiris and Haber 2014; Menaldo and Yoo 2015). Because democracies tend to have a stricter rule of law and to promotecivil liberties more than do autocracies, politicians in democracies are likely to develop a liberalized banking

system by securing property rights, promoting new entries, and privatizing publically-owned financial institutions (Keefer 2008; Barth, Caprio, and Levine 2005; Bordo and Rousseau 2006; Haber, North, and Weingast 2008). Because executive constraints in democracies mitigate the establishment of crony connections, democratic countries are more likely to promote more competitive and efficient banking markets than autocracies (Keefer 2007; Calomiris and Haber 2014).

When it comes to the threat of banking crises, however, democracy's advantages turn into drawbacks. Lipscy (2018) empirically shows that democracies face banking crises more frequently than autocracies. As the traditional literature on political business cycles argues that myopic voters and short electoral cycles produce shortsighted outcomes in macroeconomic policies (Nordhaus 1975; Hibbs 1977; Tufte 1978), voters in democracies are more concerned with eliminating the short-term financial hurdle of the debt burden than with long-term financial stability. For instance, Antoniades and Calomiris (2020) find that voters punish incumbents for contractions in mortgage credit supply, while Kern and Amri (2021) suggest politicians use not only fiscal and monetary policy to court voters but also to implement credit policies like interest rate subsidies and tax breaks to enhance credit growth. Thus, vertical accountability through elections is unlikely to produce regulations that could reduce the risk of banking crises.

Moreover, greater executive constraints and multiple veto players inefficiently delay government responses to credit bubbles in democracies. The presence of multiple veto players provides more stability in policy outcomes (Tsebelis 2011), but constraints on decision-making processes render the state less able to act on emerging issues (Kim 2007; Lipscy 2019). In contrast, regulators in autocracies can control credit expansion with fewer veto players. Hence, autocracies' inefficient banking systems could ironically better restrict the excesses of credit.

Likewise, bank bailouts are another case in which democracies produce shortsighted policy outcomes. Some argue that vertical accountability through electoral constraints drives politicians' reluctance to bail out banks because voters-as-taxpayers prefer to redress bank

insolvency with minimum public costs (Rosas 2006; Keefer 2007). However, voters' aversion to bailouts reflects their ignorance of the positive outcome of bailouts, as well as their overestimation of bailouts' long-term fiscal costs. In the short run, bailouts can appear to be an unfair income transfer to the bankers who caused a crisis from taxpayers. But assets acquired through bailouts can yield profits for public entities which hold these assets in the long run because the price of assets is below the trend price under distressed markets[1]. This misconception of the fiscal costs of bailouts is rooted in the uncertainty about long-term costs and benefits, leading democracies to shortsighted policy outcomes in the decision of bailouts, because the final costs are determined by the future market conditions and thus endogenous to the success of the bailout itself (Gandrud and Hallerberg 2015; Woll 2014)[2].

However, less attention has been paid to the effect of shortsighted democratic governance on regulation. Instead, studies of the political economy of regulation have emphasized the role of horizontal accountability: because regulation is considered as a product of rent-seeking, private interest groups that exploit regulation as a means of enhancing their profits will shape banking regulations regardless of the type of political regime[3]. However, this focus on interest groups has led to mixed predictions on the effects of democracy. On the one hand, democratic governments may directly ameliorate market failure by implementing regulation because greater executive constraints weaken the incentive to create a crony banking system (Calomiris and Haber 2014). On the other hand, democracies may be wary of enacting regulatory restrictions to avoid corruption (Barth, Caprio, and Levine 2005). This article

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[1] For instance, the Japanese government's recapitalization of banks in late 1990, which costs 10.3 trillion yen, is worth 1.3 trillion yen as of September 2021 (See URL: https://www.dic.go.jp/content/000029554.pdf). In the longest case, the recapitalized bank took 16 years to repay the capital to the government. Another example is the Troubled Asset Relief Program in the Obama administration in the US, which reported a total net government profit is 109 billion dollars as of August 2021 (See URL: https://projects.propublica.org/bailout/).

[2] In contrast to Keefer (2007) that finds the negative relationship between electoral competitiveness and fiscal costs, Gandrud and Hallerberg (2015) empirically find no negative association between electoral when they estimate the relations over a longer time horizon than the original estimations by Keefer (2007).

[3] For democracies, Stigler (1971); Posner (1974); Peltzman (1976); Becker (1983), and for autocracies, see Shleifer and Vishny (1998); Barth, Caprio, and Levine (2005).

aims to adjudicate these claims by examining banking regulations that pursue to prevent future banking crises.

2.3 Democratic Disadvantage in Banking Regulation

2.3.1 Vertical Accountability and Retrospective Evaluation

Political leaders in democracies are compelled to be myopic due to voters' preference for credit expansions and the risk of frequent turnover due to elections. An autocratic leader, on the other hand, is less sensitive to mass preferences, and thus more tolerant of the possibility that crisis-preventing regulation may cause a credit contraction. Thus, voters and politicians in democracies are less incentivized to implement intertemporal policies that might only yield future benefits.

Moreover, the vertical accountability of democratic governments discourages action in areas, like macroprudential policy, where retrospective policy evaluation is difficult. Even if macroprudential policy provides a large aggregate economic benefit, in the long run, the realization of that benefit may not occur for many years until the next potential financial crisis. Moreover, if this event is successfully prevented, it may be hard for future retrospective voters to notice as no event occurred, and thus voters may not exert vertical accountability channel. Uncertainty in the future timing and magnitude of crises thus compounds the short-termism of democratic decision-making, resulting in policy inaction. In contrast, banking crises are a critical threat to authoritarian leaders, as exogenous shocks may undermine regimes by reallocating resources that support the ruling coalitions and galvanizing mass uprising (O'Donnell, Schmitter, and Whitehead 1986; Acemoglu and Robinson 2006; Haggard and Kaufman 1995; Shih 2020). Thus, authoritarian leaders have strong incentives to implement macroprudential policies to prevent future banking crises.

2.3.2 Horizontal Accountability and Heterogenous Distribution

To implement new policies, political leaders need to overcome political constraints. The presence of multiple veto players places greater constraints on policymaking processes, thereby making it harder to adopt substantial policy changes. Although the presence of multiple veto points may help governments commit to the policies they announce (North and Weingast 1989; Tsebelis 2011), the stability the veto players provide may be a drawback when governments respond to new issues that emerge (Kim 2007; Lipscy 2019). In particular, banking regulation involves costly veto bargaining in democracies because special interest groups in financial industries are strong, employing ample resources for lobbying. On the other hand, in autocracies, discretion in the decision-making process implies that political transaction costs are internalized, and thus, costs of veto bargaining tend to be much lower.

Moreover, macroprudential regulation not only pits banks as veto players against actors from other economic sectors but also leads to fragmentation among financial institutions because these regulations create a heterogeneous distribution of benefits, depending on the business model, such as the size of assets, regions, target borrowers, and financial products. In contrast, political leaders in autocracies tend to capture the banking sector because financial industries generate rents that help maintain their ruling coalitions. Because they control the entire banking sector, their utility functions average over the mix of benefits and costs posed by regulation and crisis. If in the aggregate, a crisis is more costly than regulation, autocrats will favor and impose regulation, whereas, in a democracy, those banks which would lose more from regulation than crisis are likely to veto. Therefore, by internalizing the costs of crisis and regulation, autocrats solve the regulation problem better than high-veto-point democracies.

2.4 Macroprudential Policy: Concepts, Politics, and Measurement

2.4.1 Policy Concepts

Macroprudential policies are a novel concept that can be operationalized using a series of different policy tools, and which have been politically challenging to adopt and implement. Prior to the GFC, banking regulation focused on the soundness of individual banks, using a "microprudential" approach. This "microprudential" approach assumed that systemic risk was a matter of direct contagion from one failed institution to the other so that the regulatory goal is to maintain each bank's health (Armour et al. 2016). However, the GFC demonstrated the inadequacy of this approach. Scholars and regulators recognized that the root cause of systemic risk was the inefficiency of financial markets, where imperfect information, herding, and negative externalities drive actors' behavior (Borio 2003; Piroska, Gorelkina, and Johnson 2021), thereby creating demand for "macroprudential" policies that buttress the stability of the financial system as a whole.

Armour et al. (2016) illustrate the distinction between the microprudential and macroprudential approaches using an analogy involving medicine and public health. They note that medicine is concerned with individual lives, while public health addresses the community as a whole. Just as medical treatment of sick patients does not necessarily prevent community spread of a contagious disease, regulations aimed at protecting individual institutions do not necessarily ensure the stability of the entire financial system. Borio (2003) also summarizes the assumptions about risk made by each approach. He notes macroprudential policy assumes that risk is in part endogenous to the behavior of the financial system, so this approach accounts for the negative externality that is created by a single bank failure. On the other hand, the microprudential approach assumes that risk is exogenous, and thus the approach does not take into account correlated risks and common exposures across financial institutions. Therefore, the macroprudential approach goes well beyond individual analysis through monitoring the financial system and implementing pre-emptive regulation in antici-

pation of possible future shocks, rather than waiting until negative shocks occur (Borio 2003; Edge and Liang 2020).

2.4.2 Policy Tools

Although the concept of macroprudential policy is relatively new, some countries implemented these tools before the GFC without labeling them as macroprudential. After the crisis, scholars and policymakers defined the range of individual tools that might be implemented. The IMF summarizes the key goals of macroprudential tools: 1) to promote resilience to shocks, 2) to avoid excessive credit growth, 3) to strengthen sectoral vulnerabilities to asset prices and exchange rates, and 4) to manage liquidity (International Monetary Fund 2013). To achieve these goals, policy tools are divided into two approaches: supply-side and demand-side.

The supply-side approach regulates banks and financial institutions by imposing capital and liquidity requirements. For instance, the implementation of Countercyclical Buffers (CCyB) requires banks to maintain additional capital on their balance sheets. The basic concept of this policy tool is equivalent to classical capital requirements, but is more stringent and builds on existing microprudential regulations to cover possible losses during a systemic crisis. On the other hand, the demand-side approach regulates aggregated credit growth by limiting the size of loans according to several different metrics. For instance, Limits to Loan-to-Value ratios (LTV) cap loans, including housing, automobile, and commercial real estate loans, relative to the value of the assets. Limits to the debt-service-to-income ratio (DSTI) restrict the size of debt service payments relative to total disposable income. A more holistic approach is Limits on Credit Growth (LCG) which restricts an aggregated individual bank's credit growth to household and corporate sectors (see details in Table 2.1).

2.4.3 Politics of Macroprudential Policy

Macroprudential policy involves significant short-term costs, and policymakers are required to be forward-looking and pre-emptive for low-probability events (Edge and Liang 2020). This means that policymakers enforce macroprudential tools to slow down credit expansion just when many stakeholders, including voters, are benefiting from credit expansion. In particular, several studies suggest short-term negative impacts of demand-side macroprudential regulation. Richter, Schularick, and Shim (2019) find, for instance, that a 10 percentage point decrease in the maximum LTV ratio leads to a 1.1% reduction in output over a four-year horizon. Also, the impact of LTV or DSTI on housing markets could decrease consumption because households would need to save more to get a mortgage. Of course, the long-term goal of macroprudential policies is to avoid the negative impact on GDP when a crisis occurs, but the balance between short-term economic and welfare costs imposed by macroprudential policy and future benefits of lower financial crisis likelihood is hard to estimate. In democracies, the mismatch between long and uncertain periods between crises and short and regular election cycles leads to a bias against new macroprudential regulations.

Another political issue is distributional consequences. Unlike monetary policy, macroprudential policy tends to create winners and losers in credit allocation (Edge and Liang 2020). In particular, demand-side macroprudential tools may increase income inequality in the short term, at least. For instance, LTV and DSTI favor the wealthy because these policies make it harder for poorer consumers to buy real estate or use real estate they own as collateral (Frost and van Stralen 2018). Moreover, it is difficult for interest groups, including banks, to assess their private net benefit from regulation. In the short run, macroprudential policy squeezes bank profits by imposing strict capital control and lending reductions, while in the future, banks will be beneficiaries of regulations that mitigate systemic crises. However, it is difficult to estimate each bank's long-term benefits mainly because the future negative externality depends on their business models and effectiveness of policy implementation, as well as the expected timing and severity of the next crisis without additional regulation. Thus,

Table 2.1: **List of Macroprudential Policy Tools**

Macroprudential Tool	**Description**
Loan Restrictions	
Limits on Leverage of Bank (LVR)	Limits on leverage of banks, calculated by dividing a measure of capital by the bank's non-risk-weighted exposures.
Loan Loss Provision(LLP)	Loan loss provision requirements for macroprudential purposes, which include dynamic provisioning and sectoral provisions (e.g. housing loans).
Limits on Growth of Credit (LCG)	Limits on growth or the volume of aggregate credit, the household-sector credit, or the corporate-sector credit by banks, and penalties for high credit growth.
Loan Restrictions (LoanR)	Loan restrictions, that are more tailored than those captured in "LCG". They include loan limits and prohibitions, which may be conditioned on loan characteristics.
Limits to Loan-to-Value ratios (LTV)	Limits to the loan-to-value ratios, including those mostly targeted at housing loans, but also includes those targeted at automobile loans, and commercial real estate loans.
Limits to Debt-Service-to-Income Ratio (DSTI)	Limits to the debt-service-to-income ratio and the loan-to-income ratio, which restrict the size of debt services or debt relative to income. They include those targeted at housing loans, consumer loans, and commercial real estate loans.
Loan-to-Deposit Ratio (LTD)	Limits to the loan-to-deposit ratio and penalties for high LTD ratios.
Currency Restrictions	
Limits on Foreign Currency (LFC)	Limits on foreign currency (FC) lending, and rules or recommendations on FC loans.
Limits on Foreign Exchange (LFX)	Limits on net or gross open foreign exchange (FX) positions, limits on FX exposures and FX funding, and currency mismatch regulations.

uncertainty in (intertemporal) distributional effects prevents interest groups from assessing the utility they could gain in the future more than those of the status quo without short-term costs. This possible heterogenous distributional effect leads some banks to consider them as net losers, which increases political transaction costs in democracies.

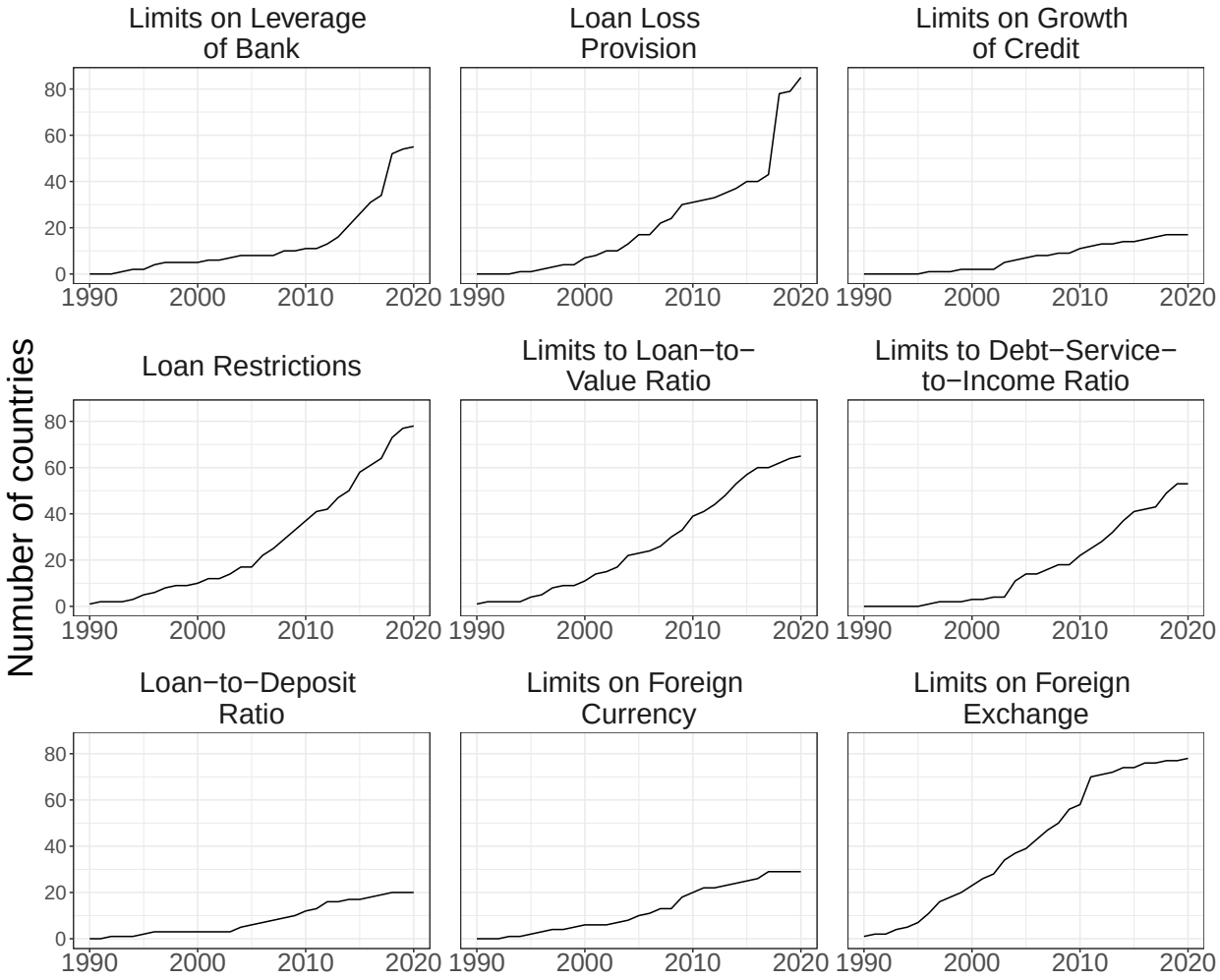

Figure 2.1: **Cumulative countries adopting macroprudential policies by policy tool.**

Source: International Monetary Fund (2014).

2.4.4 Measuring Macroprudential Policy

To operationalize and measure the implementation of macroprudential policy, I use a database collected by the IMF. This recently published integrated Macroprudential Policy (iMaPP)

database is a comprehensive examination of macroprudential policy, covering 17 policy instruments[4] for 134 countries from 1990 to 2020. This panel dataset covers the period before and after the GFC, which makes it advantageous for time series analysis compared to other data sets. For instance, the World Bank and Barth, Caprio, and Levine (2005) have conducted surveys for several banking regulations, but their data is limited to sample years of cross-section data, which limits robust causal inference. Demirguc-Kunt, Kane, and Laeven (2008) create time-series data on banking regulation, but they only examine one policy adoption, deposit insurance. This article is, to my knowledge, the first to use these richer IMF data to explore the causality of politics of banking regulation.

The database records a monthly binary variable for policy actions, which I annualized so as to treat the country-year as the unit of analysis. While the database captures the direction of policy actions, either tightening or loosening, this study focuses on the first adoption of each instrument in each country. Because macroprudential regulations are a novel tool for restricting credit expansion, the initial policy action in the study period is always a tightening of the regulation and is thus politically challenging. Thus, the initial policy adoption is a better measure of changes in regulatory frameworks than the changes in policy direction. In this analysis, I analyze nine demand-side policy tools listed in Figure 2.1 and Table 2.1.

2.5 Research Design

To analyze the effect of democracy on the adoption of macroprudential policy and the possible mechanisms through which democracy may influence policy adoption, I employ two different estimation strategies. The first strategy uses an event history model to study the timing of adoption and the democratic characteristics which affect it. Considering each policy adoption as an event, this method can capture the underlying probability of event occurrence, in this case, of macroprudential policy adoption across nine policy tools. The second estimation

[4] International Monetary Fund (2014) provides the detailed definitions of each macroprudential policy instrument.

strategy instead focuses on the relationship between large shifts in the political regime and the cumulative number of policies adopted, using a synthetic control method. Exploiting the timing of democratization, I employ the synthetic control method to draw a valid causal inference.

Explanatory variables

My primary explanatory variable is *Democracy*. In the first estimation with the event history model, I use the liberal democracy index (`v2x_libdem`) provided by the V-Dem project (Coppedge et al. 2022). In contrast to binary measures of political regime, the liberal democracy index quantifies granular differences between and within democratic countries and autocracies that could affect the timing of policy adoption. The latent factor score of democracy provided by the V-Dem is more suitable for a panel data model or event history model with time-variant covariates. By contrast, I employ the dichotomous variable of political regime in the second estimation. Because the synthetic control model and difference-in-difference methods generally assume the existence of a natural experiment, I use a dichotomous measure of democracy as a treatment variable. The Boix-Miller-Rosato Dichotomous Index (Boix, Miller, and Rosato 2013) codes legislative actions, electoral turnovers, internal coups, and external interventions as the turning point of democratization when a country satisfies conditions for both contestation and participation. Thus, their coding rule is consistent with a quasi-natural experiment assumption for synthetic control models.

In the event history models, I also examine the mechanism through which regimes aid or hinder banking regulation adoption. I consider two specific elements of democracy: 1) *Competitive Elections* (Vertical accountability), and 2) *Executive Constraints* (Horizontal accountability). I operationalize competitive elections using the electoral democracy index (`v2x_polyarchy`), the main component of the V-Dem liberal democracy index. The index quantifies the degree of suffrage, fairness and cleanness of elections. Likewise, to capture executive constraints, I use the legislative constraint on the executive index (`v2xlg_legcon`),

which is one of the components of the V-Dem liberal index. The index measures the degree to which the legislature and government agencies investigate and exercise oversight over the executive. Because the two variables, *Competitive Elections* and *Executive Constraints*, are highly correlated and difficult to disentangle in a single model, I estimate each effect separately.

Control variables

I also control for covariates that are linked to the adoption of macroprudential policies in the base model. First, I control for the effect of *Banking crisis*, which tends to increase the adoption of these policy tools. I take an updated version of the historical data of banking crises from Laeven and Valencia (2018) and convert it to a five-year moving average. Second, I include *GDP per capita* as a control variable that may impact the likelihood of adoption of macroprudential policy because, as countries develop economically, the banking sector tends to become more central to the economy.

I also conducted several additional analyses to test the robustness of the event history models. First, I consider a model that adds controls for the degree of crony expropriation. Since the political economy literature suggests that banking regulation can be employed as a rent-seeking tool by *any* regime, it is important to control for the government's predatory actions. I operationalize the effect of crony expropriation as *Corruption* because, while cronyism and corruption are not the same, they are strongly correlated. To capture corruption, I use the Indicator Quality Government (IQG) index provided by the International Country Risk Guide (ICRG) following the previous studies (Norris 2012; Menaldo 2016; Rosas 2006). The ICRG measures investors' perceptions of bureaucratic quality of governance, combining bureaucratic quality, anti-corruption, law, and order. If autocracies are more likely to adopt regulation than democracies, holding constant the quality of government, then it is less likely that differences between democracies and autocracies are the result of rent-seeking or reflective of differences in the presence of predatory regulation.

Second, I use capital account liberalization as an alternate measure of financial liberalization in my robustness checks. To attract foreign investment, governments may liberalize their domestic banking systems by opening their capital accounts. However, countries that take steps to increase foreign investment may be reluctant to impose additional regulations that may reduce their comparative advantage. I use an updated version of *Capital openness* measured by Chinn and Ito (2006).

Lastly, I control for the degree of financialization because less sophisticated banking systems require less regulation to prevent crises. I operationalize financialization as the log of private credit as a proportion of GDP. This variable is from the updated version of the Financial Development and Structure Dataset by the World Bank (Beck, Demirgüç-Kunt, and Levine 1999).

2.6 Results

2.6.1 Event History Analysis

I investigate the timing of macroprudential policy adoption using a Cox proportional hazard model that allows me to examine the common factors affecting policy implementation by stratifying baseline hazards across nine policy tools (Cox 1972; Box-Steffensmeier and Jones 2004). In this semi-parametric model, the baseline hazard rate flexibly captures global trends, such as the shared tendency of countries to adopt macroprudential policies in response to economic and political events, while leaving cross-state variation to be explained by covariates. Robust standard errors are clustered by country.

Table 2.2 shows the estimated coefficients of Cox proportional hazards regression are largely consistent with my theoretical expectations. In order to substantively interpret the results, Figure 2.2 highlights the relative risk of adoption associated with the democracy index. Each plotted point shows the change in the probability of adopting an additional macroprudential policy tool when the liberal democracy index moves from the 25th to 75th percentile among the sample countries. The top bar in Figure 2.2 indicates, all else equal,

Table 2.2: **Effect of Democracy on Macroprudential Policy.**

	DV: Macroprudential Policies on Lending and Currency Restrictions				
	(a)	(b)	(c)	(d)	(e)
Covariate	Base model				
Democracy	−0.563**	−0.770**	−0.497*	−0.921***	−0.932***
	(0.23)	(0.26)	(0.23)	(0.26)	(0.29)
Banking crisis	−0.039	−0.157	−0.066	0.194	0.062
	(0.26)	(0.28)	(0.27)	(0.27)	(0.29)
GDP per capita	0.097**	0.072	0.129**	−0.002	0.063
	(0.04)	(0.06)	(0.05)	(0.06)	(0.08)
Corruption		0.407			−0.001
		(0.46)			(0.56)
Capital account openness			−0.066		−0.125**
			(0.04)		(0.05)
Private Credit (% of GDP)				0.186	0.197
				(0.08)	(0.09)
Total country-years	28,033	23,466	26,489	25,040	20,394
Total countries	126	107	121	126	104
Total events	449	389	432	349	297
End of estimation year	2020	2020	2020	2017	2017
AIC	4,060	3,380	3,862	3,177	2,579
BIC	4,072	3,396	3,878	3,192	2,602

Note: *p<0.1; **p<0.05; ***p<0.01.
Robust country-clustered standard errors in parentheses.

the effect of changing the democracy index from autocracy (25 percentile, e.g., Kenya and Mexico in the early 1990s) to democracy (75 percentile, e.g., Canada and United Kingdom) reduces the probability of adopting an additional macroprudential policy tool in any given year by a statistically significant 26 percent (95% CI: 0.3% less likely to 50.0% less likely). Likewise, controlling for alternative explanations does not substantially change the effect of democracy on macroprudential policy adoptions. In the models controlling for a corrupted

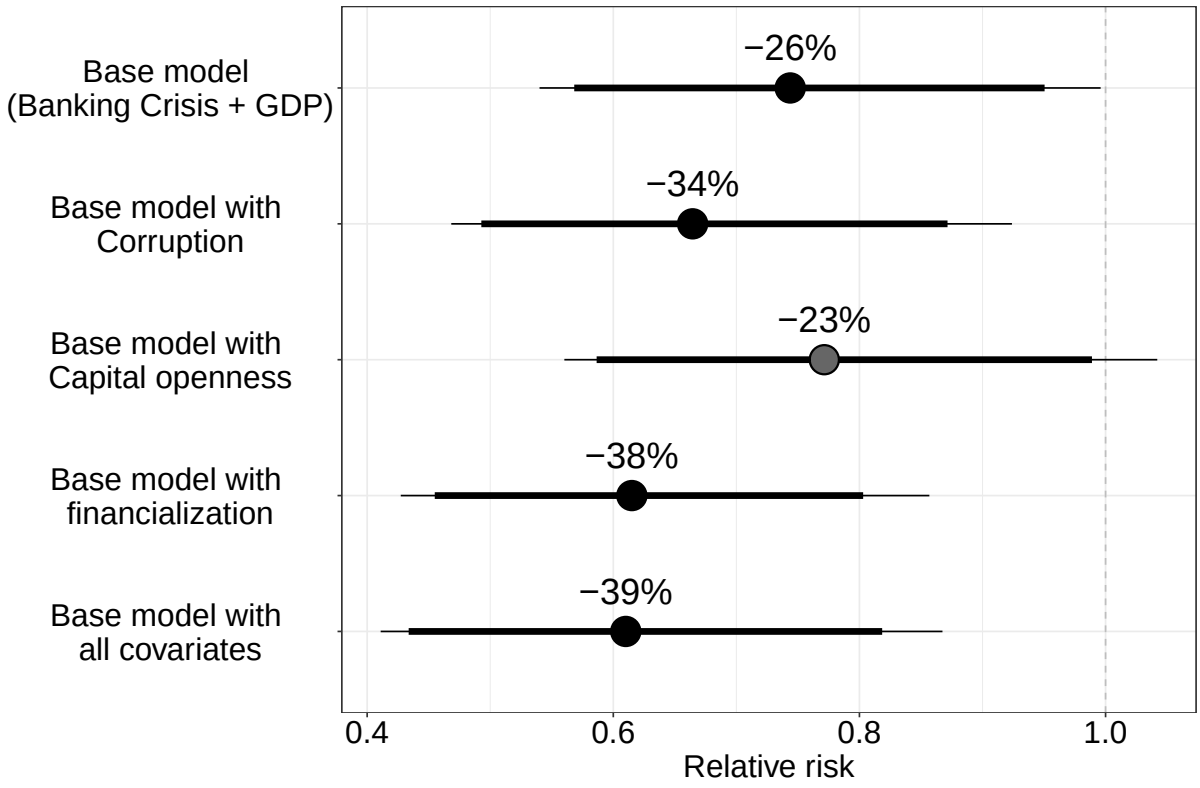

Figure 2.2: **Effect of Democracy on Macroprudential Policy**

Note: Horizontal thin and thick bars are the 95% and 90% confidence intervals, respectively. Dark, light, and white symbols indicate significance at the 5% level, and the 10% level, respectively.

system, and financialization, democracy reduces the probabilities of adopting an additional macroprudential policy by a statistically significant 33 percent (95% CI: 7.8% to 54.0%) and 38 percent (95% CI: 15.0% to 57.1%), respectively. While the model that controls for capital openness finds that the probability of adding policies is not statistically significant at 5% level, it is statistically significant at 10% level, and democracy reduces the probability by 23 percent. Lastly, the model with all covariates also is consistent with my theoretical expectation, showing that the probabilities of adding policies are decreased by 39 percent (95% CI: 12.8% to 58.7%).

2.6.2 Mechanisms

Next, I present the models that examine two mechanisms through which the democratic disadvantage occurs. I exploit *Competitive elections* and *Executive constraints* as the explanatory variables in separate models. I also conduct the same robustness checks as above by controlling for alternative explanations.

The results are reported in Figure 2.3 and Table A.1. I find the results are largely consistent with the hypotheses that both vertical and horizontal accountability have a significant negative impact on the adoption of macroprudential policies. The top red with circle bar in Figure 2.3 indicates that, all else equal, competitive elections reduce the probability of adopting an additional policy in a given year by a statistically significant 21 percent at the 10% level (90% CI: 2.0% to 39.4%) but not at the 5% level. However, in the model with all covariates, competitive election reduces by a statistically significant 32 percent at the 5% level (95% CI: 8.4% to 52.6%).

Likewise, the blue with triangle bars indicate the effect of *Executive Constraints*. In the base model, The result shows that executive constraints reduce the probability of adopting an additional policy in a given year by 14 percent, but it is not statistically significant at the 5% level (95% CI: -7.0% to 32.5%). However, overall, all results indicate the negative effect of executive constraints and are consistent with the theoretical expectation.

I also conducted the sensitivity analysis reported in Figure A.1 in Appendix. If one policy tool influences the entire result, the estimation result of excluding that policy tool will not hold a negative association between democracy and macroprudential policy adoption. To test this concern, I take a leave-one-out approach in the policy tool dependent variables. As expected, all nine results support the negative association.

2.6.3 Synthetic Control Analysis

While Cox proportional hazard models provide a simple and useful model for quantifying the relationship between regulatory adoption and fine-grained measures of democratization, in

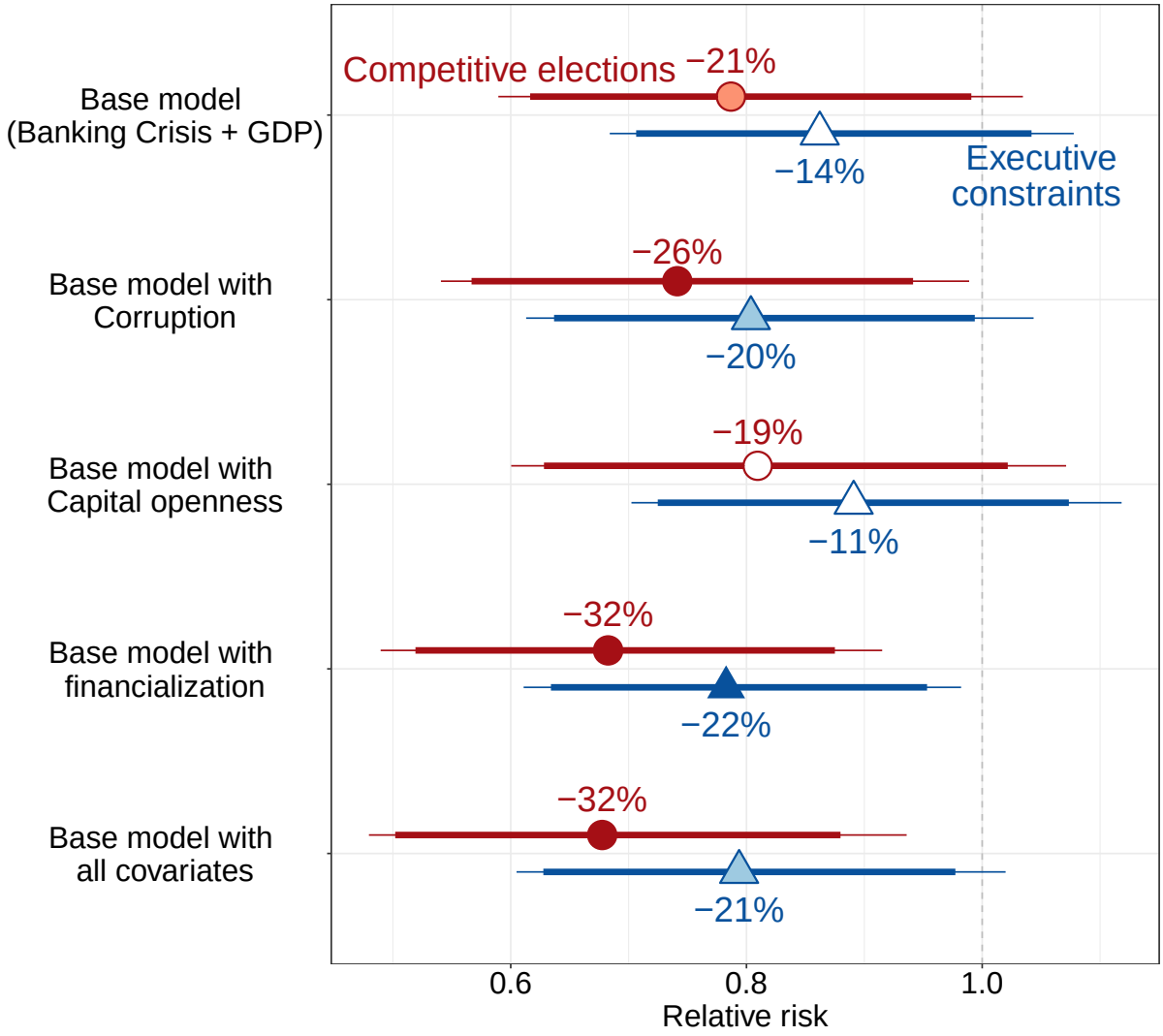

Figure 2.3: **Effect of Democratic Accountabilities on Macroprudential Policy.**

Note: Red circles and blue triangles indicate competitive elections (vertical accountability), and executive constraints (horizontal accountability). Horizontal thin and thick bars are the 95% and 90% confidence intervals, respectively. Dark, light, and white symbols indicate significance at the 5% level, the 10% level, and nonsignificance, respectively.

these models, causal identification rests on the assumption that treating observed covariates as having time- and country-invariant proportional effects on hazard rates accounts for all

time-varying confounders. To mitigate our reliance on this assumption (albeit at the cost of discarding higher precision measures of democracy), I exploit democratization as *treatment* to assume a quasi-natural experiment, using the generalized synthetic control (GSC) method Xu (2017) developed. Synthetic control models have become widely applied in comparative case studies to compare a treated unit with a synthetic control unit, a weighted average of the control units based on control variables (Abadie, Diamond, and Hainmueller 2010, 2015)[5]. In this study, using *Banking crisis* and *GDP per capita* as covariates, the method estimates simple trends of the outcome, the cumulative number of implemented macroprudential policies, for the treated countries and the synthetic unit. The trends are estimated to minimize the distance between the two in the pre-event period.

I select treatment countries in three steps. First, I use the dichotomous variable of political regime by Boix, Miller, and Rosato (2013) to identify democratizing events. Second, I select the treated countries that had a one-time regime change toward democracy between 2000 and 2010. Thus, I exclude those countries that experienced democratization before 2000 or after 2010 and those with multiple regime shifts because the first ten years of the dataset is important to mitigate overfitting, (Abadie 2021) and to keep the post-event period to capture gradual changes after the treatment. Third, I draw control countries from the set of countries that remained non-democracies throughout the study period. Based on three steps, eight treatment units are selected – Georgia (2004), Kenya (2002), Lesotho (2002), Mexico (2000), Paraguay (2003), Peru (2001), Senegal (2000), Zambia (2008) – and 31 countries are available for creation of synthetic controls.

Figure 2.4 shows the main findings of the analysis, presenting the effect of the regime shift on the implementation of macroprudential policies. The top panel (the "path" plot) shows the estimated trajectories of the cumulative implemented macroprudential policies for treatment and control countries, and the bottom panel (the "gap" plot) shows the estimated cumulative difference between the two. In the pretreatment period, both the path

[5] Xu (2017) extends this method to the case of multiple treated units and unbalanced panel data that fits to use regime changes that occurs at different timing across countries

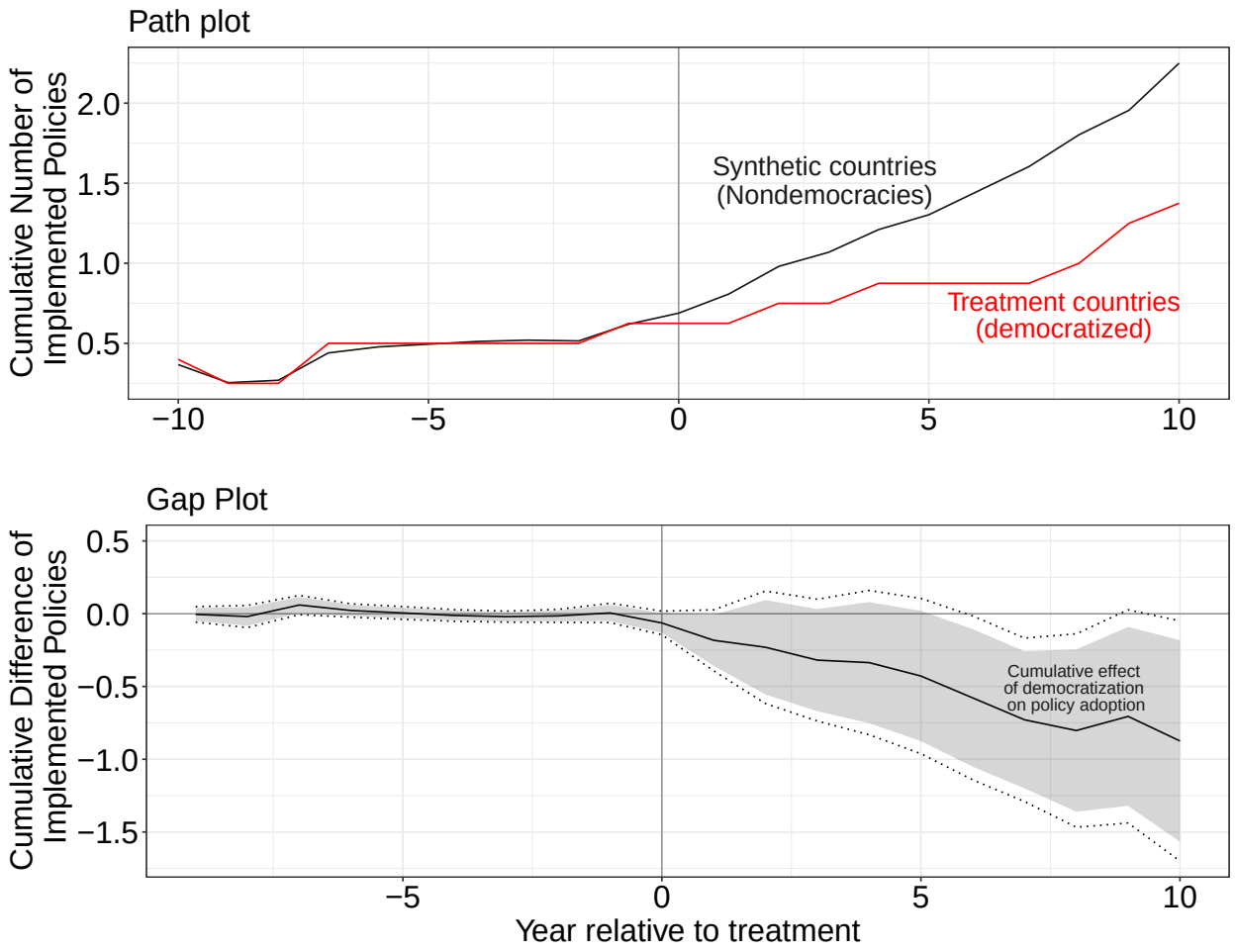

Figure 2.4: **Effect of Democratization on Cumulative Implementation of Macroprudential Policies.**

Note: Treatment countries included: Georgia (2004), Kenya (2002), Lesotho (2002), Mexico (2000), Paraguay (2003), Peru (2001), Senegal (2000), and Zambia (2008). Synthetic control countries are 31 countries. Shaded areas and dotted lines in the gap plot are the 90% and 95% confidence intervals, respectively.

plot and the gap plot show treated countries and control countries overlapping, suggesting the synthetic control estimator successfully constructs valid counterfactual units. On the other hand, the path plot indicates that democratized countries slow the pace of policy im-

plementation after the treatment event occurred, whereas the counterfactual units maintain their trend from the pre-treatment period. The gap plot also shows the estimated difference increases. For the 10 years following the event, the treatment countries implement roughly 1 fewer (0.87, 95% CI: 0.05 to 1.7) out of nine policies than control countries on average.

I also conducted several robustness tests. First, a key concern is overfitting due to the nonparametric estimation in the GSC method. I conduct an in-time placebo test that assigns the regime shift to the different dates five years before and after the date of the actual events. If the timing of increasing the difference between treatment and control countries in the placebo test does not change, the original estimation is causally plausible. Second, I conduct leave-one-out tests for control countries to check if one control country influences the entire result. As Figure A.2 and A.3 indicates, overall, the results of these tests are quite robust to these changes, suggesting the findings remain similar in substance.

2.7 Case Studies

In this section, I illustrate the causal mechanism of political regime on macroprudential policy implementation by looking at three countries that vary in their political regimes. The first case is the United States, a democratic country with an unusually large number of veto points. As the epicenter of the GFC, the US might be expected to have strong reasons to implement banking regulations to prevent future crises. However, as theoretically expected, strong and diversified veto players in the legislature preclude the implementation of more stringent regulations than international requirements. Moreover, short-termism led only to symbolic reform rather than the substantive delegation of regulatory power to the new authority. In contrast, reviewing China, one of the most stable single-party authoritarian states with centralized economic and regulatory institutions, the implementation process shows how macroprudential policies relate to the leader's ambition to stabilize the regime. China, leveraging a centralized decision-making process and with no need to fear short-term downfalls compared to democratic leaders, proactively reformed economic institutions to implement macroprudential policies for their long-term regime survival. In addition to

analyzing two countries that are solidly democratic or autocratic, I examine Hungary as a backsliding democracy that boosted the implementation of several diversified macroprudential tools after the nationalist government of Prime Minister Viktor Orbán came to power in 2010. In Hungary, an increasingly autocratic government employed macroprudential policy to achieve its financial nationalist goals.

2.7.1 United States: Fragmented, Stringent Constraints

Before the GFC, macroprudential policy tools were not implemented in the US. Adopted in 2010, the Dodd-Frank Act sought to legally define macroprudential regulations and decide which agencies would have authority to implement them. For instance, the Federal Reserve did not consider demand-side macroprudential tools as their policy option without clear statutory authority, seeing these policies as more interventionist (Edge and Liang 2020). However, Congress paid little attention to macroprudential policies. During the drafting of the Dodd-Frank Act, while some Democrats, such as Elizabeth Warren, argued that the Dodd-Frank Act should include more stringent capital requirements and investment restrictions, most Democrats focused on consumer protections instead of macroprudential regulations. On the other hand, GOP congressman Jeb Hensarling, who collaborated with industry lobbyists to pursue banking industry interests, opposed macroprudential regulation, claiming that regulations had contributed to economic stagnation (Stojkovic 2016). Thus, while the Dodd-Frank Act emphasized macroprudential regulation as an important component of the financial regulatory system, the Act did not authorize the use of demand-side macroprudential tools (Acharya, Engle, and Richardson 2012).

One of the institutional outcomes of the Dodd-Frank Act was to bring together the fragmented regulators— the Fed, the Federal Deposit Insurance Corporation, or Office of the Comptroller of the Currency, and others— as the Financial Stability Oversight Council (FSOC). However, the Act did not delegate macroprudential powers and responsibility of systemic risk to FSOC, nor to any single regulator (Goodhart 2015). Given this weak role

of the FSOC, Lombardi and Moschella (2017) argue that the Dodd-Frank is an example of symbolic delegation, in which the FSOC delegation reflects a short-term response by elected officials to show voters that they are taking action to fix past mistakes without having substantive policy delegation. As a result, the implementation of macroprudential policies in the US remained less stringent than in other countries.

2.7.2 China: Authoritarian Stability Trumps Accountability

The Chinese government implemented credit control tools before the financial crisis, including traditional window guidance (informal lending restrictions) as well as some macroprudential policy tools. For instance, in 2004, the China Banking Regulatory Commission (CBRC) imposed a maximum LTV ratio of 80% for loans for purchasing homes and a maximum DSTI ratio of 50% for borrowers to purchase homes. After the GFC, the Chinese government facilitated swift institutional reforms. The People's Bank of China (PBOC) first explicitly mentioned macroprudential policies as China's formal policy choice in the China Financial Stability Report 2010 and strengthened these policies in the 12th Five-Year Plan (2011–2016) for national development. Likewise, Xi Jingping delegated responsibility for "macro-prudential management and systemic risk prevention" to the PBOC in the 19th National Congress of the Chinese Communist Party in 2017. At the same time, fragmented financial regulators were centralized in the PBOC[6]. In effect, the PBOC assumed a "dual pillar" policy function, including both traditional monetary policy and macro-prudential management. This dual-pillar function was formalized in October 2020 when China's Central Bank Law was revised for the first time in 17 years (Kennedy and Wang 2021). These swift institutional changes, in contrast to the symbolic reform in the US, enabled the Chinese government and the PBOC to implement effective macroprudential policies.

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[6] In the 1990s, the PBOC used to be responsible for comprehensive supervision of the banking, securities, insurance, and trust industries, but it had split into the CBRC (established in 2003), China Securities Regulatory Commission (CSRC) (established in 1992), and China Insurance Regulatory Commission (CIRC) (established in 1998)(Klingelhöfer and Sun 2019)

Moreover, the concentration of macroprudential control was rooted in Xi's ambition to consolidate his power in the party. The ambition provides him with a longer-term view to proactively pursue financial stability because an economic crisis could reduce central government power. To address concerns about rising house prices and overinvestment in real estate, Xi and the PBOC adopted additional macroprudential approaches even during the economic slowdown. For instance, the bailout of Evergrande illustrates China's forward-looking macroprudential approach. In 2020, the PBOC introduced the Three Red Lines Policy[7], which aims to improve the financial condition of the real estate sector by reducing developers' leverage. As a result, Evergrande, a Chinese real estate company founded in 1996, faced liquidity issues, defaulting on some payments for its offshore bonds. In the short run, this new policy caused financial market distress, but in the long run, it contributed to deleveraging the Chinese economy. Meanwhile, Evergrande continued its operations with support from financial regulators and local governments. Moreover, the PBOC announced a new real estate loan concentration management system limiting the size of banks' loan assets. These policy implementations have been successful, in contrast to the discussion in the US, because of the top-down, centralized governance system of China's authoritarian regime.

2.7.3 Hungary: Becoming a Semi-Dictatorship

Once Orbán came to power, the Hungarian government increasingly employed macroprudential measures because he believed that the lack of government's power over financial institutions caused the 2002 election defeat (Johnson and Barnes 2015; Mérő and Piroska 2017; Piroska, Gorelkina, and Johnson 2021). To boost their implementation of macroprudential policies, Orbán delegated extraordinary power to the National Bank of Hungary (MNB). Similar to reforms in China, Orbán appointed his ally, György Matolcsy, as a gov-

[7] The three red lines are a liability-to-asset ratio over 70 percent, a net debt-to-equity ratio greater than 100 percent, and a cash-to-short-term-debt ratio less than 100 percent. Restrictions are placed on developer debt levels depending on the number of red lines that they cross.

ernor in 2013 and merged financial supervisory authority into the MNB. At the same time, he restructured the banking sector to distribute rents to his coalition by increasing domestic ownership in banking to over 50% and merging three banks during the process of reprivatization (Miklós and Simons 2021). One of outcomes was to adopt a macroprudential tool that mitigated the external vulnerability of the banking sector by converting foreign-currency-denominated funds into Hungarian forint. The BIS economists argue that the improving maturity structure of foreign funds has mitigated risks arising from the drying up of foreign liquidity and the consequent intensification of exchange rate volatility (Balog et al. 2015). Overall, the MNB has effectively managed the Hungarian domestic financial sector (International Monetary Fund 2017). While, in order to extend his tenure, Orbán's ambition of employing macroprudential policy serves an authoritarian, and perhaps corrupt purpose, the outcome of the policy implementation results in a robust financial system.

2.8 Conclusion

The theoretical and empirical analyses presented in this article help explain why democracy does not yield best outcomes in macroprudential policy. Unifying the literature on the short-termism of democratic decision-making and policy stagnation stemming from multiple veto players, my theory states that vertical and horizontal accountabilities in democracies limit macroprudential policy implementation because retrospective policy evaluation is difficult, and heterogenous distributional effects increase the cost of veto bargaining. In contrast, authoritarian leaders have less fear of short-run economic downfalls than democratic leaders and thus have more reason to focus on regulatory reforms to implement macroprudential policies for their long-term regime survival. As the China and Hungry cases illustrated, because authoritarian leaders take advantage of their consolidated powers in the banking sector, authoritarian regimes are, all else equal, about 25% more likely to implement macroprudential policy than democracies. The empirical result also shows that democratization causes one fewer cumulative implementation out of nine policy tools. The finding suggests that democratic countries may not be adequately prepared for future banking crises.

The mechanism of democratic disadvantage indicated in this article advances the literature on democratic governance. Recent studies argue that authoritarian states may have advantages in dealing with sweeping challenges such as pandemics and climate change, because they are more likely to restrict civil liberties than are democracies (Cheibub, Hong, and Przeworski 2020; Thomson and Ip 2020; Cepaluni, Dorsch, and Branyiczki 2022; Beeson 2018), but a few studies focus on how the democratic accountability system can cause inefficient policy implementation (von Stein 2022). In pandemic response, for instance, policymakers may not be rewarded by voters in the long-term because the success of policy response results in controlling the spread of infection, in which voters may not retrospectively evaluate the policy effects. Moreover, given the amount of negative externalities produced by climate change, the heterogeneity of possible winners and losers created by policy measures makes the transaction costs for stakeholder bargaining high, and thus it is likely to lean toward maintaining the status quo under a political system with high horizontal accountability. The mechanisms of democratic disadvantage shown in this article should open a further investigation into the politics of policy response to these global challenges.

Finally, my results provide a potential avenue to investigate how democracy may overcome its disadvantage through delegation. Future research should examine these domestic delegation processes that could be insulated from electoral pressure, not only in the area of banking regulation but also in other policy fields. Additionally, creating international standards could be another solution to democratic disadvantages, as the Basel Committee on Banking Supervision has played a critical role in shaping macroprudential regulation and compliance. However, their autonomy has also been encroached upon by interstate politics, resulting in the setting of limited international standards. Thus, future studies may also analyze the delegation forms to international organizations that could be effective for unknown future crises.

Chapter 3

ESTIMATING WAVES OF TEMPORAL HETEROGENEITY: A TIME-VARYING PARAMETER MODEL APPROACH

Kenya Amano and Jouchi Nakajima

Abstract

Recent methodological developments in changepoint models have successfully identified structural changes in time-series cross-sectional data analysis. However, these models ignore gradual changes that happen over prolonged periods. Some scholars have developed theories to explain these slow-moving political relationships, but there are few statistical tools to empirically test these theories. To help researchers better analyze gradual changes, we propose the use of a Bayesian methodological strategy for time-varying parameter models to identify slow-moving structural changes. Specifically, we develop a time-varying parameter probit (TVPP) model, which estimates a time-varying relationship between a binary response and explanatory variables. We illustrate the utility of the TVPP models using simulated data and examples drawn from two important debates in democratization studies: (i) the identification of shifting relationships between oil wealth and democratization and (ii) the effects of income on democratic transition and consolidation. In both applications, we find that the proposed method successfully identifies substantively meaningful slow-evolving heterogeneity over sample periods.

3.1 Introduction

Political scientists analyze statistical relationships from time series data to test their theories. Time series analysis faces methodological challenges if there are hidden structural changes in the data-generating process. A simple econometric model that assumes the effect on a coefficient is constant over time results in model misspecification and omitted variable bias when the data have temporal heterogeneity. Recent developments in changepoint models have proposed methods to identify these hidden breaks (Western and Kleykamp 2004; Spirling 2007; Park 2011, 2012; Hermansen, Knutsen, and Nyg 2021; Kent, Wilson, and Cranmer 2022; Park and Yamauchi 2023). The models have also been widely used in applied work in political science such as the study of courts (Hendershot et al. 2013; Pang et al. 2012), Congress Smith et al. (1999); Wawro and Katznelson (2014), civil war and battle death (Cederman, Gleditsch, and Wucherpfennig 2017; Cunen, Hjort, and Nyg 2020), terrorist attacks (Brandt and Sandler 2010; Santifort, Sandler, and Brandt 2013) and democratization and democratic consolidation (Hermansen, Knutsen, and Nyg 2021; Svolik 2015).

However, these models ignore gradual structural changes that happen over prolonged periods. If the causal relationship between x and y shifts immediately after a breakpoint, changepoint models may be appropriate to estimate the structural change. But political relations could be sticky and slow-moving. Theoretically, in the literature on institutional changes—- historical institutionalism in particular—, scholars have reexamined the assumption of *punctuated equilibrium* that causal processes and institutional changes unfold very rapidly, instead of considering the possibility that these changes can occur slowly and over time (Abbott 2001; Mahoney 2000; Mahoney and Thelen 2009; Thelen 2004; Pierson 2004; Sewell 2005; Tilly 1995; Gerschewski 2021). When the true relation slowly shifts from State A to State B, changepoint models misspecify the breakpoint as a one-time equilibrium shift. For instance, assume the demise of the Soviet Union and the end of the Cold War is a *critical junctures* (e.g. Fukuyama 1992); the changepoint model is forced to assume that many things in social relations would all change within just one year before and after 1991 because

most studies of comparative politics and international relations use country-year as a unit of analysis. However, political actors and institutions exhibit path dependence, which can slow down the pace of change even when there is a clear exogenous event (Pierson 2004; Mahoney 2000; Mahoney and Thelen 2009). If the true political relationships change gradually, the abrupt shift assumption may cause biased results.

In this paper, we propose the use of time-varying parameter models to identify gradual structural changes. Based on previous research that uses a nonlinear state space model (Frühwirth-Schnatter and Wagner 2006; Park 2010; Martin and Quinn 2002), we develop Time-Varying-Parameter Probit (TVPP) model that enables us to capture incremental changes in the underlying structural relationship between a binary outcome and explanatory variables. We also extend the TVPP model to the dynamic probit model, which is widely used in democratization studies, to estimate the dynamic process of the binary outcome variable by including the lagged outcome variable. The TVPP model assumes that the time-varying parameters follow random-walk processes in the data-generating process, while the changepoint model assumes discrete changes between a finite number of hidden regimes. To estimate the latent random-walk processes within time-series data, we employ Kalman filtering and simulation smoother, which we embed within Markov chain Monte Carlo (MCMC) estimation of our model, following the Bayesian approaches proposed by the previous studies (Frühwirth-Schnatter and Wagner 2006; Carter and Kohn 1996; de Jong and Shephard 1995; Martin and Quinn 2002).

This framework has several benefits. First, it allows researchers to estimate the changes without assuming the number of breaks, which is required for the changepoint models. Second, the TVPP models are more robust to model misspecification and attenuation bias than changepoint models when the relationship between outcome and explanatory variables gradually changes over time. We show in our simulation studies that the attenuation bias in the changepoint model could produce underestimates of the coefficient shift or even false positives. Lastly, this estimation framework also allows us to answer substantively interesting questions through counterfactual simulations. In one application, we show how the

trajectory of the quantities of interests would have changed when the time-varying parameter would have been fixed at a certain level compared to what actually happened.

After evaluating the performance of the TVPP models relative to changepoint models with simulated data, we illustrate the proposed methodology by applying it to two studies in democratic transition and consolidation. As Huntington (1991) describes, the data generation process of causes of democratization changes across and within the *waves* of democracy, and thus the political relations to democratic transition and consolidation are long-term, slow-moving phenomena. We first reinvestigate the proposition by Ross (2012) that oil income had a more pronounced negative effect on democratization after the 1970s. Consistent with Andersen and Ross (2014) and Ross (2012), the TVPP model finds empirical evidence that the oil's nondemocratic effects gradually emerged during the 1980s. Next, revisiting a controversy on the relationship between economic development and democratization, we examine the temporal heterogeneity in the relationship by employing the dynamic probit version of the TVPP models. We find the positive and statistically significant effect of income on democracy has gradually decreased since the beginning of the twenty century, and the effect becomes statistically insignificant after the demise of the Soviet Union and the end of the Cold War.

Finally, we see our contribution as two-fold. First, we propose to employ time-varying parameter models to identify gradual structural changes by developing the method for binary data. In political science, Beck (1983) first introduced the idea of time-varying parameter models to identify structural breaks. Martin and Quinn (2002) estimate the time-varying location of the median justice in the U.S. Supreme Court using dynamic ideal point estimation. Park (2010) also proposes a time-varying parameter model in count data. However, political scientists have underestimated the time-varying parameter approach in empirical applications compared to changepoint models. This is to our knowledge the first to demonstrate that the time-varying parameter approach has advantages in diagnosing the slow-moving changes in political relationships, which the studies of historical institutionalism value. Second, the two applications identify temporal heterogeneity in the relations to democratic transition and

consolidation. In particular, the magnitude of the relationship between income and democracy gradually wanes over time, showing the gradual structural changes that occurred during the first and second reversals of democratization. More strikingly, the relationship becomes statistically insignificant after the demise of the Soviet Union and the end of the Cold War. The empirical results partly support the theories in the previous democratization studies, in which change in the international system influences the democracy-income relationship. We also demonstrate the counterfactual analysis using the time-varying parameters that may generate hypotheses, forming a basis for future research.

3.2 Empirical Strategies: Time-Varying Parameter Approach

Our time-varying parameter modeling methodology draws on a state space model developed by de Jong and Shephard (1995) and West and Harrison (1997) and later extended to nonlinear models, such as the Poisson process (Frühwirth-Schnatter and Wagner 2006). In political science, Park (2010) and Park (2011) introduce the changepoint models using this technique for binary and ordinal response data, while Martin and Quinn (2002) conduct the time-varying parameter for binary data in the context of ideal point estimation. Based on these previous studies, we extend the simple probit and the dynamic probit model with the time parameters evolving over time.

3.2.1 Time-Varying Parameter Probit Model

Consider a standard probit model in a panel-data form:

$$y_{it} = \begin{cases} 1 & (\text{if } z_{it} > 0) \\ 0 & (\text{if } z_{it} \leq 0), \end{cases} \tag{3.1}$$

$$z_{it} = \boldsymbol{x}_{it}'\boldsymbol{\beta} + \mu_i + e_{it}, \quad e_{it} \sim N(0,1). \tag{3.2}$$

where y_{it} is the binary response of individual (country) i at time t, for $i = 1, \ldots, I$, and $t = 1, \ldots, T$, $\boldsymbol{x}_{it}$ is a $k \times 1$ vector of explanatory variables, $\boldsymbol{\beta}$ is a $k \times 1$ vector of coefficients,

and μ_i is an individual fixed effect.

We extend the probit model with time-varying coefficients:

$$y_{it} = \begin{cases} 1 & (\text{if } z_{it} > 0) \\ 0 & (\text{if } z_{it} \leq 0), \end{cases} \tag{3.3}$$

$$z_{it} = \boldsymbol{x}_{it}'\boldsymbol{\beta}_t + \mu_i + e_{it}, \quad e_{it} \sim N(0,1), \tag{3.4}$$

$$\boldsymbol{\beta}_{t+1} = \boldsymbol{\beta}_t + \boldsymbol{v}_t, \quad \boldsymbol{v}_t \sim N(0, \boldsymbol{\Sigma}), \tag{3.5}$$

where $\boldsymbol{\beta}_t = (\beta_{1t}, \ldots, \beta_{kt})'$ is a $k \times 1$ vector of *time-varying coefficients*. Each of the time-varying coefficients, β_{it}, follows a first-order random-walk process with the covariance matrix in equation (3.5) assumed to be diagonal such that $\boldsymbol{\Sigma} = \text{diag}(\sigma_1^2, \ldots, \sigma_k^2)$.[1] We assume that $\boldsymbol{v}_t$ and e_{it} are mutually independent.

We model the TVPP with unit fixed effects to control for unit-specific factors, as formulated by the fixed effect parameter μ_i in equation (3.4). Because studies in comparative politics and international relations frequently use country-year time-series cross-section data that face omitted variable bias, it is important to remove time-invariant heterogeneity within units (countries).

3.2.2 Extension to Dynamic Probit Model

We extend the TVPP model to the dynamic probit model. The dynamic probit model is widely used in political science, in particular, studies of democratization as Przeworski

[1]The random-walk process allows both temporary and permanent shifts in the coefficients. The drifting coefficient is meant to capture a possible non-linearity, such as a gradual change or an abrupt structural break. In practice, this assumption implies a possibility that the time-varying coefficients capture not only the true movement but also some spurious movements because the coefficient can freely move under the random-walk assumption under the risk of overfitting. In other words, there is a risk for the time-varying coefficients to overfit the data if the relations of y_{it} and x_{it} are obscure. If one assumes the time variation of the relationship between the response and explanatory variables stationary, an alternative approach is to make the time-varying coefficient follow a stationary autoregressive process such as AR(1) model.

et al. (2000) first employ this model to estimate the effect of income on democratization (Boix and Stokes 2003; Dunning 2008; Houle 2009; Przeworski et al. 2000). The model allows us to estimate the asymmetric impacts of income on the shift from an authoritarian regime to democracy and from democracy to authoritarianism in one regression. In the democratization literature, for instance, the dynamic probit model uses the dichotomous measure of democracy as the dependent variable ($y_t = 1$ if the country is democracy at the time t), and interacts with the lagged dependent variable (y_{t-1}), political regime in the previous period, with each of independent variables. Using the estimates of each independent variable and its interaction variable with the lagged dependent variable, one can interpret the coefficients on each independent variable as their probability of democratization, which is from autocracy ($y_{t-1} = 0$) to democracy ($y_t = 1$), whereas the sum of the coefficients on each independent variable and the interaction variables reflect their probability of democratic consolidation, which is from democracy ($y_{t-1} = 1$) to democracy ($y_t = 1$).

Specifically, in the TVPP model above, we replace equation (3.4) by the dynamic probit representation as

$$z_{it} \;=\; \boldsymbol{x}_{it}'\boldsymbol{\beta}_t + (y_{i,t-1}\boldsymbol{x}_{it})'\boldsymbol{\gamma}_t + \mu_i + e_{it}, \tag{3.6}$$

where $\boldsymbol{\beta}_t$ is the vector of coefficients associated with the transition from autocracy $(t-1)$ to democracy (t), while $\boldsymbol{\gamma}_t$ is the $k \times 1$ vector of coefficients associated with the state holding democracy between $t-1$ and t. Note that, when $\boldsymbol{y}_{i,t-1} = 1$, the right-hand side of the equation reduces to $\boldsymbol{x}_{it}'(\boldsymbol{\beta}_t+\boldsymbol{\gamma}_t)+\mu_i+e_{it}$, where $\boldsymbol{\beta}_t+\gamma_t$ measures the impact of the explanatory variables on the probability of democratic consolidation.

3.2.3 Bayesian estimation

To estimate the TVPP model, we employ a Bayesian estimation strategy. The likelihood of the model defined by equations (3.3)–(3.5) includes so many latent variables $(\boldsymbol{\beta}_1, \ldots, \boldsymbol{\beta}_T)$ that implementing a standard maximum likelihood estimation is computationally challenging. To

overcome it, we take an approach of Bayesian inference and utilize the MCMC method in our analysis of the TVPP model. The Bayesian estimation for the standard Probit model with a Gibbs sampler has been well established (see, e.g., Chib and Greenberg 1996; Koop 2003). We extend the sampler to the one that explores a posterior distribution of the TVPP model. A key aspect of the sampling method is that the equations form a linear and Gaussian state-space model, conditional on z_{it}. de Jong and Shephard (1995) develop an efficient MCMC sampler for the linear and Gaussian state space model, which we employ in our estimation method. Their efficient sampler generates a sample from the joint posterior distribution of $(\boldsymbol{\beta}_1, \ldots, \boldsymbol{\beta}_T)$. With this sampler, the MCMC converges more quickly than the one that uses posterior sampling from each posterior distribution of $\boldsymbol{\beta}_t$ given $(\beta_{t-1}, \beta_{t+1})$ and other parameters recursively for $t = 1, \ldots, T$.

Let $\boldsymbol{y}$ be all the responses of $\{y_{it}\}$, for $i = 1, \ldots, I$, and $t = 1, \ldots, T$. Note that the panel data $\boldsymbol{y}$ do not need to be balanced. A modification of the sampler for unbalanced-form of panel data is straightforward. Define $\boldsymbol{\beta} = (\boldsymbol{\beta}_1, \ldots, \boldsymbol{\beta}_T)$, $\boldsymbol{\mu} = (\mu_1, \ldots, \mu_I)$, and $\boldsymbol{\sigma} = (\sigma_1, \ldots, \sigma_k)$. Further define $\boldsymbol{z}$ as all the collections of $\{z_{it}\}$.

Setting priors $\pi(\boldsymbol{\mu})$ and $\pi(\boldsymbol{\sigma})$ for the parameters $\boldsymbol{\mu}$ and $\boldsymbol{\sigma}$, respectively, we obtain the full joint posterior distribution of the TVPP model conditional on data $\boldsymbol{y}$ given by

$$\pi(\boldsymbol{\beta}, \boldsymbol{\mu}, \boldsymbol{\sigma}, \boldsymbol{z}|\boldsymbol{y}) \propto \pi(\boldsymbol{\theta}) \cdot \prod_{i,t} f(y_{it}|z_{it})\pi(z_{it}|\boldsymbol{\beta}, \boldsymbol{\mu}) \cdot \prod_{t=1}^{T-1} \pi(\boldsymbol{\beta}_{t+1}|\boldsymbol{\beta}_t, \boldsymbol{\sigma}). \tag{3.7}$$

We develop the MCMC algorithm for generating samples from the full posterior distribution. Specifically, we propose the following posterior sampler:

MCMC algorithm for the TVPP model

1. Sample $\boldsymbol{z} \,|\, \boldsymbol{y}, \boldsymbol{\beta}, \boldsymbol{\mu}$

2. Sample $\boldsymbol{\beta} \,|\, \boldsymbol{y}, \boldsymbol{z}, \boldsymbol{\mu}, \boldsymbol{\sigma}$

3. Sample $\boldsymbol{\mu} \mid \boldsymbol{y}, \boldsymbol{z}, \boldsymbol{\beta}$

4. Sample $\boldsymbol{\sigma} \mid \boldsymbol{\beta}$

The detail of each sampling step is described in Appendix.

Finally, one reason to prefer Bayesian estimation for this model is to include unit fixed effects without concerning a bias caused by fixed effects. Generally, we might have a biased estimate when we estimate a binary response model such as the probit- and a logit-type panel data analysis with fixed effects. It is also well known that the dynamic binary model with fixed effects causes incidental parameter problems (Neyman and Scott 1948; Lancaster 2000). Suppose that the number of time periods, T, is fixed, then an estimate of the coefficient, β, is severely biased because the number of nuisance parameters grows quickly as the number of unit fixed effects increases. However, we can avoid this problem in the Bayesian approach as suggested by previous studies (e.g., Lee 2016), following the idea of conditional logit approach by Chamberlain (1980). The Bayesian approach constructs a sequence of samplers to assess a joint posterior distribution as a whole, where each sampler generates a sample from the posterior distribution conditional on other parameters in the model, as in the MCMC algorithm explained above. It means that a part of the samplers is based on the conditional logit model, which avoids the problem as Chamberlain (1980) proposed.

3.3 Simulation Study

In this section, we will evaluate our estimation strategy using simulated data. We generate binary time series data for time length $T = 50$ with three scenarios for structural breaks. The time series data include the $k = 2$ explanatory variables in $\boldsymbol{x}_{it}$ and the time-varying parameters, (β_{1t}, β_{2t}). The first scenario (a) is the *Punctuated Equilibrium* case, in which the parameter abruptly shifts from one level (State A) to the other (State B) at a certain breakpoint. We specify the change point at $t = 26$, in the middle of the $T = 50$ sample period from no effect (($\beta_{1,1} = 0$) to 10 for β_{1t}, and 10 to no effect for β_{2t}. Second, we generate data with a gradual structural change, which we label scenario (b). The parameter in this scenario

starts increasing from zero for β_{1t} (decreasing from 10 for β_{2t}) in the early period of the sample at $t = 11$, and continues to increase (decrease) until the end of the estimation period. Lastly, we consider the gradual shift reaches a new equilibrium in scenario (c). The parameter in this scenario starts and changes the same as scenario (b), but it ends its evolution in the later period at $t = 40$ until the end of the estimation period. We also examine different sizes of units in the panel data. As the number of units grows, generally, we have more information on the time-varying parameters at each time point. Specifically, we generate data with the number of units, $I = (20, 40, \ldots, 120)$. Note that we include the unit effect in this simulation as we have modeled above, which is generated from the uniform distribution $U[-1, 1]$.

Table 3.1: **Average of the First and Last 10 Periods of Estimated Coefficients ($\boldsymbol{\beta}_{2t}$).**

			First 10 period ($t = 1, \ldots, 10$)	Last 10 period ($t = 41, \ldots, 50$)	Diff. between First and Last
(a)	**Abrupt scenario**	**Truth**	10	0	-10
		CP	9.98*	-0.2	−10.2*
			[9.2 – 10.8]	[-0.5 – 0.2]	[-10.6 – -9.7]
		TVPP	9.84*	-0.6	−10.5*
			[7.9 – 11.8]	[-2.0 – 0.8]	[-11.0 – -9.9]
(c)	**Gradual with new equilibrium scenario**	**Truth**	10	0	-10
		CP	7.7*	1.8†	−5.9*
			[7.2 – 8.3]	[1.5 – 2.1]	[-6.2 – -5.6]
		TVPP	10.7*	0.2	−10.5*
			[8.7 – 12.7]	[-1.0 – 1.4]	[-11.3 – -9.7]

Note: The table summarizes the model performances for the TVPP and changepoint models by calculating the averages of the first and last ten periods of the estimated coefficients, based on $\boldsymbol{\beta}_{2t}$ for scenario (a) and (c) in Figure 3.1.
* and † indicate significance at the 5% level and false positive, respectively.

We estimate the TVPP and changepoint models for these three scenarios to compare their performances. As for the changepoint model, we employ the model and the MCMC algorithm developed by Park (2010), where the coefficients shift from the regime $s = 1$ to $s = 2$ with the probability p. In the MCMC estimation for both models, we draw 5,000 samples after the initial 500 samples are discarded as a burn-in period. With this iteration

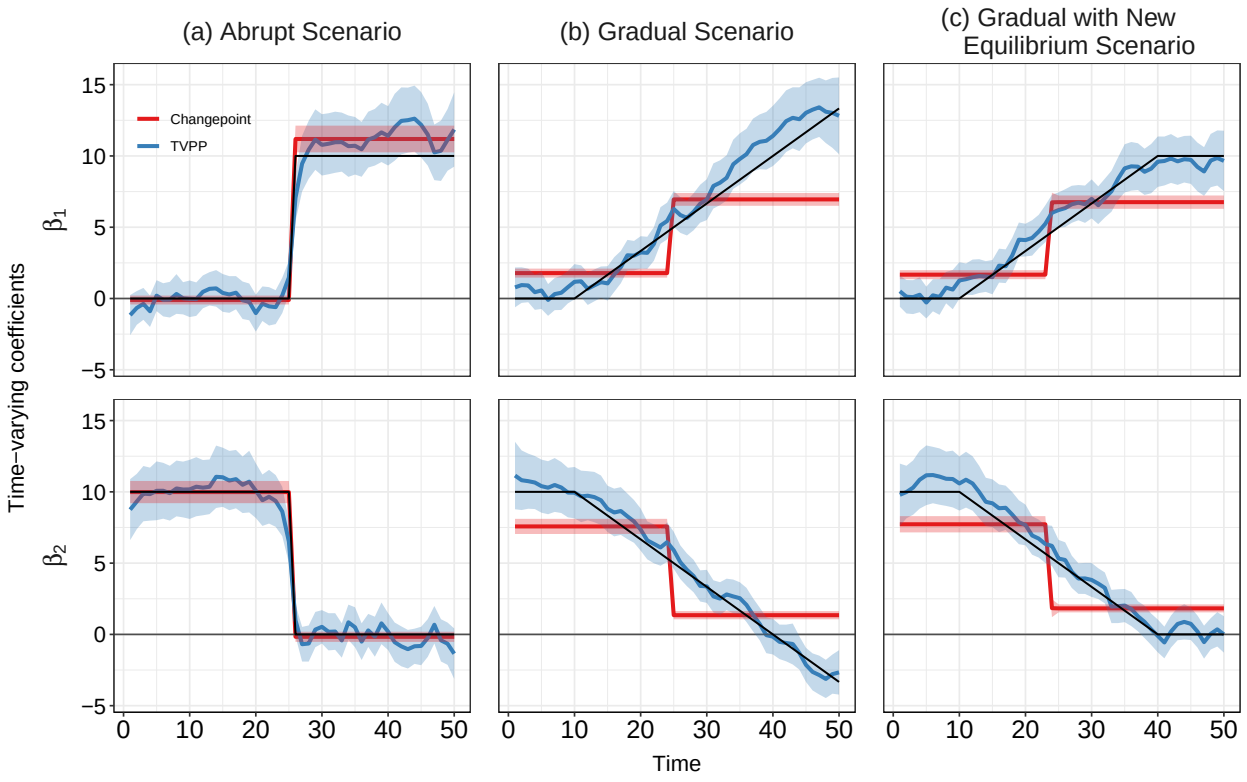

Figure 3.1: **Simulation Outcomes for the TVPP and the Changepoint Models.**

Note: Simulation outcomes from 50 sets of simulated data. The black, blue, and red lines are true values, the posterior means of the TVPP model, and those of the changepoint model, respectively. Shaded areas indicate 95% confidence intervals.

size, we found that the MCMC sequence converged well. We set up the following priors: for the TVPP model, $\mu_i \sim N(0, 1)$, $\sigma_j^2 \sim IG(25, 25)$, for $j = 1, 2$, and $\boldsymbol{\beta}_{1t} \sim N(\mathbf{0}, 100\boldsymbol{I})$, where IG denotes the inverse gamma distribution; and for the changepoint model, $\boldsymbol{\beta}_s \sim N(\mathbf{0}, 100\boldsymbol{I})$, for $s = 1, 2$, and $p \sim B(10, 1)$.

Figure 3.1 illustrates the estimated parameters from the TVPP (blue line) and the changepoint model (red line) against the true value (black line). Note that we obtain them using one dataset simulated each from (a) abrupt scenario, (b) gradual scenario, and (c) gradual with new equilibrium scenario with 100 units ($I = 100$). The solid and shaded areas indicate

the posterior means and 95% credible intervals, respectively.

For Scenario (a), it is evident that the estimate of the changepoint model largely traces the true values. In particular, β_{2t} in the bottom-left panel for the changepoint model traces almost exactly the true values. The TVPP model also works well as it captures the regime shift, although the estimate fluctuates to some extent. For Scenario (b), the TVPP largely follows the true value, while the changepoint model works poorly. The changepoint model yields the regime shift as it occurs around $t = 25$ with the estimate of the pre-break and post-break regime apart from the true value. Despite the fact that the true value in the beginning (end) of the estimated period is zero (negative) for β_{1t} (β_{2t}), the changepoint model indicates the false positive relationship. In contrast, the TVPP model traces the true values well, and its estimate is statistically insignificant at the beginning of the estimated period for β_{1t}. Likewise, β_{2t} is negative and statistically significant at the end of the period. The attenuation bias produced by the changepoint model does not change even if the true value reaches a new regime in Scenario (c). In the same way, the TVPP model works better than the changepoint model in Scenario (c). Because the TVPP model can capture both the incremental slope shift and regime change, the TVPP model can trace the true values better than the changepoint model, which assumes a discrete regime change.

We also compare the magnitudes of structural changes between Scenario (a) and (c), by computing the average of the posterior means of $\boldsymbol{\beta}_{2t}$ for the first and last 10 periods of the sample (first: $t = 1, \ldots, 10$; last:$t = 41, \ldots, 50$). The true value starts from 10 and decreases to zero. The rightmost column of Table 3.1 indicates the difference in the average of the posterior means between the first and last periods. In (a) an abrupt scenario, the changepoint model estimates the difference that is about the same as the truth value, while the TVPP model has a slightly larger impact and a wider credible interval. On the other hand, in (c) a gradual with a new equilibrium, the changepoint model estimates the smaller magnitude of the structural change (-5.9) than the true value (-10) and the TVPP model (-10.5) because the changepoint includes transitional periods as the post-break effect. Moreover, the average of the last 10 periods in the changepoint model indicates a positive

and statistically significant result (1.8), causing a false positive indicated as † in Table 3.1.

To further evaluate the performance of each model, we compute the root mean squared estimation error (RMSE) of the posterior draws. Let β_{it} denote the true value and $\beta_{it}^{(g)}$ denote samples generated at g-th iteration of the MCMC. Following Park (2011, 2012), we compute the RMSE as follows:

$$\text{RMSE}_{\boldsymbol{\beta}} = \sqrt{\frac{1}{G}\sum_{g=1}^{G}\left\{\frac{1}{(t_1 - t_0 + 1)p}\sum_{t=t_0}^{t_1}\sum_{i=1}^{p}\left(\beta_{it}^{(g)} - \beta_{it}\right)^2\right\}}, \tag{3.8}$$

where G is the iteration size of the MCMC samplers. We set the evaluation period as the one in which we specify the gradual change, $t_0 = 15$ and $t_1 = 35$. We repeat the estimation for 50 sets of data, where we compute this RMSE for each simulation and average the RMSE across 50 sets.

Figure 3.2 shows the RMSE in the changepoint model (red line) and the TVPP model (blue line) for each simulation with different sizes of units as indicated by the horizontal axis. As expected, the changepoint model has smaller RMSEs than the TVPP model in (a) abrupt change scenario, but the TVPP model outperforms the changepoint model in (b) gradual change scenario and (c) gradual with new equilibrium scenario. Moreover, while the estimation errors accumulated in the changepoint model as the number of units increases, the TVPP sharply decreases the RMSE when the number of units increases. This result confirms that our TVPP model performs practically well, capturing both the gradual and abrupt changes in the data-generating processes.

3.4 Application 1: Democracy and Natural Resource

Our first application is the political relationship between resource wealth and democracy. Besides income, resource wealth, especially petroleum, is considered the primary factor of regime stability. The debate over the political resource curse, the claim that higher levels

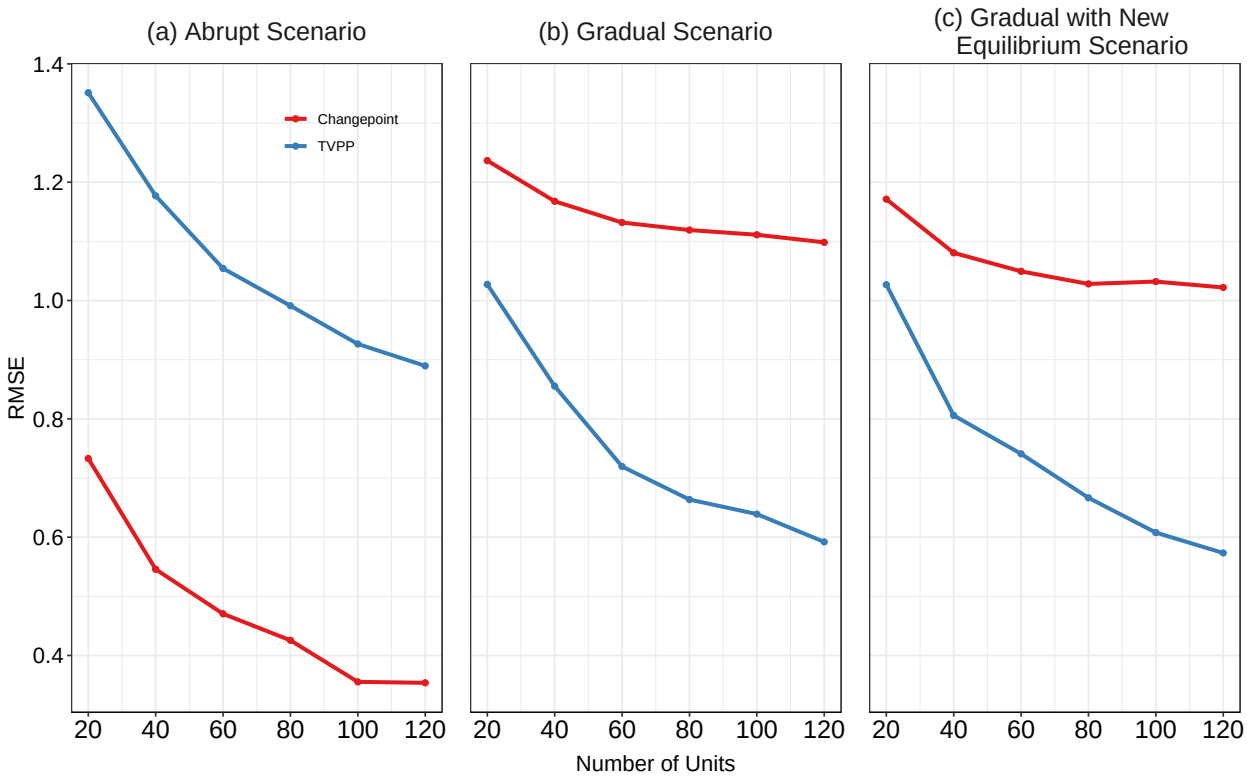

Figure 3.2: **Root Mean Squared Error of the TVPP Model and the Changepoint Model from Simulated Data.**

Note: Simulation outcomes from 50 sets of simulated data. The true values of each scenario are followed by Figure 3.1. A lower RMSE indicates good predictive accuracy.

of oil wealth make autocratic governments more stable and hence less likely to transition to democracy, has drawn attention to democratization studies. After the extant literature advanced and debated theories, data, and empirical methods, many studies are broadly consistent with the claim that oil wealth makes autocratic governments more stable but with certain conditions (Ross 2012; Andersen and Ross 2014; Tsui 2011; Ahmadov 2014).

While much of this research has tried to clarify the conditions under which petroleum wealth has negative impacts on democracy, one important condition is a temporal dimension. In their critique of the seminal work by Haber and Menaldo (2011) that dismisses the resource

curse argument, Andersen and Ross (2014) argue that there was a structural break in the relationship between oil wealth and democracy. The *big oil change* they call occurred in the late 1970s when the oil industry was transformed by a wave of nationalizations and contract revisions that enabled the governments of host countries to seize control of these rents. To identify this possible structural break, Andersen and Ross (2014) estimate the term interacting oil wealth variables with time dummies, and Ross (2012) subsets the sample data into before and after 1980 to estimate the relationship between the transition to democracy and oil income. With these strategies, these studies conclude that structural change causes the resource curse, while there might be no resource curse before the 1970s.

Yet, the estimations with time dummies or subsampling produce estimation biases because the results can vary depending on which period is specified. Even using strong prior knowledge about the timing, the number, and the duration of structural changes, researchers cannot statistically validate their prior if the change is incremental. The changepoint model may find the structural change of oil wealth effect, but the abrupt structural change assumption is not suitable in this case because the *big oil change* theory claims that the structure of the international oil industry was incrementally changed. Andersen and Ross (2014) describe that "(t)he transfer of rents often took place over a 5- or 10-year period, as governments **gradually** gained control over foreign assets, renegotiated or abrogated contracts, reorganized existing national oil companies or established new ones, and developed new regulations. This makes it hard to identify a single year when the salient dimensions of nationalization took place". Therefore, the TVPP model is well suited to capture the gradual change of the oil effect on democracy.

In this application, we reanalyze Ross (2012), which estimates the effect of the total oil income on binary data of regime transition covering 174 countries from 1960 to 2006. To test the temporal effect, the study subsamples the data into two periods: 1960-1979 and 1980-2006. However, dividing the data by 1980 does not have unequivocal reasons to be a breakpoint. Following Ross (2012), we estimate the time-varying coefficient of the effect of total oil income (log) on the timing of regime transition from autocracy to democracy, taking

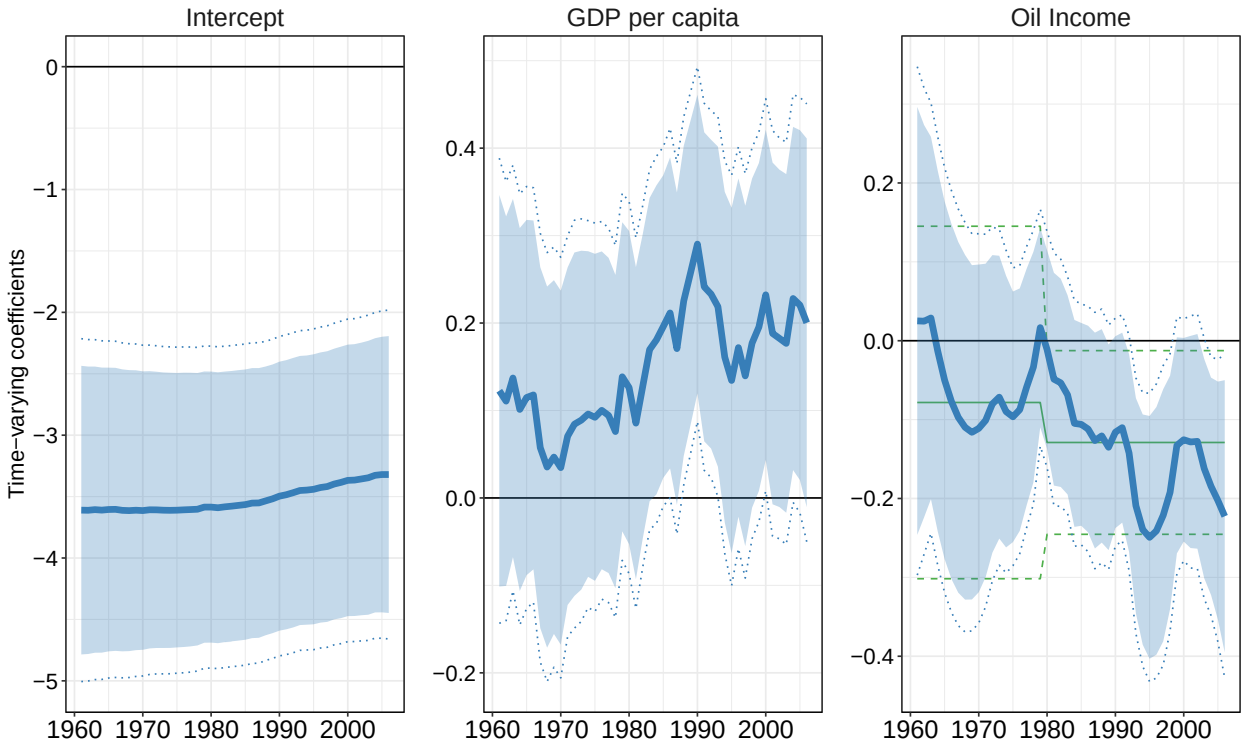

Figure 3.3: **Time-Varying Parameters for the Oil Effect on Democratic Transition.**

Note: The outcome variable of this model is democratic transition, taking value 1 if a country has regime transition at year t. The blue line is the posterior means of the TVPP model, and the green solid line is the coefficient estimated by Ross (2012). The shaded areas and the dotted lines are 90% and 95% confidence intervals, respectively.

value one if the country i has regime transition at year t, otherwise zero. The model also includes income (log) and regime duration since 1946 as covariates with country-fixed effect.

Figure 3.3 plots the posterior estimates for the time-varying coefficients of total oil income in the blue line and shaded area. The right panel shows that the coefficients are between zero to -0.1 before 1980, but the 95% credible intervals (shaded area) are wide and overlap zero: the effect of total oil income is not statistically significant. After 1980, the time-varying coefficient clearly declined until the middle of the 1990s, indicating the level shift of

the coefficients. While the 95% credible intervals overlap zero in the latter of the estimation periods, the 90% credible interval (dotted lines) indicates that total oil income has a negative effect and is statistically significant.

Compared to the original estimation, the timing of the structural break is similar, but the magnitude is distinct. The green horizontal lines indicate the coefficients of total oil income in the original estimations by Ross (2012), showing the estimates prior to 1980 in the original study and the TVPP model are almost equivalent. The estimated timing of the structural change in the TVPP model is also almost identical to those assumed in the original study, but the relationship between democratization and oil wealth gradually changes from 1980 through the mid-1990s. This supports the theoretical argument that the *big oil change* would take place over 10 years, which the simple logit estimation could not reveal. Moreover, the magnitude of the coefficients for the post-break is larger for the time-variant estimates, suggesting the nondemocratic oil effect is more robust than the originally estimated.

We also estimate the effect of total oil income on the binary political regime type because the time-varying parameters in Figure 3.3 are fluctuate due to the small number of democratization events (the proportion of $y = 1$ is 2.3 percent). In this model, the outcome variable takes the value one if the country i is democratic at year t, or zero if authoritarian. Compared to the previous model, this model has more information on the outcome variable (the proportion of $y = 1$ is 43.8 percent), which could yield more stable time-varying coefficients [2]. Figure 3.4 indicates an almost parallel trend with the previous model, but the time-varying coefficients are smothered both in total oil income and GDP per capita. Moreover, the effect of total oil income declines in the middle of the 1980s, and it gets statistically significant

[2]We change the prior on σ_j^2 from the simulation study above to smooth the time-varying parameters. In the model with the outcome variable of the transition to democracy (Figure 3.3), we set $\sigma_j^2 \sim IG(400, 2)$, whose mean and standard deviation are roughly (0.005, 0.0003). We employ this rather tighter prior with a smaller mean than the uninformative prior used in the simulation study because the estimation with the uninformative prior yields wild fluctuations in the estimate of the time-varying parameters due to a few samples that take one in the outcome variables (the proportion of $y = 1$ is 2.3 percent). On the other hand, for the model with the outcome variable of the binary democracy index (Figure 3.4), in which the proportion of $y = 1$ is 43.8 percent, we set a looser prior as $\sigma_j^2 \sim IG(100, 10)$, whose mean and standard deviation are roughly (0.1, 0.01).

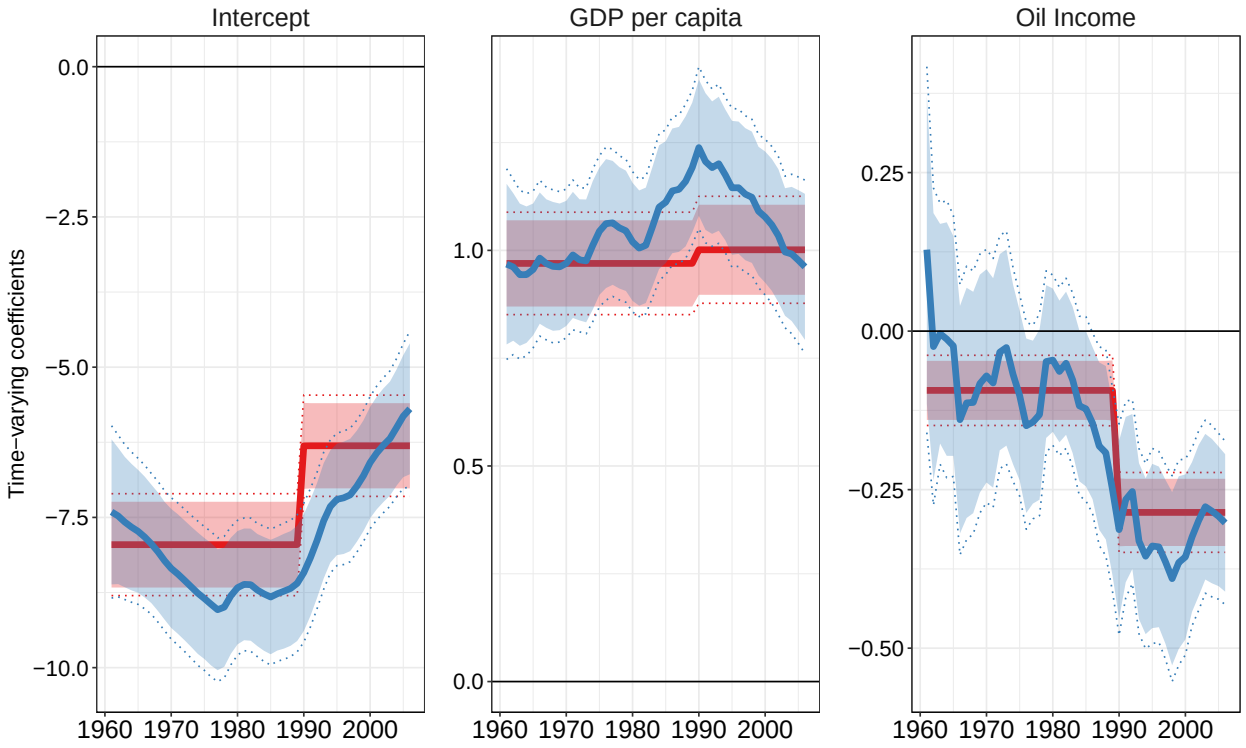

Figure 3.4: **Time-Varying Parameters for the Oil Effect on Binary Democracy Index.**

Note: The outcome variable of this model is the level of democracy in a binary index, taking value 1 if a country is democracy at year t. The blue and red lines are the posterior means of the TVPP model and the changepoint model. The shaded areas and the dotted lines are 90% and 95% confidence intervals, respectively.

at the 5% level. Thus, the result suggests that oil's antidemocratic effect has grown during the 1980s. Given the data limitation on pre-1960, the confidence intervals at the beginning of the data are wider, so we cannot definitely judge the oil effect at the beginning of the estimated period.

To compare the performance of the TVPP models to the changepoint model, we also estimate the oil effect on the state of the political regime using the changepoint model used in the simulation. The red lines and shaded area in Figure 3.4 show the abrupt shift of

the coefficient of oil income in 1990, indicating the model neglects the gradual change in the international oil industry starting in the late 1970s. Moreover, the coefficient of the pre-break periods is negative and statistically significant at the 5% level, suggesting that the oil's antidemocratic effect is always significant throughout the estimated periods. This result is contradicted by the original theoretical argument of the emergence of the resource curse after 1980. Thus, the changepoint model causes attenuation bias because the coefficient of pre-break includes the transition periods, deviating from the original theoretical argument. Moreover, the magnitude of the coefficient in the post-break period is smaller than in the TVPP model.

Meanwhile, the time-varying coefficients of GDP per capita in Figure 3.4 show that the effect of GDP per capita on democracy is positive and statistically significant over the estimated period. The effect increases from the beginning of the estimated period and then the effect sharply declines after 1990. We examine this democracy-GDP relation in depth in the next section.

3.5 Application 2: Democracy and Development

Our second application is the statistical relationship between democracy and economic development that has been the center of debates in comparative politics. Since Lipset (1959) developed the modernization theory, scholarship has examined the causal effect of economic development on democratization. Theoretically, the critics of the modernization theory argue that the statistical association between income and democracy holds because the survival of wealthy democracies is more likely, showing that democratization is random than systematic (Przeworski et al. 2000). Acemoglu and his colleagues (Acemoglu et al. 2008, 2009) also reject the modernization hypothesis, arguing that the historically rooted institutions affect the long-term relationship between economic development and political regime. Others, on the other hand, develop conditional modernization theory; scholars find new theories to hold economic modernization theory by adding the conditions and triggers of democratization (Boix 2011; Kennedy 2010; Miller 2012; Treisman 2020). Some others also underscore the

international factors that cause the spatial and temporal clustering of democratization may change the relationship between income and democratization (Huntington 1991; Levitsky and Way 2006; Boix 2011; Cook, Hays, and Franzese 2023). Despite the developments of theories, data, and empirical methods, the literature on the causes of democracy is unsettled.

This is partly because the empirical results depend on which temporal dimension is analyzed, such as whether it includes the nineteenth-century, prewar, or early twenty-first centuries. For instance, Boix (2011) separately estimates the effect of GDP per capita on democratization in different periods, resulting in that the substantive effects are significant during the first and third wave of democratization, but there are no effects during other periods. Treisman (2020) also indicates the idiosyncratic temporal effects by conducting the time interaction model. Cook, Hays, and Franzese (2023) and Abramson and Montero (2020) develop the models to capture the lag effects of both space and time. With respect to the temporal heterogeneity approach, Hermansen, Knutsen, and Nyg (2021) employ the changepoint model that identifies the structural breaks when the Berlin Wall fell.

We employ the TVPP model to estimate the temporal effects of income, as a proxy of economic development, on democratization and democratic consolidation, revising the seminal work by Przeworski et al. (2000). We follow Przeworski et al. (2000) in estimating a dynamic probit specification, where y_{it} is the dichotomous variable capturing democracy, taking the value one if the country i is democratic at year t, or zero if authoritarian. The classification of political regimes is based on a dichotomous regime defined by Boix, Miller, and Rosato (2013). Because the original work by Przeworski et al. (2000) only includes the sample period from 1960 to 1990, we extend the timeframe further back in time, using the Boix-Miller-Rosato dichotomous coding of democracy, starting in 1800 (Boix, Miller, and Rosato 2013).

In a dynamic probit model, we regress regime type on lagged values of GDP per capita and interact with the lagged dependent variable (i.e. whether the country was a democracy

in the previous period) with each of the independent variables as follows:

$$\Pr(y_{it} = 1) \quad = \phi\{\beta_{1t} + \beta_{2t} GDP_{i,t-1} + \gamma_{1t} y_{i,t-1} + \gamma_{2t} y_{i,t-1} GDP_{i,t-1} + \mu_i\} \tag{3.9}$$

where $\Pr(y_{it} = 1)$ signifies the probability that country i is a democracy in year t, $\phi()$ is the cumulative probability function of the standard normal distribution, $y_{i,t-1}$ is a lagged democracy variable, and μ_i is country fixed effects. This model estimates two β_{it} that show the relationship between democracy and GDP per capita in autocracies (the independent variables entered on their own) and two γ_{it} in democracies (the sum of the direct effect of each interaction variable with the lagged democracy variable). Thus, in the effect of income, the coefficients on GDP per capita variable, β_{2t}, reflects its association with *transition to democracy*, whereas the sum of estimates and the interaction variables, $\beta_{2t} + \gamma_{2t}$, reflects its association with *democratic consolidation*.

While Przeworski et al. (2000) does not include six oil-exporting countries (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates), we include those countries.

Figure 3.5 plots the posterior estimates for the time-varying coefficient for *Democratic transition* in the top panel and *Democratic consolidation* in the bottom panel. Looking at this estimated long-time series data in the top-right panel, while the credible intervals at the beginning of the estimated period are wider due to fewer number of countries, the coefficients of GDP per capita for *Democratic transition* increase until the mid-twenty century, and then, it gradually wanes toward the end of the data periods. On the other hand, the coefficients of GDP per capita for *Democratic consolidation* gradually decline over prolonged periods, and the sign of the coefficients are always positive and statistically significant at the 5% level.

Following Huntington's third wave classification (Huntington 1991), we zoom in the coefficients of GDP per capita for *Democratic transition* and draw the lines indicating the years of the breaks of the waves. We also add two more lines in 1991 as the end of the Cold War, and 2007 as the beginning of the Great Financial Crisis. Figure 3.6 indicates that after the

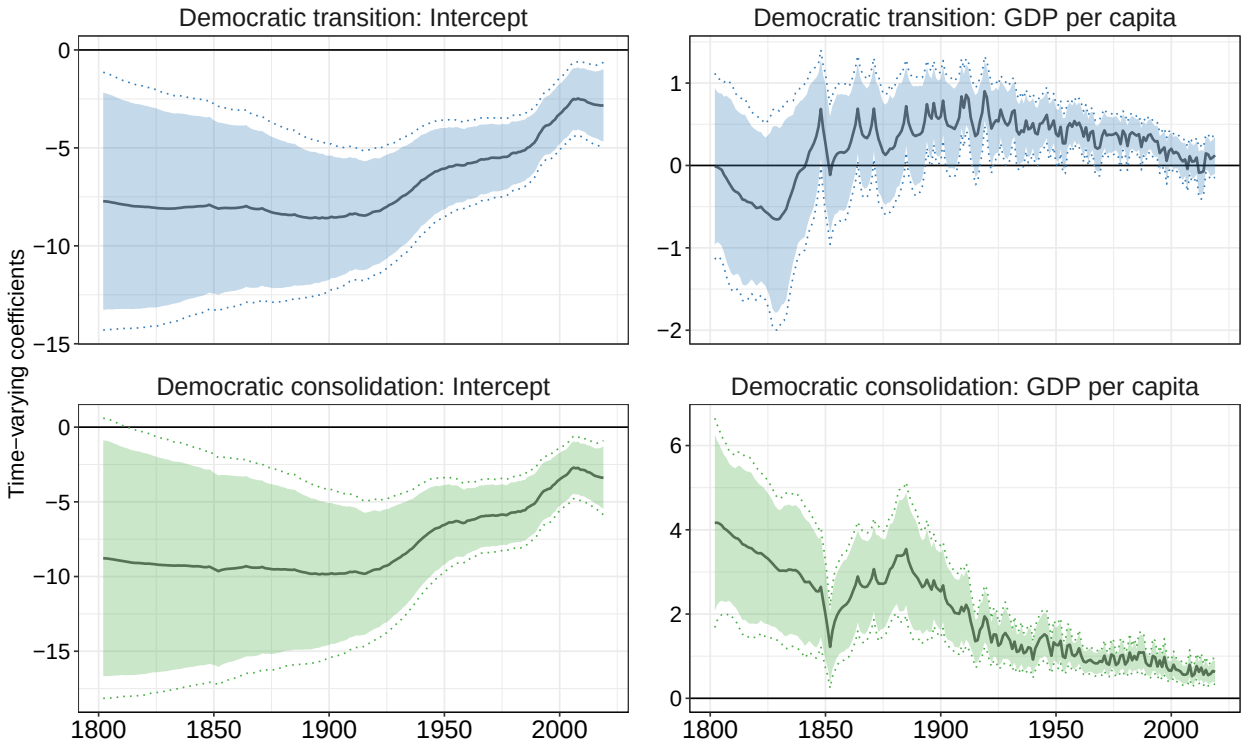

Figure 3.5: **Time-Varying Parameters for the Democracy-Income Relationship.**

Note: The outcome variable of this model is the level of democracy in the binary index, taking value 1 if a country is democracy at year t. The blue and green lines are the posterior means of the TVPP model for democratic transition, β_{2t} in equation (3.9), and democratic consolidation, $\beta_{2t} + \gamma_{2t}$ in equation (3.9), respectively. The shaded areas and the dotted lines are 90% and 95% confidence intervals, respectively.

beginning of the first reverse wave and the second reverse wave, the coefficients for *Democratic transition* show the level shift to around 0.5, and to 0.3, respectively. Then, after the demise of the Soviet Union in 1991, the coefficients clearly decline, and the credible intervals overlap zero, exerting a structural change in the relationship between economic growth and democratization from the positive income effect to statistically insignificant relations.

The estimated result of the temporal heterogeneity is distinct from the Boix (2011)'s estimation. In his estimation, Boix (2011) divides the time-series data into five periods:

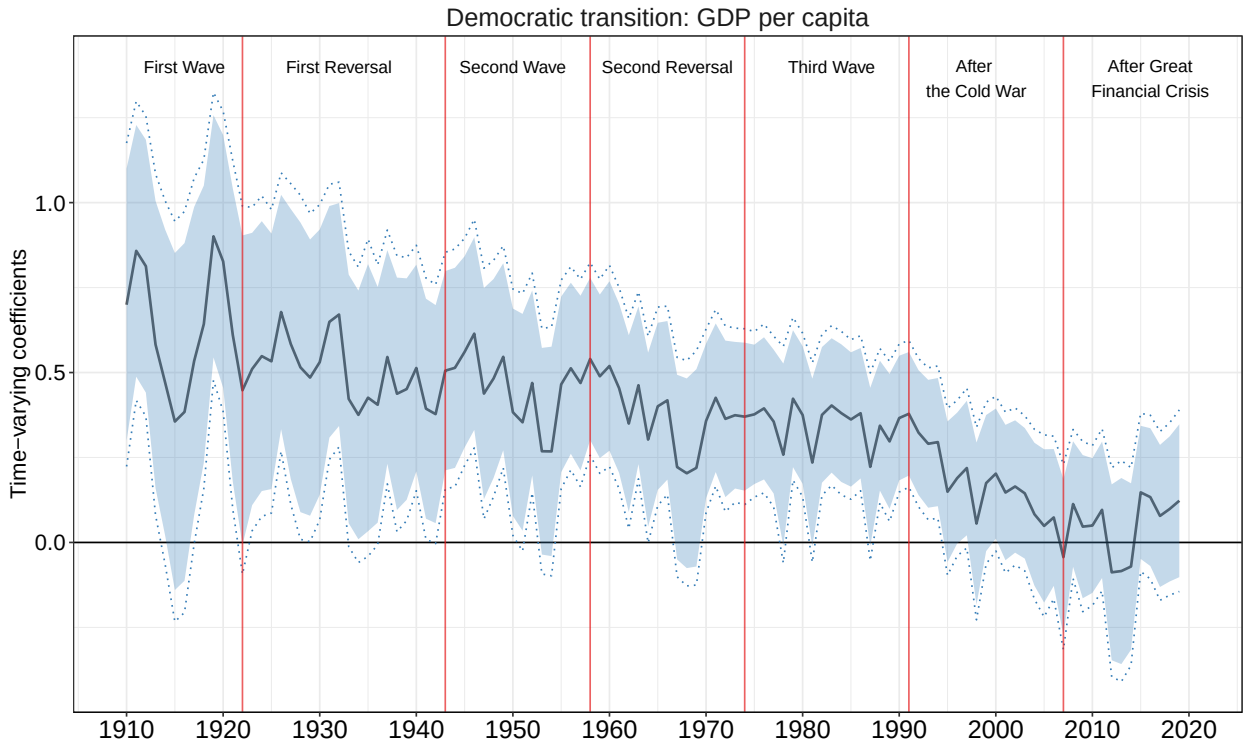

Figure 3.6: **Time-Varying Parameters for the Income Effect on Binary Democracy Index.**

Note: The outcome variable of this model is the level of democracy in the binary index, taking value 1 if a country is democracy at year t. The blue line is the posterior means of the TVPP model for democratic transition, β_{2t} in equation (3.9). The shaded areas and the dotted lines are 90% and 95% confidence intervals, respectively. The red lines indicate the end of the first wave (1922), the first reversal (1943), the second wave (1958), the second reversal (1974), the third wave (1991), and after the Cold War period (2007).

pre-first wave (1800–49); the first wave (1850–1920); the first reversal (1920–44); the second wave and reversal (1945–75); and the third wave (1976–2000). He finds that the positive and statistically significant relationship between income and democracy only during the first wave and third wave, while we find the statistical relation holds until the end of the Cold War. Moreover, Boix (2011)'s classification fails to specify the timing of the shift in the income-democracy relation because the subsampling approach relies on the researcher's subjective

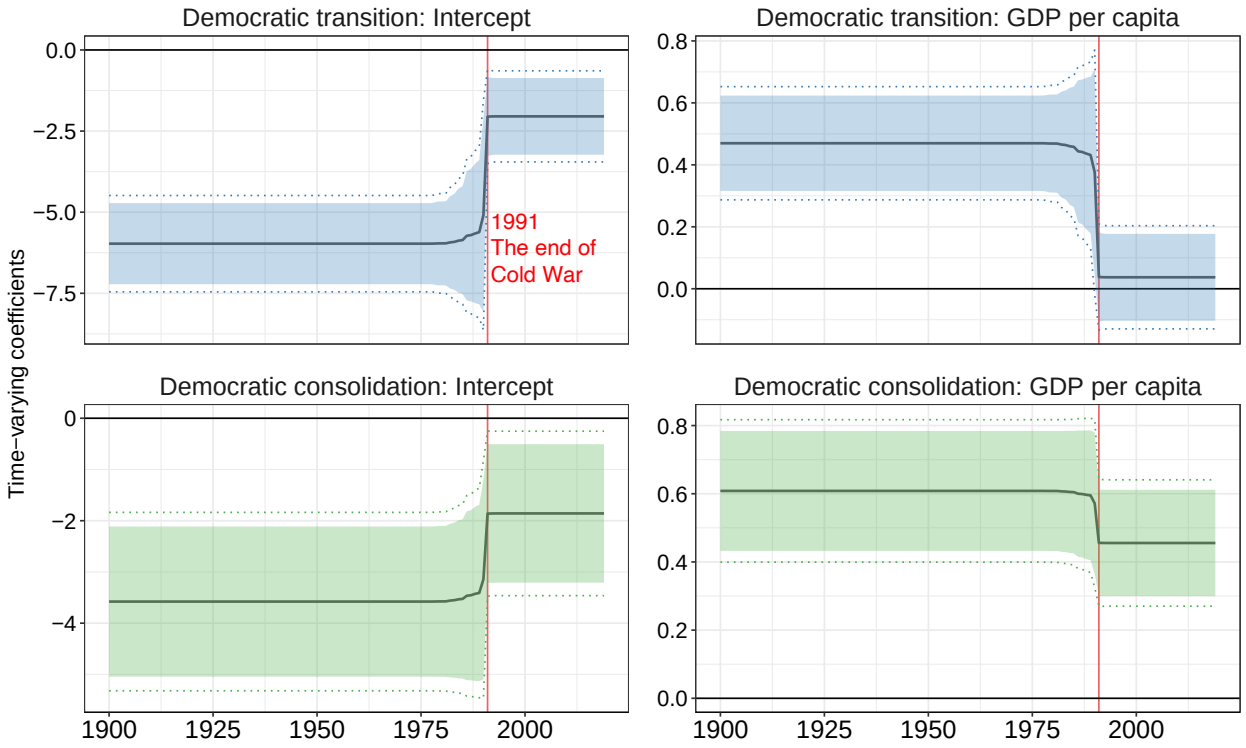

Figure 3.7: **Changepoint Model for the Income Effect on Binary Democracy Index.**

Note: The outcome variable of this model is the level of democracy in the binary index, taking value 1 if a country is democracy at year t. The blue and green lines are the posterior means of the changepoint model for democratic transition, and democratic consolidation, respectively. The shaded areas and the dotted lines are 90% and 95% confidence intervals, respectively.

decision on the possible breaks.

Compared to the changepoint model, the timing of the break is consistent with the previous study by Hermansen, Knutsen, and Nyg (2021). Employing the changepoint model to the continuous measure of democracy (V-Dem), they find the break occurring in 1989 when the Berlin Wall fell. We also estimate the breakpoints with Park's Bayesian changepoint model (Park 2010). Figure 3.7 shows the model identifies the break in 1991, and the coefficients become statistically insignificant after the 1991 break. However, it is difficult to

capture the nuanced gradual change of the relations.

One possible interpretation for the break and the change of the relationship is the change of the international system (Boix 2011; Dunning 2004; Gleditsch and Ward 2006; Levitsky and Way 2006). After the Soviet Union disintegrated and the Cold War ended, the influence of the Soviet Union on many autocratic regimes was removed, and thus the democratic transition occurred without the democracy-income channel. On the flip side of the coin, the uncontested hegemon of the United States in the last two decades may support a robust wave of democratization (Boix 2011; Levitsky and Way 2006). Another explanation is the rise of hybrid regimes, which are categorized as authoritarian regimes in the binary classification of this model. By introducing elections, legislature, or other accountability institutions to co-opt the opposition, the hybrid regimes could maintain their regime while at the same time promoting economic growth (Wright 2008; Gandhi and Lust-Okar 2009; Shih 2020).

This interpretation is also confirmed by the time-varying parameter of the intercept. The time-variant intercepts indicate the probabilistic impact on democratization by age, excluding the income effect: the larger the coefficient, all else equal, the more likely a given age is to democratize than other ages. Thus, the top-right panel of Figure 3.5 shows that the slope of the time-varying coefficient becomes steeper after 1991, suggesting that a country is more likely to democratize than during the Cold War. Moreover, both the coefficients of GDP per capita and intercept suggest that the transition to democracy is less likely after 2007 because the income effect is not statistically significant and the age effect has declined.

Finally, to further evaluate the income effects, we also conduct the counterfactual analysis by using conditional posterior distributions. We construct a counterfactual scenario that the effect of GDP per capita on democratization would not be changed after the end of the Cold War. Specifically, the coefficients of GDP per capita from 1992 to 2019 are extrapolated by the mean of the time-varying coefficients from 1950 to 1991. Figure 3.8 shows the number and the share of democratic countries with the counterfactual result. The green lines indicate the counterfactual results, and the shaded area and the dotted lines are the 90% and 95% credible intervals. We observe that the number and the proportion of democracies increase

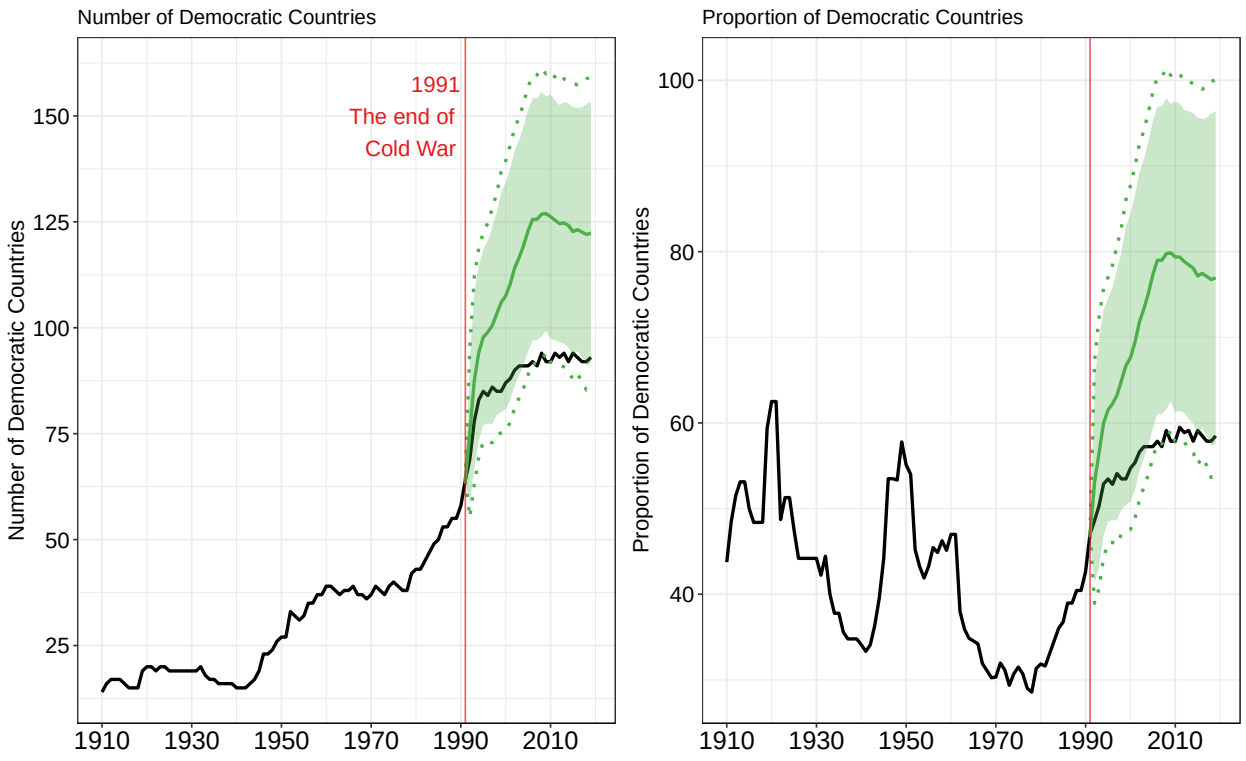

Figure 3.8: **Counterfactual Analysis on After the End of the Cold War.**

Note: This figure reports results from a counterfactual study with a scenario that the effect of GDP per capita on democratization would not be changed after the end of the Cold War. The green lines of the left and right panels estimate the number of democratic countries and the proportion of democratic countries. The shaded areas and the dotted lines are 90% and 95% confidence intervals, respectively.

faster in the counterfactual scenario than in the actual trajectory after 1991. Although the 95% credible intervals overlap the actual values in both plots, the predicted values after 2000 are statistically significant at the 10% level. Thus, the number of democracies declines after 2007 because the income shock occurred during the Great Financial Crisis and the age effect estimated from the intercept negatively impacts the democratic transition and consolidation.

3.6 Conclusion

In this article, we introduced the use of the time-varying parameter model for diagnosing and modeling the gradual changes of temporal heterogeneity in politics. The findings of the simulation study and two applications suggested that the proposed methods help capture the incremental changes in historical panel data analysis, avoiding model misspecification and attenuated bias compared to the changepoint model. For example, we show in the simulation study that the changepoint model has the risk of producing false positive or false negative when the political relationships shift gradually because the assumption of abrupt, discrete level shifts in the changepoint model ignores the transition periods. In our application to the oil curse study by Ross (2012), we also demonstrate that the changepoint model causes a false negative impact of oil effect on democracy, while the TVPP model shows statistically insignificant relations before the structural change in the international oil industry, suggesting the oil curse theory is dismissed before the 1980s.

Our reanalysis of the relationship between economic development and democracy finds the temporal heterogeneity over the long historical period. The finding supports the conditional modernization theory that assumes the magnitude of the effect of economic development may be stronger or weaker in different periods. In contrast to Boix (2011)'s finding, however, we show that modernization theory holds from the nineteenth century until the end of the Cold War, and the theory does not hold, especially after the Great Financial Crisis starting in 2007. It is beyond the scope of this article to investigate the reasons that formulate this temporal heterogeneity, but our estimation results and the counterfactual analysis using the time-varying parameters advance a more nuanced understanding of the relationship between economic development and democracy.

Moreover, we believe that the utility of time-varying parameter models provides a potential avenue to investigate political relationships beyond democracy. A slow, gradual institutional change is often ignored in empirical study, so the theories in historical institutionalism have been tested mainly in qualitative analysis. We demonstrate that the time-varying pa-

rameter models could test a variety of institutional changes without having a strong prior temporal heterogeneity. Because our TVPP model is limited to analyzing binary data, future research to broadly apply time-varying parameter model will develop methods for beyond binary models, such as ordinary data and instrumental variable models.

Chapter 4

DEMOCRACY-AT-RISK: ESTIMATE VULNERABILITY AND RESILIENCE OF DEMOCRACY

Kenya Amano

Abstract

Political science is rich in theories, hypotheses, and data to examine political relationships that involve *non-linear* relationships between outcomes and explanatory variables. While qualitative studies have empirically tested these asymmetric relationships, quantitative empirical tools to adequately address them are limited. To address asymmetric hypotheses, this article proposes a method that estimates the conditional distribution, rather than just the mean, of the outcome variable as a function of explanatory variables using quantile regression and skewed t-distribution. By focusing on the conditional distribution, we can analyze the effects across the lower and upper tails of the probability distribution, capturing asymmetry through the empirical shape of the full distribution. I demonstrate the utility of this approach by exploring the risks of democratic vulnerability and resilience and their association with two economic drivers: income levels and income distribution. I find that when income level increases, the upside and downside democracy risks are symmetric, and regime stability increases with higher income across all levels of democracy. However, the effect of income inequality is asymmetric: while rising income inequality moderately increases the risk of democratic regression, it significantly decreases the probability of increasing the level of democracy.

4.1 Introduction

A wide range of political science theories, hypotheses, and data examines the political relationship that is not *linearly* constructed. However, the standard empirical approach faces methodological challenges if the quantities of interest drawn from theories are not the conditional mean of the outcome variable on the explanatory variables. Many scholars have identified the issue of the mean-centric approach and proposed methods to estimate quantities of interests that do not rely on a *linear* assumption but allow for flexibly *asymmetry* assumption (Braumoeller and Goertz 2000; Clark, Gilligan, and Golder 2006; Goertz, Hak, and Dul 2012; Braumoeller 2006; Rosenberg, Knuppe, and Braumoeller 2017).

Some scholars, for instance, argue that hypotheses about necessary conditions are effective in theorizing politics (Clark, Gilligan, and Golder 2006; Braumoeller and Goertz 2000). Clark, Gilligan, and Golder (2006) illustrate the neorealist war theory that claims anarchy causes war as one example. The theory implies that anarchy is a necessary, but not sufficient, condition for interstate war because we observe many cases of "not war" under conditions of anarchy. Other studies underscore the cases of data-generating processes that create boundary lines, either ceilings, floors, or both, that restrict the range of the observations and create truncated or censored data. Duverger's law is a good example of theories with a ceiling boundary. Duverger (1954) argues that single-member district plurality electoral systems are sufficient to produce a two-party system. This theory leads to the hypothesis that there is an upper limit on the effective number of parties in districts of a certain magnitude, suggesting no observation in the data where the effective number of seat-winning parties is larger than the district magnitude (Duverger 1954; Taagepera and Shugart 1993; Rosenberg, Knuppe, and Braumoeller 2017).

To address the asymmetric hypothesis, scholars have proposed several methods. Multiplicative interaction term models are commonly used to test asymmetric hypotheses in quantitative research (Clark, Gilligan, and Golder 2006; Braumoeller and Goertz 2000). However, the approach relies on the deterministic assumptions of the relationship among

variables, requiring modeling these assumptions prior to estimations, which is analogous to qualitative analysis, such as Qualitative Comparative Analysis. Rosenberg, Knuppe, and Braumoeller (2017) also point out the issue of the standard ordinary least squares (OLS) regression in multiplicative interaction term models because it ignores the data generation process that creates asymmetry due to the focus on estimating the central tendency of the data, the mean value of the outcome variable conditional on explanatory variables. To relax the deterministic assumption on asymmetry, more flexible approaches that estimate the degree of asymmetry from data are proposed. The methods include stochastic frontier analysis (Rosenberg, Knuppe, and Braumoeller 2017), nonparametric frontier models (Rosenberg, Knuppe, and Braumoeller 2017), and quantile regression models (Goertz, Hak, and Dul 2012; Rosenberg, Knuppe, and Braumoeller 2017). These methods, however, have received little attention among political scientists, despite their potential to address important questions in political science.

In this article, I reevaluate the use of quantile regression to explore asymmetric hypotheses. I propose to estimate a conditional distribution, not just the mean, of the outcome variable as a function of explanatory variables with quantile regression. Following the method employed by Adrian, Boyarchenko, and Giannone (2019), I map the estimated quantile coefficients into the skewed t-distribution, a flexible distribution function that indicates the estimated conditional distribution of the outcome variable. Whereas in standard linear models, a conditional mean, or expected value, is calculated as a single value by multiplying each of the estimated effects by the probability of each effect occurring and then summing all of those values, estimating the conditional distribution disaggregates effects at the lower and upper tails of the probability distribution, and thus captures asymmetry through allowing either the upper or lower tail to be fatter or thinner.

To illustrate the theoretical and methodological significance of this approach, I estimate the resilience and vulnerability of democracy conditional on economic factors. In this application, I focus on two primary economic factors which have long been examined by political economy literature on democratization and consolidation: levels of income and income in-

equality. For each of the two factors, the literature has distinguished between theories of democratization that take the probability of a transition to democracy as their dependent variable and theories of consolidation that take the probability of a democratic breakdown as their dependent variable. In particular, Przeworski and Limongi (1997) distinguish the former as an "endogenous" theory and the latter as an "exogenous" theory in the relationship to the levels of income, and then they reject only the endogenous modernization theory, showing asymmetry between the two theories (Przeworski and Limongi 1997; Przeworski et al. 2000). Likewise, the theories on the association between income distribution and democracy do not only rely on a linear assumption. Whereas Boix (2003) argues the linear relationship between income distribution and democracy, claiming that decreasing the level of economic inequality bolsters democratization, Houle (2009) theorizes the asymmetry of the democracy-inequality relationship: inequality decreases democratic consolidation but has no net effect on democratization.

Using quantile regression, I estimate the conditional distribution of democracy as a function of economic factors to quantify the risks of democratic vulnerability and resilience. The conditional distribution provides three components that determine the shape of the distribution: 1) the mean of the distribution, which provides an expected value of the level of democracy analogous to the conditional mean of standard linear models, 2) the variance of the distribution, and 3) the skewness of the two tails of conditional distribution that captures asymmetry. To quantify the asymmetric risks from the conditional distribution, I estimate the probability of changing the level of democracy at a certain level. I call such probabilities as Democracy-at-Risk (DaR), dividing into the downside Democracy-at-Risk estimating from the lower tail of the distribution, and the upside Democracy-at-Risk from the upper tail. Democracy-at-Risk represents not only the mean effect of explanatory variables but also integrates the uncertainty through variance and the asymmetry through skewness of both tails of the distribution.

Democracy-at-Risk is also a flexible measure of the risk of regime stability and vulnerability. If you are interested in the democratization of authoritarian regimes, the upside

Democracy-at-Risk is the quantity of interest, calculating the probability of the level of democracy rising above a certain level[1]. Researchers also allow to estimate the risks of democratic consolidation and regression, by comparing the upside and downside Democracy-at-Risk. Theoretically, in the terminology of Democracy-at-Risk, Przeworski et al. (2000) predict the asymmetric effects of income level on the level of democracy, expecting that the downside Democracy-at-Risk is smaller (less likely to be autocratic) while the upside Democracy-at-Risk is larger (more likely to be democratic).

To demonstrate the effects of the level of income and income equality, I construct counterfactual scenarios in which I change each economic factor while holding everything else constant. In the scenarios of changing the level of income, I find a symmetric shift of the upside and downside Democracy-at-Risk. The estimated distribution shows that both lower and upper tails become parallelly thinner when GDP per capita increases, suggesting that levels of income contribute to regime stability at any level of democracy, either democracy or autocracy. This result is contradicted by the asymmetric assumption in Przeworski's theory.

On the other hand, the effect of income inequality is asymmetric. When income inequality increase, the probability of rising the level of democracy (the upside Democracy-at-Risk) decreases, while the downside Democracy-at-Risk increases. In other words, income inequality in democracy asymmetrically impacts more on democratic backsliding and less on democratic consolidation.

The contributions of this article are both methodological and substantive. First, I demonstrate how researchers can explore the asymmetric assumption by using quantile regression to answer important questions in political science fields. In recent years, quantile regressions have methodologically developed in the statistical and econometric literature to apply longitudinal data and binary, categorical data. This evolution has attracted scholars who study economic and financial data, where there are asymmetric data-generating processes.

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[1] You can use the continuous measures of democracy to set the cutoff value to distinguish democracy and autocracy. For instance, Freedom House defines 2.5 or below (from 1 to 7 scales), Polity defines 6 or above (from -10 to 10 scales), and V-Dem defines 0.5 or above (from 0 to 1) as the cutoff to democracy.

For instance, the IMF and BIS have used the conditional distribution approach to forecast economic growth rates and inflation (Adrian, Boyarchenko, and Giannone 2019; Adrian et al. 2018; Banerjee et al. 2020). While some political scientists conduct quantile regression (Alexander, Harding, and Lamarche 2008, 2011; You et al. 2015; Goertz, Hak, and Dul 2012; Rosenberg, Knuppe, and Braumoeller 2017), this paper is, to my best knowledge, the first to employ this method to political institutions to quantify the risks around the determinants of changes.

Second, this article expands on existing scholarship on democratic backsliding, the incremental erosion of democratic institutions, rules, and norms that stem from fair and competitive elections. A large number of scholars have studied the causes of democratic backsliding, including political polarization (Haggard and Kaufman 2021), the rise of populism (Berman and Snegovaya 2019; Prato and Wolton 2018), and the decline in foreign support for democracy (Hyde 2020). Revisiting both the modernization theories (Lipset 1959) and the distributive conflict theories (Boix 2003; Acemoglu and Robinson 2006), this article draws an integrated picture of both theories. The empirical results contribute to showing the nuanced implications of the cause of democratic backsliding.

4.2 Advantages of Quantile Regression

Studies of political regimes use the democracy measure as a continuous value for examining a nuanced and subtle change in the quality of democracy, such as democratic backsliding. The continuous democracy indexes show a bimodal distribution that skews to the higher score, a cluster of consolidated democracies, and the lower score of consolidated autocracies (Treisman 2020). Figure 4.1 plots the liberal democracy index (`v2x libdem`)[2] provided by V-Dem Institute (Coppedge et al. 2022) against the log of GDP per capita for 119 countries from 1980 to 2017, and the density plot on the right of the scatter plot indicates the bimodal distribution of the liberal democracy index.

[2]I multiply the liberal democracy index by 100 for convenience.

The OLS regression techniques provide summary point estimates that calculate the average effect of the set of explanatory variables on the *average country in democracy index space*. However, this focus on the *average country* may hide important features of the underlying relationship when we are interested in the relationship at different points in a continuous democracy measure. For instance, in Figure 4.1, I draw the slope coefficients of the quantile regression of the liberal democracy index associated with the 5th (red line) and 95th (blue line) quantile, and the OLS estimates (black line). The red 5th quantile slope is flatter than the OLS estimates, as following consolidated authoritarian countries such as China (purple diamond). On the other hand, the blue 95th quantile slope captures some consolidated democracies such as Sweden (pink asterisk) and the United States (blue triangle). Thus, the OLS may not appropriately represent the changes from upper quantiles to upper quantiles or from lower quantiles to lower quantiles. Quantile regression techniques can therefore help us obtain a more complete picture of the underlying relationship between democracy and a set of economic and political factors.

Another advantage of quantile regression is that it avoids the restrictive assumption of normally distributed errors, and thus the approach is robust to outliers and heavy-tailed distributions. Since a political regime is sometimes changed drastically due to coups or wars, the data includes outliers and skewed distribution within and across countries. Two highlighted countries in Figure 4.1 indicate such moves. As for the case of democratization, Bulgaria (red circle) shifts to the 95th quantile from below the 5th quantile, whereas Hungry (green square) experiences democratic backsliding, moving to below 50 of the liberal democracy index from the 95th quantile. Although Figure 4.1 only presents the 5th and the 95th quantile, by adding more quintiles, quantile regression allows us to estimate these heavy-tailed distributions together with the median. Thus, quantile regression is a powerful tool that makes the task of modeling distributions flexible without having prior assumptions on distributions, even when the underlying story is complex and multi-dimensional (Angrist and Pischke 2008).

Despite the advantage of quantile regression, the application of this method in the po-

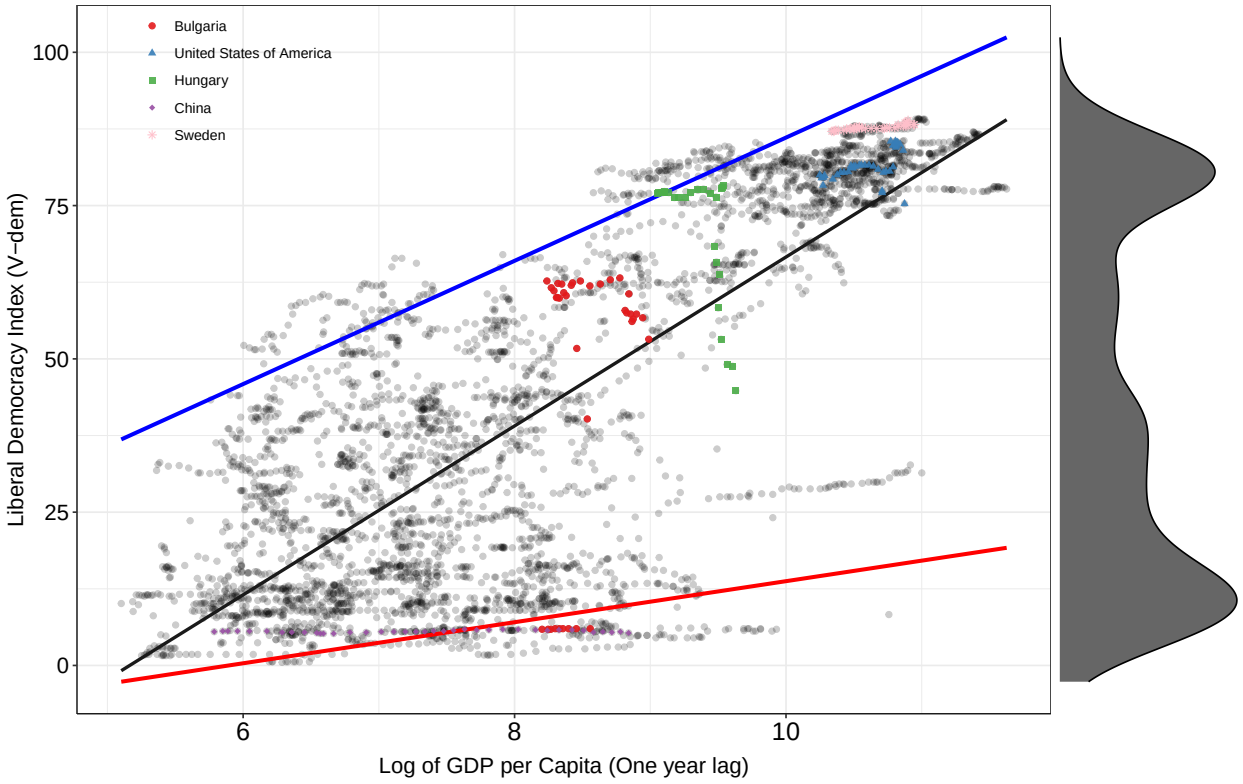

Figure 4.1: **Democracy Index and GDP per Capita with Quantile Regression Slopes.**

Note: The data includes the liberal democracy index and GDP per capita for 119 countries from 1980 to 2017. The red, blue, and black lines are the slope coefficients of the quantile regression of the liberal democracy index associated with the 5th and 95th quantiles, and the OLS estimates.

litical science field has been limited. One reason is the difficulty in interpreting quantile regression results. While many studies present a set of coefficients at quantiles in a regression table or a line plot of their coefficients, these results can not intuitively capture the substantive meaning of the regression results. Meanwhile, Goertz, Hak, and Dul (2012) and Rosenberg, Knuppe, and Braumoeller (2017) underscore the advantage of the use of quantile regression to test asymmetric hypotheses by identifying a quantile that creates an asymmetric relationship between the outcome variable and explanatory variables. But Rosenberg,

Knuppe, and Braumoeller (2017) admit the limitation that this approach can only be applied to bivariate settings. They also cast doubt on the substantive implications from the varied quantiles, and thus they argue that researchers are constrained to use the 5th or 95th quantiles as a fixed obvious choice (Goertz, Hak, and Dul 2012; Rosenberg, Knuppe, and Braumoeller 2017).

However, recent developments in quantile regression methods provide tools for better estimation and interpretation. As discussed in detail later, Adrian, Boyarchenko, and Giannone (2019) fit the quantile regression coefficients into the skewed t-distribution in order to smooth the quantile function and indicate a probability density function, allowing us to understand the probability distribution given the set of explanatory variables. The conditional distribution provides quantities of interest through the mean, variance, and skewness of the distribution.

The mean of the conditional distribution is analogous to the conditional mean function of standard regression models. As Figure 4.2 shows, the shift of the mean of the conditional distribution changes the probability of your quantity of interest in both tails. The top-left panel of Figure 4.2 indicates that the change of mean to 6 from 5 lowers the probability of the democracy index falling below 4 to 3.5% from 18.2%. Likewise, the top-right panel indicates the change in the variance of the distribution. The narrower spread makes both tails thinner, suggesting the stability of the liberal democracy index increases. On the other hand, the wider spread increases the tail risks, making the state of regime vulnerable. The example in the top-right panel shows the wider spread case: the change of variance increases the probability of the democracy index falling below 4 to 25.2% from 18.2%. Lastly, skewness informs the asymmetric effect of explanatory variables on the democracy index. The bottom-left and bottom-right panels of Figure 4.2 indicate that the distributions are skewed, making the lower tail thin in the bottom-left and fat in the bottom-right, while the upper tail becomes thinner in the bottom-left and fatter in the bottom-right panel. Thus, this change of shape decreases the probability of the democracy index falling below 4 to 10.5% from 10% in the bottom-left panel and increases the probability to 32.7% from 18.2% in the the bottom-right

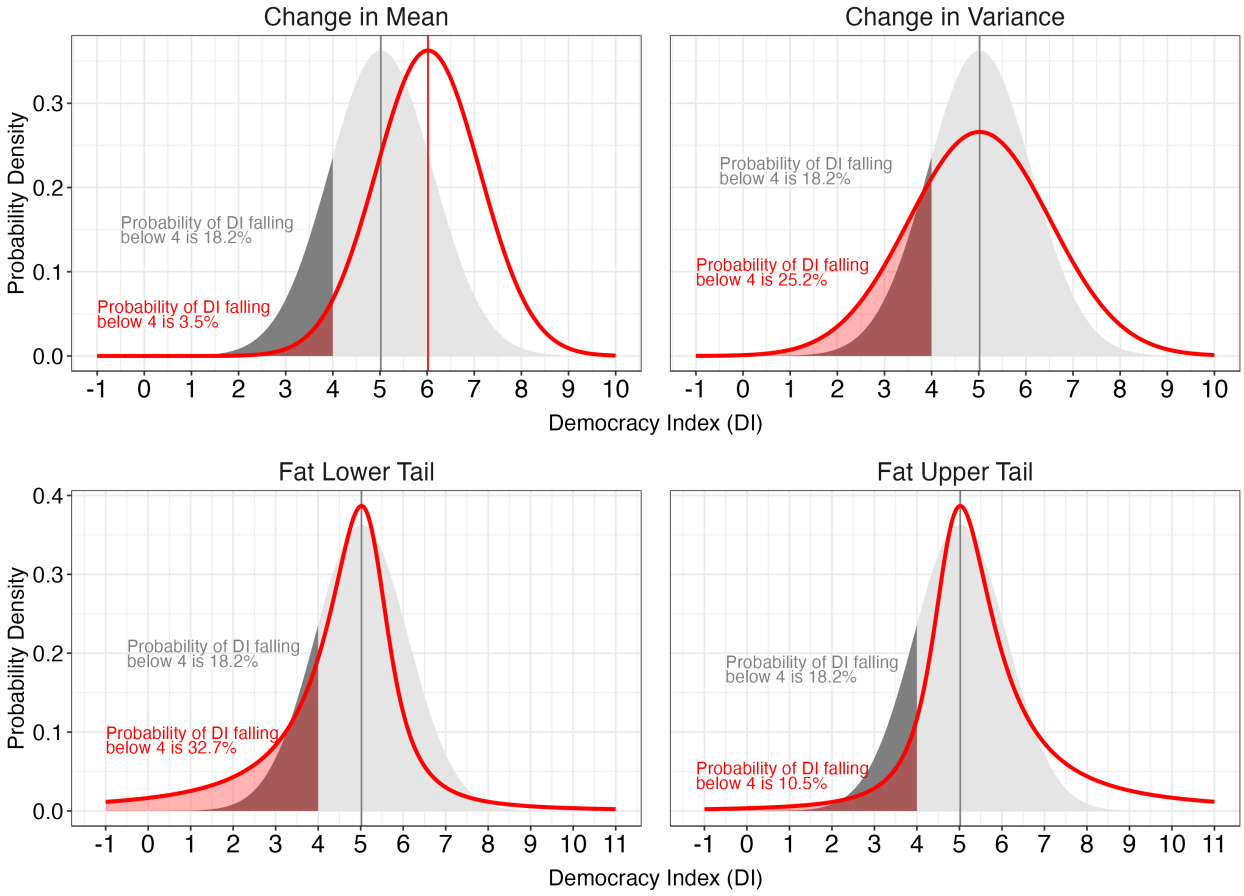

Figure 4.2: **Probability of Changing Democracy Index with Conditional Distribution Variation.**

Note: The gray shaded areas represent the baseline distribution, while the red solid lines represent the conditional distribution with changes in mean, variance, and upper and lower tails. The darker gray and red shaded areas indicate the probability of the democracy index falling below 4.

panel.

Leveraging these methodological developments in the quantile regression approach, I empirically estimate the conditional distributions to analyze the determinants of nuanced changes in the level of democracy. In the next section, I will illustrate that asymmetric assumptions embedded in the theories of democratic transition and consolidation can fit into

this proposed method.

4.3 Asymmetric Assumptions in Theories of Democracy

The statistical relationship between democracy and economic factors has been a center of debate in comparative politics. Since Lipset developed modernization theory (Lipset 1959), scholarship has examined the causal effect of economic factors on democratization. To capture more nuanced changes in the level of democracy, recent studies of democratic backsliding also examine these theories of democratic transitions and breakdowns (Waldner and Lust 2018). In this section, revisiting the debates on democracy and economic factors, I demonstrate how existing theories can be translated into theories about asymmetric relationships which can be tested using quantile regression.

4.3.1 Modernization Theory

Scholarship on the relationship between income levels and democratization finds evidence for both democratic transitions and consolidation. Lipset (1959) argues that there is a positive relationship between the level of economic development and democratization, hypothesizing that as societies develop economically, the emergence of the middle class enables them to challenge a dictatorship. Economic development can bring about social changes, such as the spread of education, the acceleration of communication, and the expansion of mobilization and incorporation, that help regimes transition to democracies (Huntington 1968). Thus, the original modernization theory simply posits that the levels of income affect democratization or increase the democracy index, while the theory does not indicate the direction of autocracy.

On the other hand, first Przeworski and later Acemoglu and his colleagues argue against modernization theory, assuming the asymmetric relationship between economic development and democracy. Przeworski et al. (2000) dismiss the one direction of the relationship, which economic development increases the risk of democratization, because countries may randomly democratize due to reasons unrelated to their level of economic development (dismiss

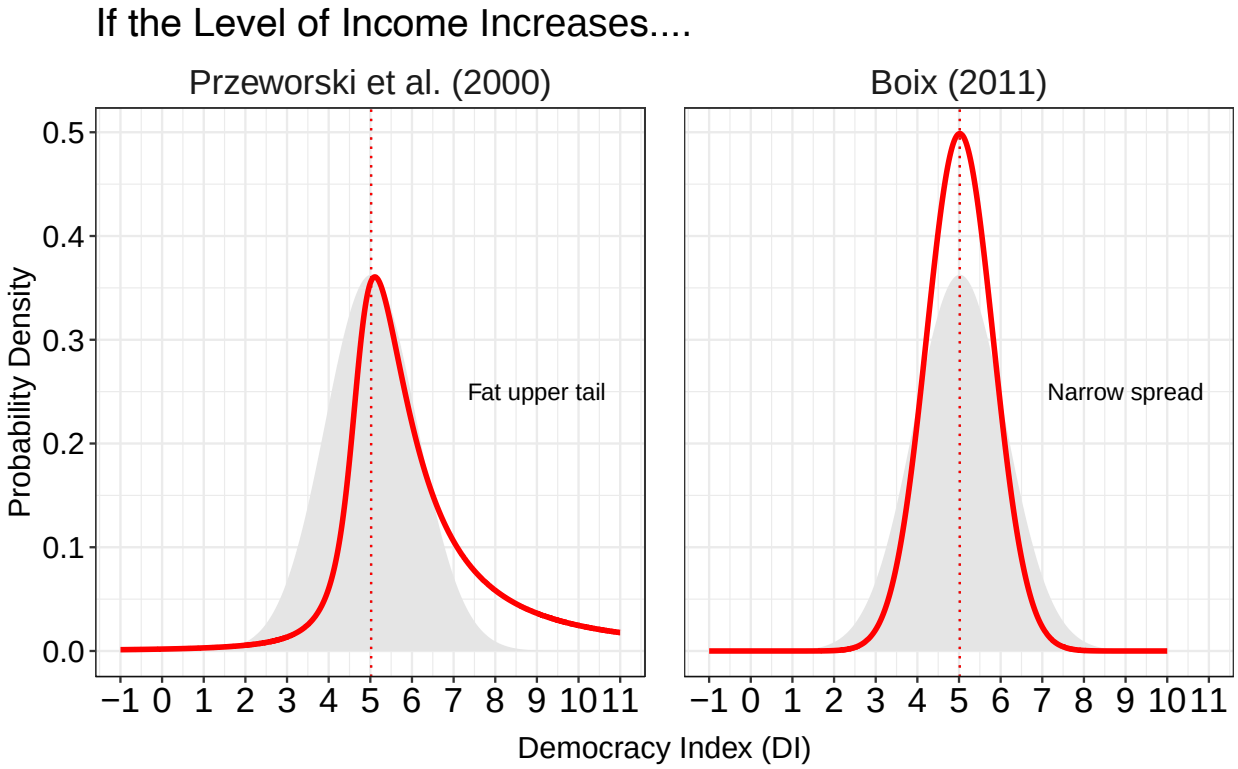

Figure 4.3: **Predicted Change in Democracy based on Theories of Democracy and Income level.**

Note: The gray shaded areas represent the baseline distribution, while the red solid lines represent the predicted conditional distribution with increases in the level of income based on the theories by Przeworski et al. (2000) and Boix (2011). The dotted lines indicate the mean value of each conditional distribution.

endogenous modernization theory). Conversely, they support another direction of the relationship that economic development decreases the risk of autocratization because once democracies experience higher economic development, they are less likely to slip into autocracy (exogenous modernization theory). Thus, this school of studies posits that levels of income asymmetrically impact the political regime transition.

The left panel of Figure 4.3 demonstrates to map Przeworski's idea into the shape of the conditional distribution. Because the theory argues increasing the level of economic

development lower the risk of falling into authoritarian rule, the lower tail of conditional distribution indicates a thin tail. On the other hand, the theory predicts democratization is random, meaning the uncertainty or variance is large. Thus, the upper tail of conditional distribution shows a fat tail. Therefore, the upside Democarty-at-Risk (DaR) is larger, whereas the downside Democracy-at-Risk is smaller when the level of economic development increases.

In contrast, Boix (2011) develops his argument by adding conditions in his response to Acemoglu's criticism. He demonstrates temporally heterogeneous effects of endogenous modernization, which appear to be strong for the 19th century, moderate for the interwar period, and barely distinguishable from zero for the postwar period because the effect of economic development is strongly mediated by the structure of the international system (Boix 2011; Bermeo and Yashar 2016). Boix (2011) also argues that wealthy countries do not increase the likelihood of democratization with any extra growth, instead extra growth stabilizes the state of the political regime. Thus, Boix (2011) suggests that economic development has little impact on the level of democracy.

As the previous chapter of the dissertation reveals, my argument is closely tied to Boix (2011) because I expect that levels of income have little effect in the sample of countries during and after the third wave of democracy. Due to the dynamic change in the international order created after WWII, this period includes not only the spread of democracy to a wide range of developing and former Soviet countries but also several cases in which countries regressed to an authoritarian regime (Boix 2011; Haggard and Kaufman 2012). At the same time, we observe a rise of institutionalized authoritarianism in which a variety of institutions in dictatorships help their regime survive (Gandhi and Lust-Okar 2009; Svolik 2012; Wright 2008). These institutions, including elections, pastries, legislatures, and executive constraints have lessened the risk of democratic transition compared to the period before the third wave.

I also illustrate Boix's idea in the shape of the conditional distribution in the right panel of Figure 4.3. Because Boix's argument underscores the stability of their regime rather than changing the level of democracy, he predicts that increasing the level of economic development

lowers the variance of the distribution. Thus, the downside and upside Democracy-at-Risk will be smaller as both tails become thin. But, as the right panel of Figure 4.3 shows, Boix expects that the mean of the distribution does not change, predicting that the economic development does not change the mean of the conditional distribution, but variance.

4.3.2 Distributive Conflict Theory

When it comes to income inequality, the seminal work of Meltzer and Richard (1981) provides the original idea behind the distributive conflict models of regime change. The Meltzer-Richard model posits the conflict between the wealthy minority and the poor majority. In such a case, because politicians appeal to the median voter, the wider the divergence between the median and mean income, the more one may expect generous tax and transfer programs that redistribute resources from the wealthy to the poor.

Boix (2003) and Acemoglu and Robinson (2006) build on the Meltzer-Richard model to extend the model of transitions and consolidation of democracy, assuming strategic interactions between elites and masses. Boix (2003) argues that the effect of inequality is linearly negative: democratization is less likely when income inequality increases. Based on the assumption that the decision-making power rests with elites and not with masses, Boix (2003) argues that elites are more likely to grant democracy when inequality is low because the costs of repression outweigh those of being taxed. As the left panel of Figure 4.4 shows, this liner assumption can simply be put into conditional distribution analogous to the OLS, because it only changes the mean of the conditional distribution.

Likewise, Acemoglu and Robinson (2006) also argue that the relationship between inequality and democracy is symmetric but has an inverse-U shape, assuming two economic conditions. On the one hand, in the lower income inequality condition, the probability of democratization linearly increases as income inequality increases until it gets to the middle levels of inequality where elites have less to fear from redistribution, but the masses still have incentives to democratize. In this hypothesis, democratization is unlikely to occur in

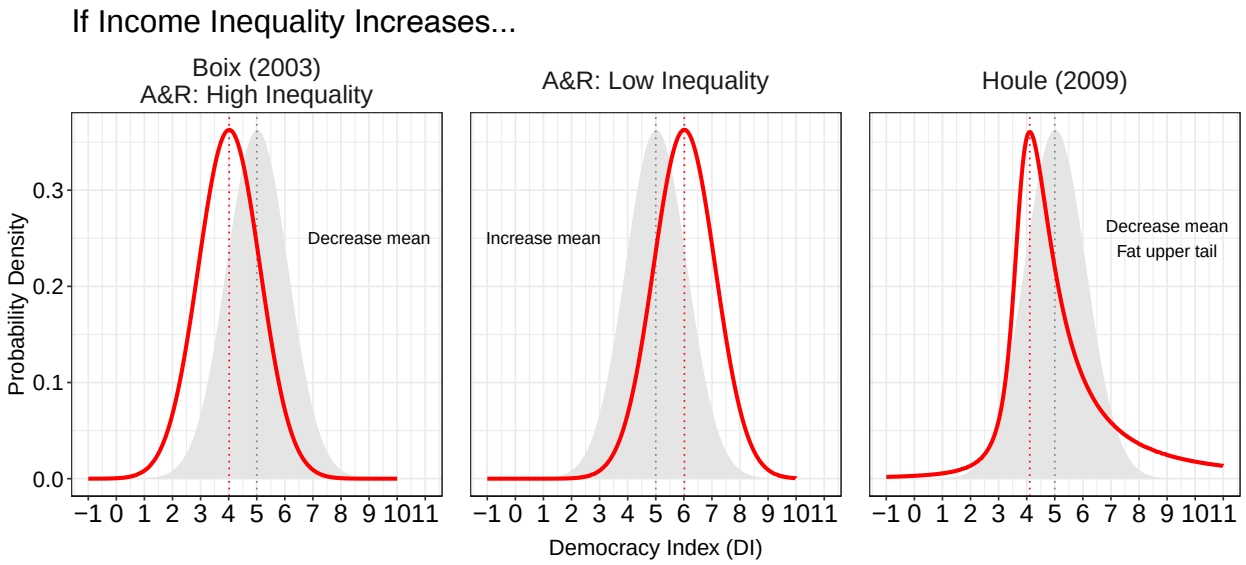

Figure 4.4: **Predicted Change in Democracy based on Theories of Democracy and Income Inequality.**

Note: The gray shaded areas represent the baseline distribution, while the red solid lines represent the predicted conditional distribution with increases in income inequality based on the theories by Boix (2003), Acemoglu and Robinson (2006), AR, and Houle (2009). The dotted lines indicate the mean value of each conditional distribution.

authoritarian governments with low levels of inequality because the demand of the poor for redistribution is also attenuated. On the other hand, in the higher income inequality condition, the probability of democratization declines as income inequality increases. The latter assumption is similar to Boix's argument that elites repress the masses when inequality becomes significant. Thus, this idea can be illustrated in the same conditional distribution in the left panel of Figure 4.4. Conversely, the center panel indicates the former scenario under the lower income inequality, expecting that the mean of the conditional distribution increases when income inequality increases.

Other scholars, however, propose an alternative hypothesis based on a linear assumption. Houle (2009) argues that the impact of inequality on elites and masses is ambiguous if democratization requires elites to acquiesce to the demands of the poor. Haggard and Kaufman

(2012) also supports this view and highlights that theoretical models proposed by Acemoglu and Robinson (2006) depends on various parameters, such as the cost of repression or asset mobility, due to potential indeterminacy. Thus, these scholars expect that increasing income inequality has no net effect on democratization. Rather, these scholars argue that increasing income inequality promotes democratic breakdowns because redistributive pressures from the poor motivate elites to deploy force against incumbents in order to reimpose authoritarian rule (Houle 2009). These hypotheses expect that the mean of the conditional distribution decreases as income inequality rises. It also predicts the asymmetric tails because increasing income inequality has no effect on the rise of the level of democracy, expecting the variance of the upper tail is small, and thus, the tail is thin. On the other hand, the lower tail of the conditional distribution is fat because the theory argues increasing income inequality increases the risk of falling into authoritarian rule, indicated in the left panel of Figure. 4.4.

4.4 Estimation Strategy

4.4.1 Measuring Quantile Effects

To estimate the conditional relationship between democracy, income level, and income inequality, I conduct quantile regressions with fixed effects. Let us denote by $Y_{t+1,i}$ the democracy index of country i at time $t+1$. I use the liberal democracy index (`v2x libdem`) provided by V-Dem Institute (Coppedge et al. 2022) for Y[3]. I consider the following model:

$$Y_{i,t+1} = \alpha_i + \beta X_{i,t} + U_{i,t} \tag{4.1}$$

where α_i is a fixed effect. The vector $X_{i,t}$ contains three variables: the lag of the dependent variable ($Y_{i,t}$), the log of `GDP per capita` and `Income Inequality Ratio`. The data for `GDP per capita` is from World Bank and Penn World Table. `Income Inequality Ratio` is calculated by the ratio of the average incomes of the top 10% to the bottom half, using

[3] I multiply the liberal democracy index by 100 for convenience to avoid the long decimal points.

World Inequality Database.

Following the model proposed by Koenker (2004), the conditional quantiles for the democracy index are obtained as

$$Q_{Y_{i,t+1}}\left(\tau \mid X_{i,t}\right) = \alpha_i + X'_{i,t}\beta(\tau) \tag{4.2}$$

By definition, the τ-th quantile of the distribution of democracy is the value $Q_Y(\tau)$. For instance, when $\tau = .10$, $Q_{Y_{i,t+1}}(\tau \mid X_{i,t})$ describes the lower decile of $Y_{i,t+1}$ given $X_{i,t}$, while $\tau = .5$ gives us the conditional median. The coefficient α_i captures time-invariant country-specific effects that may shift the averaged location of distribution for each country i. More specifically, the fixed effects do not capture the country-specific association among quantile coefficients (shape), but it does capture the parallel shift of quantile coefficients (location) to calculate the average coefficients across countries.

In a quantile regression of $Y_{i,t+1}$ on $X_{i,t}$, the regression slope β_τ is chosen to minimize the quantile weighted absolute value of errors, whereas ordinary least squares regressions minimize the value of squared errors. Koenker (2004) proposes a method that treats unobservable fixed effects as parameters to be jointly estimated with the covariate effects for different quantiles[4]. Specifically, parameter estimates are estimated as follows:

$$\begin{aligned}&\left(\hat{\beta}\left(\tau_k, \lambda\right), \{\alpha_i(\lambda)\}_{i=1}^{N}\right) \\ &\quad = \arg\min \sum_{k=1}^{K}\sum_{t=1}^{T}\sum_{i=1}^{N} w_k \rho_{\tau_k}\left(Y_{i,t+1} - \alpha_i - x'_{i,t}\beta\left(\tau_k\right)\right) + \lambda \sum_{i=1}^{N}\left|\alpha_i\right|\end{aligned} \tag{4.3}$$

where $\rho_\tau = u(\tau = I(u < 0))$ denotes the piecewise linear quantile loss function ($I(.)$ is an indicator function) proposed by Koenker and Bassett (1978)[5], and w_k is the relative

[4] This methodological development is important. One of the technical issues why quantile regression is not widely used among political scientists is that, while quantile regression can conduct interaction terms or instrumental variables as a conventional regression does, the application of these methods to panel data is methodologically limited. Because political science research frequently employs time-series data and its techniques, researchers need to employ proper tools, such as fixed effects or instrumental variables, to identify causal effects (under suitable assumptions).

[5] See also Angrist and Pischke (2008).

weight given to the k-th quantile, which controls for the contribution of the k-th quantile on the estimation of the fixed effects. In this paper, following the previous studies (Alexander, Harding, and Lamarche 2011; You et al. 2015; Lamarche 2010), I employ equally weighted quantiles $w_k = 1/K$. λ is the tuning parameter that shrinks the individual effects toward zero to improve the performance of the estimate of β. When the term λ goes to zero, the penalty term disappears, and we obtain the usual fixed effects estimator; when the term λ goes to infinity, we obtain the estimate of the model without the individual effects (Pooled model). I set $\lambda = 1$, following You et al. (2015).

I estimate coefficients for nine quantiles: 10, 20, 30, 40, 50, 60, 70, 80, and 90 percent quantiles. The confidence intervals are computed by block bootstrapping using country clusters with 1,000 replications.

4.4.2 Fitting t-distribution to Estimate Conditional Distribution

To substantively understand the set of quantile coefficients, I fit the result of quantile regressions to the skewed t-distribution in order to smooth the quantile function and estimate conditional distribution. Theoretically, quantile regression provides us with approximate estimates of the quantile function, an inverse cumulative distribution function of the democracy index. In practice, these estimates are difficult to map into a probability distribution function because of approximation error and estimation noise.

To solve this problem, following the approach conducted by Adrian, Boyarchenko, and Giannone (2019), originally developed by Azzalini and Capitanio (2003), I fit the skewed t-distribution in order to smooth the quantile function and indicate a probability density function.

$$f(\hat{Y}|X, \mu, \sigma, \alpha, \nu) = \frac{2}{\sigma} t\left(\frac{\hat{Y} - \mu}{\sigma}; \nu\right) T\left(\alpha \frac{\hat{Y} - \mu}{\sigma} \sqrt{\frac{\nu + 1}{\nu + \left(\frac{\hat{Y} - \mu}{\sigma}\right)^2}}; \nu + 1\right) \tag{4.4}$$

where $t(\cdot)$ and $T(\cdot)$ respectively denote the PDF and CDF of the Student t -distribution.

The four parameters of the distribution pin down the location μ, scale σ, fatness ν, and shape (degree of freedom) α. Relative to the t-distribution, the skewed t-distribution adds the shape parameter, which regulates the skewing effect of the CDF on the PDF. I estimate the four parameters $\{\mu_{i,t}, \sigma_{i,t}, \alpha_{i,t}, \nu_{i,t}\}$ of the skewed t-distribution f to minimize the squared distance between the estimated quantile function $Q_{Y_{i,t+1}}(\tau \mid X_{i,t})$ from the equation (2) and the quantile function of the skewed t-distribution $F^{-1}(\tau; \mu_{i,t}, \sigma_{i,t}, \alpha_{i,t}, \nu_{i,t})$ from the previous equation (4) to match the $10, 20, 30, 40, 50, 60, 70, 80$ and 90 percent quantiles:

$$\{\hat{\mu}_{i,t+1}, \hat{\sigma}_{i,t+1}, \hat{\alpha}_{i,t+1}, \hat{\nu}_{i,t+1}\} = \underset{\mu,\sigma,\alpha,\nu}{\arg\min} \sum_{\tau} \left(\hat{Q}_{y_{i,t+1}|x_t}(\tau \mid x_{i,t}) - F^{-1}(\tau; \mu, \sigma, \alpha, \nu) \right)^2 \quad (4.5)$$

The approach can draw the conditional distribution for any given pair of year t and country i or hypothetical scenario to simulate the effect of economic factors.

4.4.3 Quantities of Interest from Conditional Distribution

To understand the substantive impact of the economic variables, I conduct two counterfactual experiments that explore how the levels of income and income inequality affect the conditional distribution of the democracy index.

First, I create the baseline distribution by interpolating the mean values of all variables into the estimated quantile coefficients and then map t-distribution to obtain the conditional distribution. Next, I change the value of each economic factor by one standard deviation. To compare the baseline and the counterfactual distributions, I also calculate the Democracy-at-Risk as the probability that the democracy index changes to a certain threshold. These risks are two-sided, with the upside Democracy-at-Risk estimating from the upper tail that indicates the "risk" of increasing the democracy index, and the downside Democracy-at-Risk from the lower tail, the risk of decreasing the democracy index. Democracy-at-Risk allows research to ask a substantive question of democratization. For example, if you are interested in the risk of autocratization from democracy, you can set the threshold value of 50 for

distinguishing between democracy and authoritarianism and thus the downside Democracy-at-Risk can be estimated as the probability of the level of democracy falling below 50.

Formally, let denote Y_A^* as a pre-specified threshold, and the conditional upside Democracy-at-Risk, $\mathrm{P}^{Down}(\overline{Y}) \equiv \mathrm{Prob}(\overline{Y} < Y^*)$, is the probability mass below Y^* in the conditional density $f(\overline{Y}|\mu, \sigma, \alpha, \nu)$:

$$\mathrm{P}^{Down}(\overline{Y}) \equiv \int_{-\infty}^{Y^*} f(\overline{Y}|\mu, \sigma, \alpha, \nu) d\overline{Y} \tag{4.6}$$

where at the probability of the democracy index falling below Y^* is (100-τ) percent[6]. In other words, this expression defines the downside Democracy-at-Risk through the integral of the PDF over the democracy index support up to a specified threshold or, equivalently, through the CDF.

4.5 Estimation Results

4.5.1 Estimated Quantile Regressions

I first estimate the quantile coefficients before fitting them into skewed t-distribution. Figure 4.5 shows the raw estimated coefficients from the quantile regressions at the 10, 20, 30, 40, 50, 60, 70, 80, and 90 percent quantiles in the blue line, together with the least squares estimate in the green line. Figure 4.5 highlights nonlinearities associated with both the levels of income (the log of GDP per capita) and income inequality (income ratio of the top 10 percent to the bottom half). In particular, the slope of income levels decreases from the lower to upper quantiles. Whereas the coefficient of the OLS estimation is positive but not statistically significant, the coefficients in the upper quantiles are positive and statistically significant, and those in the lower quantiles are negative and statistically significant. In the case of the middle quantiles, the slope is close to zero, and the confidence intervals overlap with zero. This indicates that the effect of the level of income on the level of

[6] Similarly, we can define the conditional upside Democracy-at-Risk, $\mathrm{P}^{Up}(\overline{Y}) \equiv \mathrm{Prob}(\overline{Y} > Y^*)$, as $\mathrm{P}^{Up}(\overline{Y}) \equiv \int_{Y^*}^{\infty} f(\overline{Y}|\mu, \sigma, \alpha, \nu) d\overline{Y}$, which is the probability of the democracy index rising above Y^*.

democracy for the middle quantiles is uncertain. On the other hand, the upper and lower quantiles exhibit heterogeneous effects. However, without a benchmark or baseline effect for comparison, it remains unclear the extent of this heterogeneity and its implications for the level of democracy.

In contrast, income inequality shows a negative relationship, particularly in the middle quintiles, where the effect is statistically significant. This suggests that income inequality has a significant and negative impact on the level of democracy, unlike the level of income. Both the upper and lower quantiles also display negative coefficients, although the confidence intervals overlap with zero. The effect size is larger for the upper quantile compared to the lower quantile. Again, however, evaluating this asymmetry and its implications on democracy is challenging without a benchmark or baseline effect for comparison.

4.5.2 Estimated Conditional Distribution

To illustrate the effects of the changes in the political and economic factors on the conditional distribution, Figure 4.6 and Figure 4.7 indicate the conditional probability density functions for the democracy index, fitted as skewed t-distributions. As mentioned above, I set all variables to their means to estimate the baseline result shown as the shaded areas, and then create two hypothetical scenarios for each economic factor. First, I change the values of the level of income by one standard deviation holding other variables constant: the left panel of Figure 4.6 indicates the decrease of GDP per capita scenario, and the left panels of 4.6 indicate the increase of GDP per capita scenario. Next, I change the values of income inequality by one standard deviation holding other variables constant. Figure 4.7 shows this decrease and increase in income inequality scenarios.

To compute the Democracy-at-Risk, which represents the probability of changing the level of democracy across various scenarios, I establish threshold values for both the upside and downside risks. This approach allows researchers to set the thresholds based on their specific interests flexibly. In this particular analysis, I focus on examining the marginal impact of

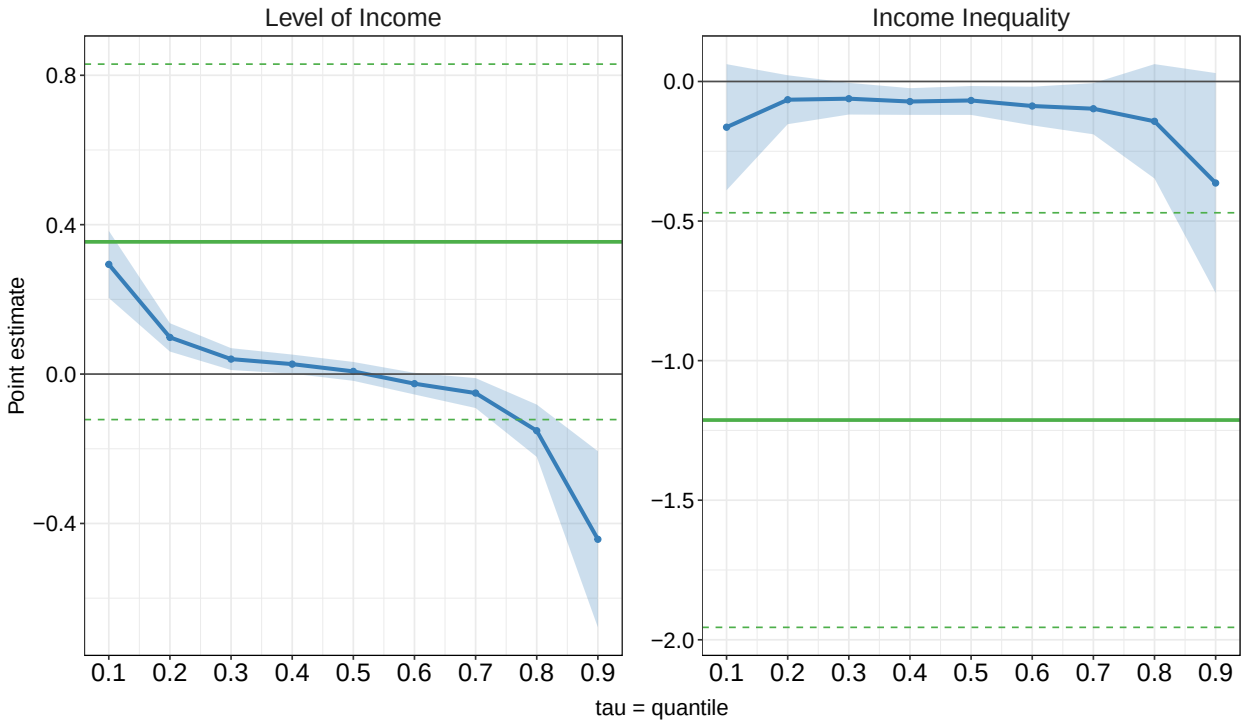

Figure 4.5: **Estimated Quantile and OLS Coefficients.**

Note: The blue shaded areas are the 95% confidence interval. The Coefficients of the OLS estimation and the 95% confidence intervals are indicated in the green solid and green dashed lines, respectively.

each economic factor on the level of democracy for an *average country*. It is important to note that this *average country*, computed by taking the mean values of all variables, is purely hypothetical. As previously mentioned, the distribution of the level of democracy is bimodal, meaning that the mean value (42.0) does not accurately represent the majority of countries. Nonetheless, this hypothetical mean country serves as a useful baseline for setting the threshold and estimating the Democracy-at-Risk. In the baseline scenario, I calculate the level of democracy at the 10th and 90th quantile probabilities, as a 10% risk captures the marginal and asymmetric effects sufficiently. For the downside risk, the value is calculated to be 40.8, while it is 42.9 for the upside risk.

Figure 4.6 presents the scenario that changes the level of income, suggesting the symmet-

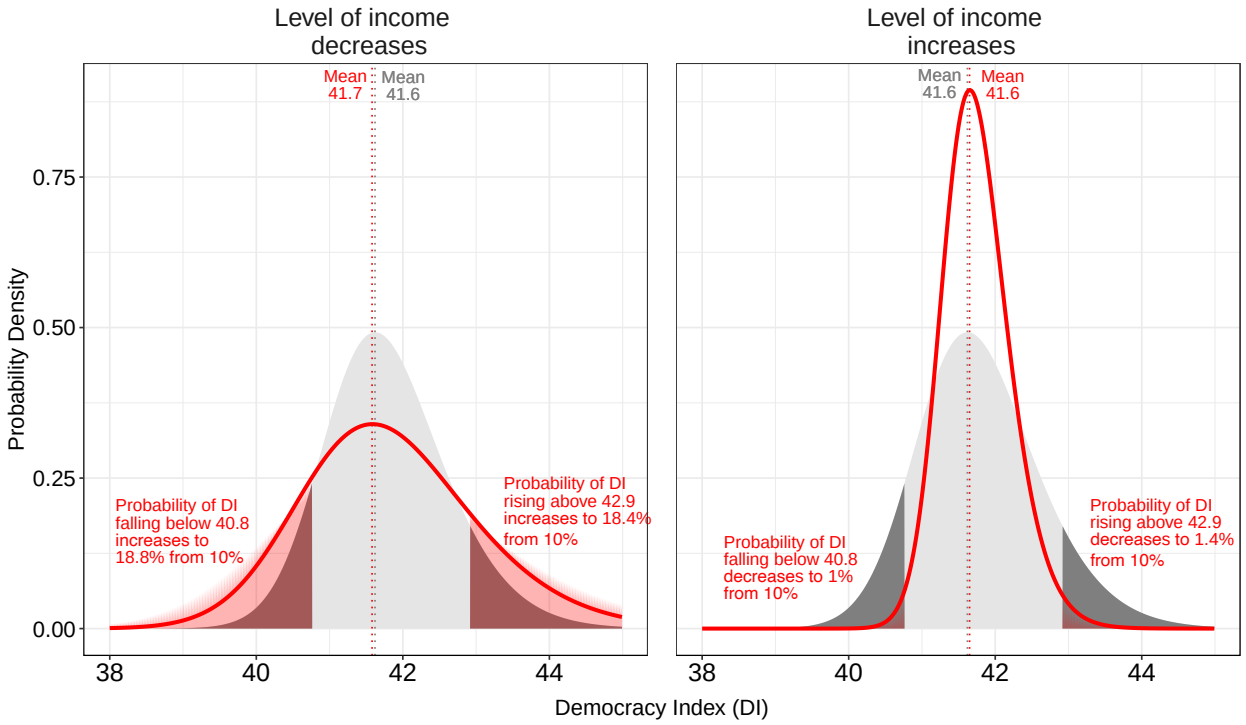

Figure 4.6: **Effect of Changes in the Level of Income on Probability Densities.**

Note: The gray shaded areas are estimated as a baseline distribution by interpolating the mean values of all variables into the estimated quantile coefficients. The red solid lines indicate the estimated conditional distribution when the level of income changes one standard deviation from its mean. The darker gray shaded areas indicate the probability of the democracy index falling below 40.8 or rising above 42.9 at 10% confidence. The darker red areas also indicate the probability of the democracy index falling below 40.8 or rising above 42.9. The gray and red dotted lines are the mean of the distribution.

ric impact. When it comes to the location of the mean of the distribution, neither scenario shows any change in their respective mean. Instead, as the level of income increases by one standard deviation, the variance of the distribution is squeezed. On the other hand, as the level of income declines, the variance of the distribution is stretched. The downside and upside Democracy-at-Risk are almost symmetrically changed in both scenarios. When the level of income decrease, the downside and upside Democracy-at-Risk increase to 18.8% and 18.4% from 10%. On the other hand, when the level of income increases, the downside and

upside Democracy-at-Risk increase to 1.0% and 1.4% from 10%, suggesting the stability of the regime at any level of the democracy index increases.

The results of this study support Boix's theory while challenging Przeworski's asymmetric assumption. According to Przeworski et al. (2000), they predict that the probability of increasing the level of democracy would also increase as the level of income increases, resulting in a thicker upper-tail distribution. Similarly, they expect that as the level of income increases , the lower-tail distribution, representing the downside Democracy-at-Risk, should become thinner. However, the results of this study indicate a symmetric shift in both tails of the distribution, contradicting Przeworski's prediction. Instead, as Boix (2011) expects, the level of income influences not the mean of democracy but variance. This suggests that both democracies and authoritarian countries are more likely to consolidate their political regimes because economic development may provide more resources to the incumbent to maintain their regimes. Consequently, significant regime shifts, such as democratization or democratic backsliding, become less likely due to the increase in the level of income.

In contrast, Figure 4.7 illustrates the asymmetric distributional changes. In the left panel, as the income inequality ratio decreases, the mean of the conditional distribution shifts slightly to the left. Conversely, in the right panel, an increase in income inequality is associated with slight leftward shifts. Additionally, the plot reveals that a decrease in the income inequality ratio leads to a fatter upper tail while the lower tail remains stable at the baseline distribution. Similarly, an increase in inequality results in a thinner upper tail, while the lower tail remains stable in the right panel of Figure 4.7. These changes in distribution asymmetry are also reflected in the downside and upside Democracy-at-Risk in both scenarios. When income inequality decreases, the downside Democracy-at-Risk decreases slightly from 10% to 9.4%, while the upside Democracy-at-Risk increases 12.3% from 10%. Conversely, when income inequality increases, the downside Democracy-at-Risk increases slightly to 10.6% from 10%, while the upside Democracy-at-Risk decreases 7.9% from 10%.

While Boix (2003) and Acemoglu and Robinson (2006) assume a linear relationship between democracy and income inequality, the shape of the estimated conditional distribution

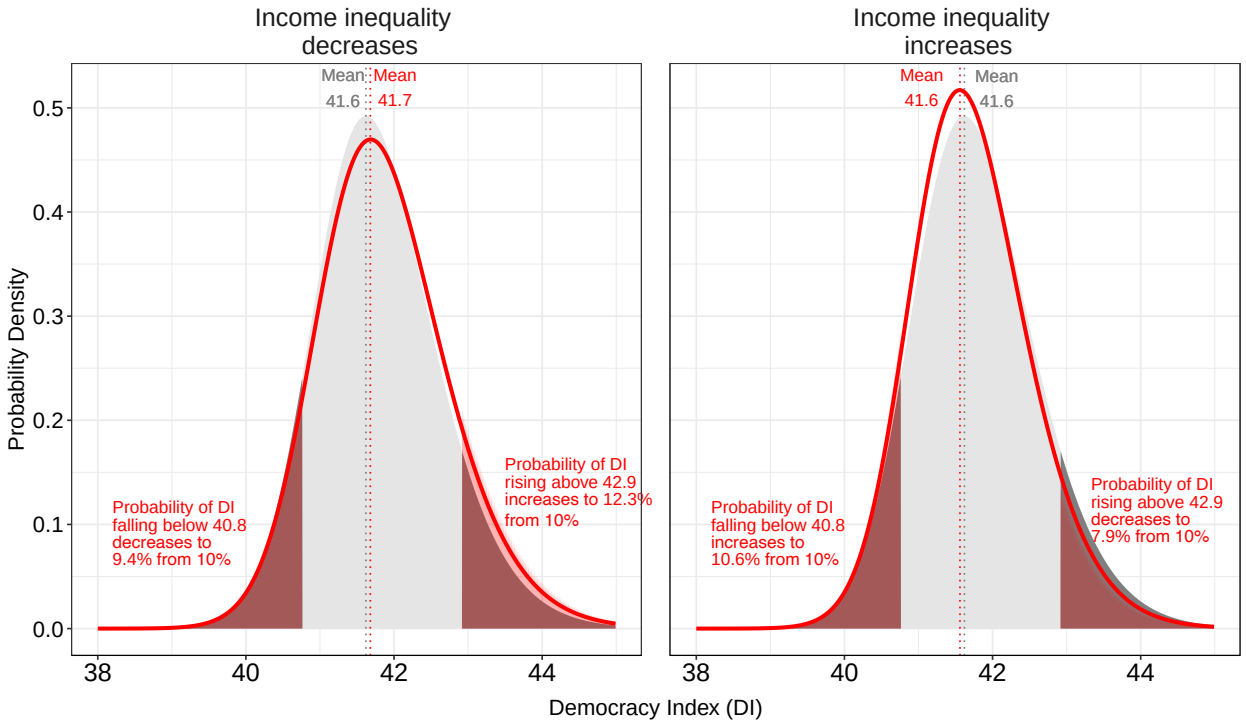

Figure 4.7: **Effect of Changes in Income Inequality on Probability Densities.**

Note: The gray shaded areas are estimated as a baseline distribution by interpolating the mean values of all variables into the estimated quantile coefficients. The red solid lines indicate the estimated conditional distribution when the level of income changes one standard deviation from its mean. The darker gray shaded areas indicate the probability of the democracy index falling below 40.8 or rising above 42.9 at 10% confidence. The darker red areas also indicate the probability of the democracy index falling below 40.8 or rising above 42.9. The gray and red dotted lines are the mean of the distribution.

suggests an asymmetric relationship. The asymmetric assumption by Haggard and Kaufman (2012) and Houle (2009) is supported by the results, but the shape of asymmetry is the opposite. They argue that there is little association between income inequality and the upside Democracy-at-Risk, while the downside Democracy-at-Risk is larger because elites would impose authoritarian rule under redistributive pressures from the poor (Houle 2009). However, the estimated results present the risks are asymmetric in that the changes in the upside Democracy-at-Risk is larger than the downside Democracy-at-Risk.

It is beyond the scope of this article to explore the reasons behind this asymmetric relationship, but the results have implications for the analysis of democratic backsliding. Backsliding and consolidation entail nuanced changes in democratic rule rather than sudden transitions between different political regimes, as theorized by (Houle 2009). Therefore, the improvement of democratic governance is more likely to be influenced by the combined efforts of both the masses' social activities and the elites' endeavors. The assumption that democratization is exclusively determined by the equilibrium of strategic interaction between elites and masses may be overly restrictive when considering the gradual improvement of democratic rules. Consequently, an increase in income inequality may not necessarily lead to a significant alteration in the downside risk of democracy. This is because income inequality does not make the costs for elites of mobilizing against democratic rule outweigh the losses arising from redistribution under democratic rule.

Lastly, to compare the upside and downside Democracy-at-Risk for each economic factor, I conduct hypothetical scenario analyses where each economic factor takes values ranging from two standard deviations below the mean to two standard deviations above the mean, while other factors remain at their mean values. Similar to the previous approach, I set the threshold values for the upside and downside Democracy-at-Risk to be the democracy index when the probabilities in both tails are 10% in the baseline scenario[7]. Figure 4.8 illustrates the downside Democracy-at-Risk using red lines and the upside Democracy-at-Risk using blue lines.

In the left panel of Figure 4.8, the downside and upside Democracy-at-Risk move in parallel. As the conditional distributions compress towards the mean, resulting in lower variances, the probability of the democracy index falling below 40.8 (or rising above 42.9) becomes zero as the level of income increases. This suggests that an increase in the level of income stabilizes the current state of the political regime at any level of the democracy index. On the contrary,

[7]Specifically, the values are 40.8 for downside risk and 42.9 for upside risk. I also conduct sensitivity analyses with different thresholds calculated through the probabilities in both tails are 5% and 25% in the baseline scenario. The details are described in Appendix

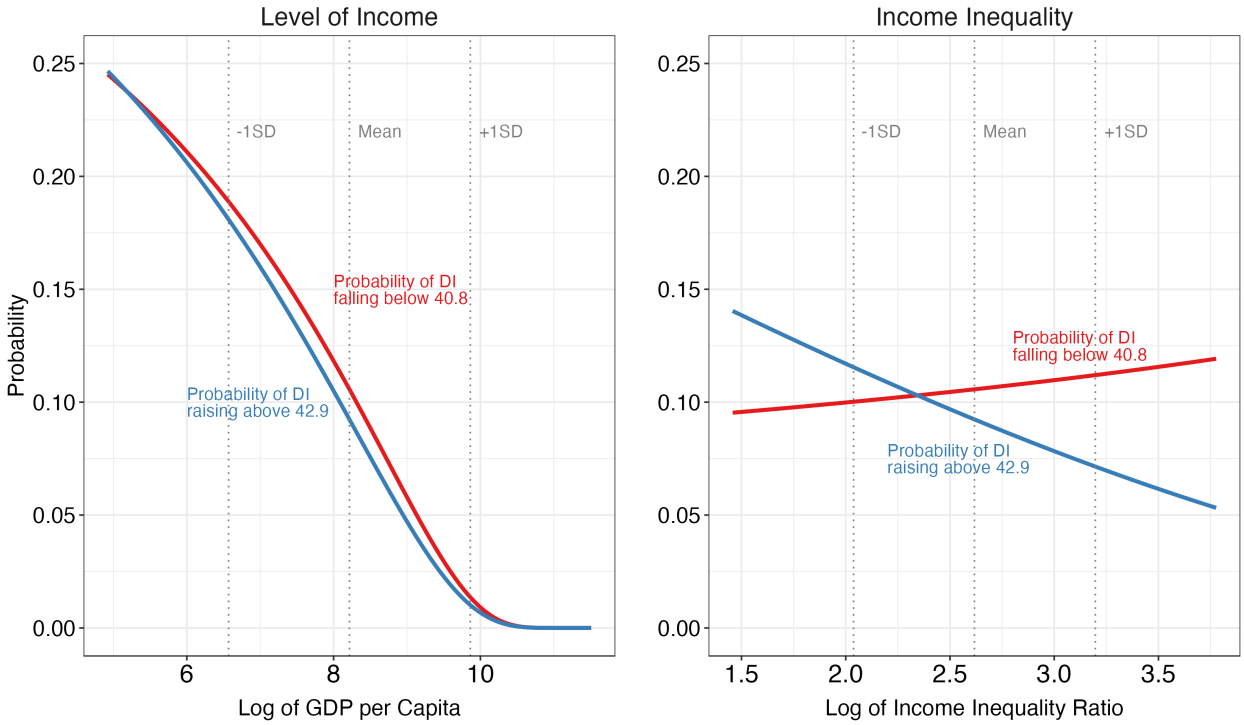

Figure 4.8: **Effect of Changes in Economic Factors on Democracy-at-Risk.**

Note: The red line indicates the downside Democracy-at-Risk, the probability of the democracy index falling below 40.8, and the blue line indicates the upside Democracy-at-Risk, the probability of the democracy index rising above 42.9. These thresholds are estimated from the probabilities in both tails are 10% in the baseline scenario. The gray dotted lines indicate the mean values of each economic variable, one standard deviation below and above the mean.

as shown in the left panel of Figure 4.8, the downside and upside Democracy-at-Risk exhibit asymmetric movements. The downside Democracy-at-Risk, which represents the probability of the democracy index falling below 40.8, increases as the income inequality ratio rises, while the upside Democracy-at-Risk, representing the probability of the democracy index rising above 42.9, decreases. Furthermore, the slope of the upside Democracy-at-Risk is steeper compared to the slope of the downside Democracy-at-Risk. This suggests that the impact of income inequality on democratic consolidation is more significant than its impact on democratic regression. Therefore, similar to the previous analysis, these results highlight

the symmetric effect of the level of income and the asymmetric impact of income inequality on the dynamics of democracy.

4.6 Conclusion

This article introduces the use of quantile regression and fitting the quantile coefficients to conditional distribution to explore asymmetric political relationships. Despite many political science studies embedding asymmetric assumptions in their theories, hypotheses, and data, these studies are mainly tested in qualitative approaches, such as Qualitative Comparative Analysis. Few scholars offer quantitative tools to explore asymmetric assumptions, and thus these tools are paid little attention. I propose the method to quantify asymmetry using quantile regression and the skewed t-distribution, demonstrating the effectiveness of the method in capturing nuanced impacts of economic factors on the level of democracy. While I focus on the theories on democracy in the application, this article provides a tool that allows researchers to examine a wide range of important questions in political science that have potentially asymmetric theories that have not been tested.

Nevertheless, the method proposed in this article has room for further development. First, it is difficult to use the shape of conditional distribution and the downside and upside risk of each factor in statistical decisions because the estimations of the skewed t-distribution do not provide confidence intervals. While the applications in this article, as well as previous studies (Adrian, Boyarchenko, and Giannone 2019; Adrian et al. 2018; Banerjee et al. 2020), treat the quantile coefficients as known at the first stage, future research could propagate the estimation uncertainties into the skewed t-distribution. Second, the method can be extended to examine more complicated and nuanced theories and data by relaxing the assumption of the proposed method. For instance, the fixed effect quantile regression model in this article only captures the parallel shift of quantile coefficients (location) to calculate the average coefficients across units. But the recent studies of quantile regression offer the fixed effect model that estimates the unit-specific association among quantile coefficients that differentiate the skewness of conditional distribution (Machado and Silva 2019). Likewise,

future studies could incorporate instrument variables to have a robust causal identification strategy, estimate the quantile coefficient for count and binary data, depending on data and application, or use the Bayesian approach to fitting the skewed t-distribution, instead of maximum likelihood, to explore the more complex data that require prior distribution to converge.

Appendix A

APPENDIX TO CHAPTER 2

A.1 Effect of Democratic Accountabilities on Macroprudential Policy

Table A.1: **Effect of Democratic Accountabilities on Macroprudential Policy.**

	DV: Macroprudential Policies on Lending and Currency Restrictions									
	IV: Competitive elections					IV: Executive constraints				
	(a)	(b)	(c)	(d)	(e)	(a)	(b)	(c)	(d)	(e)
Covariate	Base model					Base model				
Competitice elections	−0.517*	−0.655**	−0.465	−0.815**	−0.839**					
	(0.22)	(0.24)	(0.22)	(0.24)	(0.26)					
Executive constraints						−0.334	−0.502*	−0.269	−0.553**	−0.547*
						(0.18)	(0.20)	(0.18)	(0.20)	(0.23)
Banking crisis	−0.038	−0.158	−0.065	0.186	0.067	−0.067	−0.189	−0.099	0.136	0.009
	(0.26)	(0.28)	(0.27)	(0.27)	(0.29)	(0.26)	(0.28)	(0.27)	(0.27)	(0.29)
GDP per capita	0.082*	0.066	0.118*	−0.021	0.06	0.062	0.043	0.096	−0.063	0.021
	(0.04)	(0.06)	(0.05)	(0.05)	(0.08)	(0.03)	(0.06)	(0.04)	(0.05)	(0.08)
Corruption		0.237			−0.172		0.259			−0.229
		(0.44)			(0.54)		(0.45)			(0.55)
Capital account openness			−0.067		−0.129**			−0.067		−0.125**
			(0.04)		(0.05)			(0.04)		(0.05)
Private Credit (% of GDP)				0.174	0.195				0.192	0.211
				(0.08)	(0.09)				(0.08)	(0.09)
Total country-years	28,141	23,574	26,597	25,130	20,484	28,067	23,527	26,532	25,074	20,437
Total countries	126	107	121	126	104	126	107	121	126	104
Total events	449	389	432	349	297	448	389	432	349	297
End of estimation year	2020	2020	2020	2017	2017	2020	2020	2020	2017	2017
AIC	4,060	3,381	3,862	3,179	2,580	4,052	3,382	3,864	3,182	2,584
BIC	4,073	3,397	3,878	3,194	2,602	4,064	3,398	3,880	3,197	2,606

Note: *p<0.1; **p<0.05; ***p<0.01.
Robust country-clustered standard errors in parentheses.

A.2 Sensitivity Analysis: Leave-one-out Macroprudential Policy Tool

In this analysis, I take a leave-one-out approach for the dependent variable, a set of macroprudential policy tools, because one policy tool might strongly influence the results. If one policy tool influences the entire result, the estimation result of excluding that policy tool will not hold a negative association between Democracy and macroprudential policy adoption. Figure A.1 shows nine leave-one-out tests for five different combinations of covariates. All nine results indicate the relative risk of adopting macroprudential policies when *Democracy* moves from the 25th to 75th percentile among the sample countries is below 1, suggesting that the effect of democracy on macroprudential policy implementation is robust and not driven by one particular macroprudential tool. While some tests are not statistically significant at the 5% level, partly because of the smaller sample size, the relative risks are clearly negative, as expected.

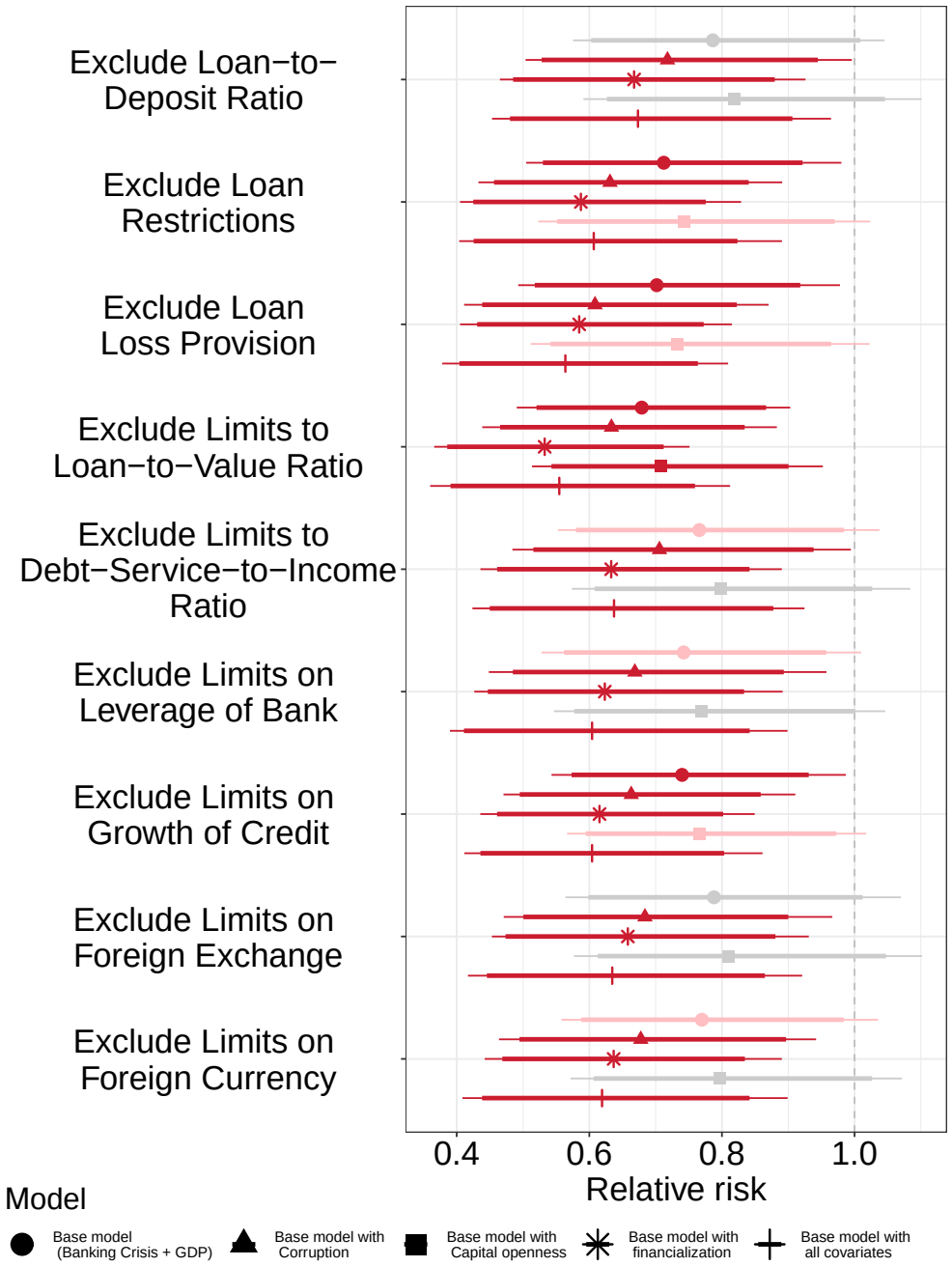

Figure A.1: **Leave-One-Out Test for Effect of Democracy on Macroprudential Policy**

Note: Horizontal thin and thick bars are the 95% and 90% confidence intervals, respectively. Red, light red and gray colors indicate significance at the 5%, and 10% level, and insignificance, respectively.

A.3 Placebo Test for Generalized synthetic control

A.3.1 In-Time Placebo Test: Changing Treatment Timing

In this analysis, I conduct an in-time placebo test that assigns the regime shift to different dates five years before and after the actual events. If the timing of increasing the difference between treatment and control countries in the placebo test does not change, the original estimation is causally plausible. On the top panel, I advance the timing of the treatment event to five years. The result shows the estimated difference between treatment countries and control countries becomes negatively wider, but the difference is not statistically significant at both 90% and 95% levels. Likewise, on the bottom panel, I shift the timing of treatment five years before the actual event. The red line, the original estimation, and the black line, the placebo estimation, clearly overlap each other, suggesting that democratization's treatment effect is robust.

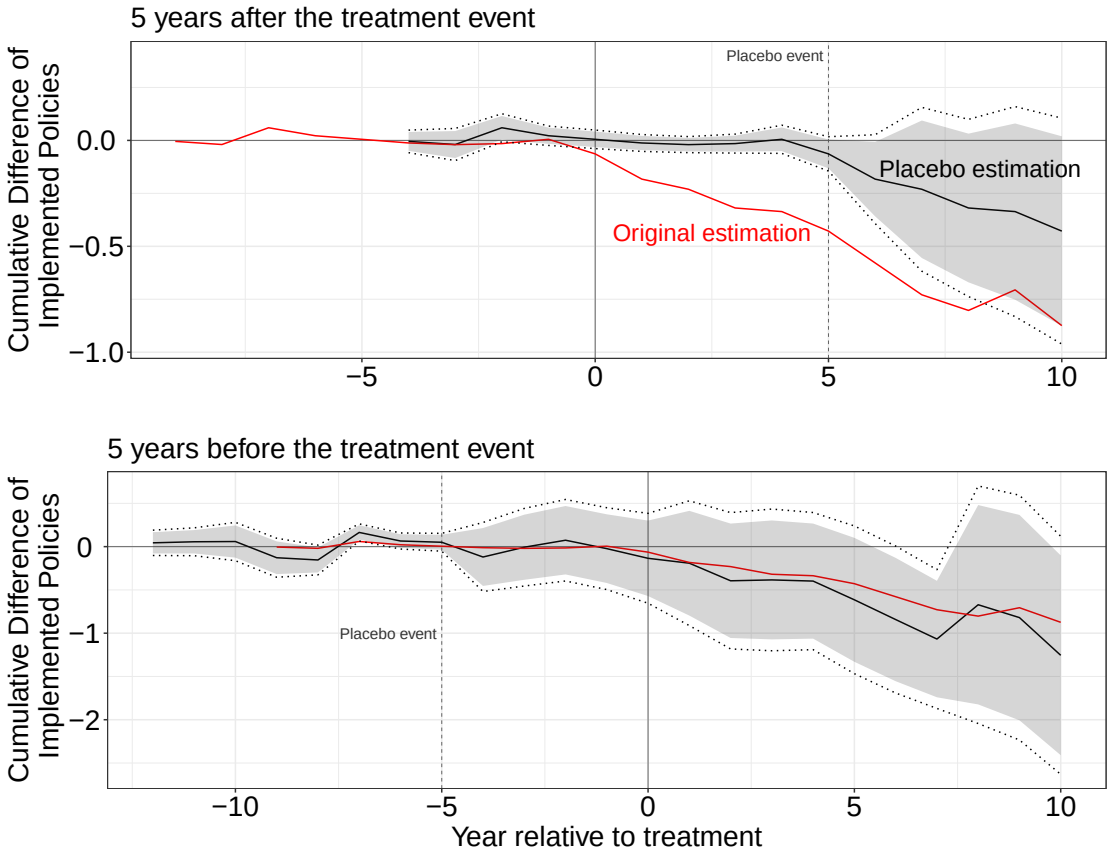

Figure A.2: **In-Time Placebo Test for Effect of Democratization on Cumulative Implementation of Macroprudential Policies**

Note: Treatment countries included: Georgia (2004), Kenya (2002), Lesotho (2002), Mexico (2000), Paraguay (2003), Peru (2001), Senegal (2000), and Zambia (2008). Red lines indicate the original estimation. Synthetic control countries are 31 countries. Shaded areas and dotted lines in the gap plot are the 90% and 95% confidence intervals, respectively.

A.3.2 Leave-One-Out Test for Control Countries

In this analysis, I conduct leave-one-out tests for synthetic control countries, in which I remove each of the control countries and repeat the synthetic control estimations. Suppose the estimated weight is heavily toward one country, and the policy implementation in that country affects the trajectory of the synthetic country unit. In that case, that single country could generate the difference between the treatment and synthetic control countries. To address this issue, a leave-one-out test can identify the influence of each country as a control unit. The red line of Figure A.3 indicates the difference between the treatment and the synthetic control countries in the original estimation, and the gray lines are the results of leave-one-out tests for all 31 control countries (31 estimations). Overall, the results are consistent with the original estimation, in which the estimated difference cumulatively increases after the event occurs. While the estimations excluding some countries that aggressively implement macroprudential policies, such as Kyrgyzstan, China, and Oman, are not statistically significant ten years after the event, these results still hold statistically significant seven and eight years after the event, and the amount of difference is as large as the original estimation, suggesting that democratization's treatment effect is robust.

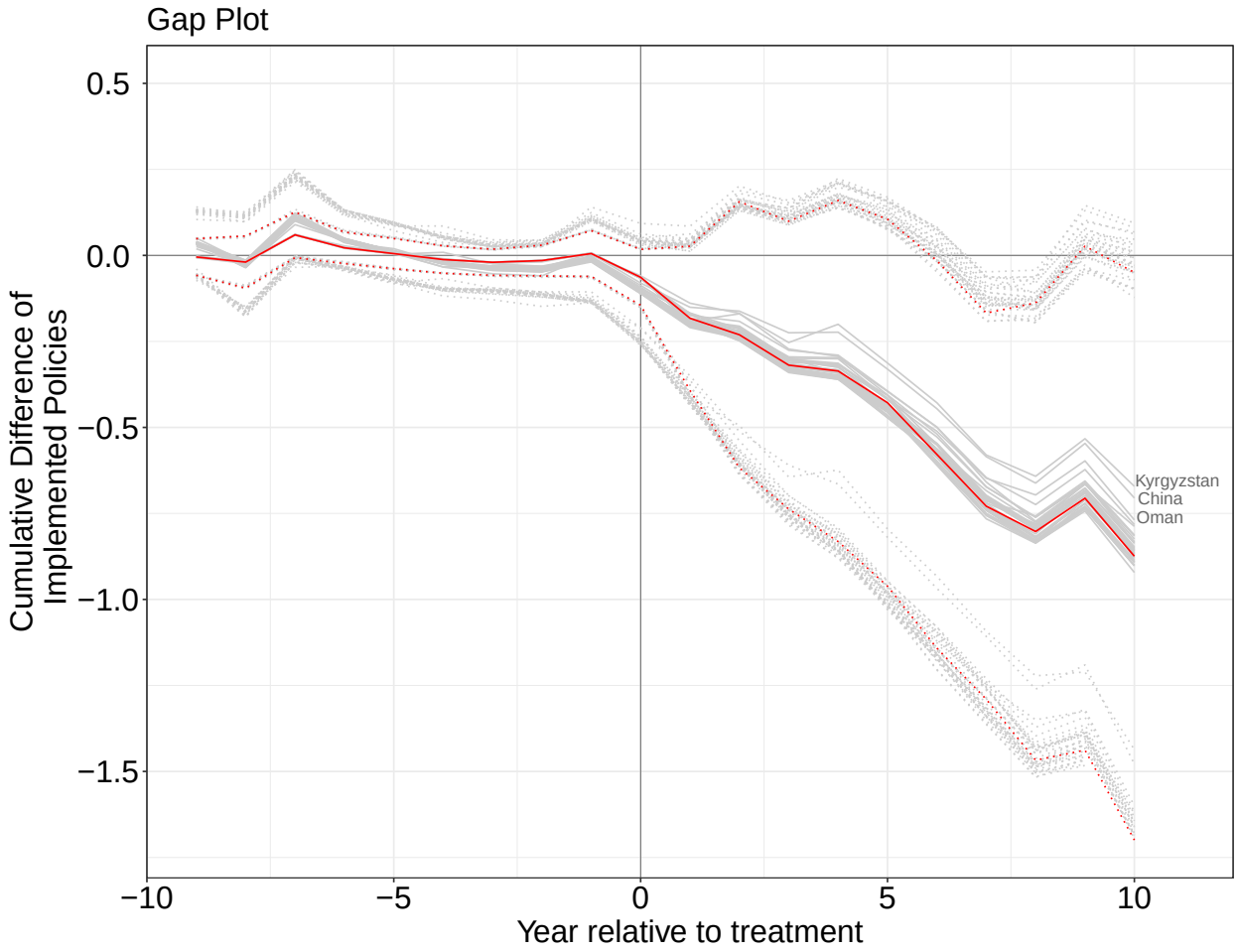

Figure A.3: **Leave-One-Out Test for Effect of Democratization on Cumulative Implementation of Macroprudential Policies**

Note: Treatment countries included: Georgia (2004), Kenya (2002), Lesotho (2002), Mexico (2000), Paraguay (2003), Peru (2001), Senegal (2000), and Zambia (2008). Red lines indicate the original estimation. Synthetic control countries are 31 countries for original estimation (red line) and 30 countries for other estimations. Dotted lines in the gap plot are the 95% confidence intervals.

Appendix B

APPENDIX TO CHAPTER 3

B.1 Sampling Algorithm of the TVPP Model

This appendix fully describes the sampling algorithm of the TVPP model. Each conditional sampler is standard except the Kalman filter and simulation smoother used to efficiently generate the time-varying parameters $\boldsymbol{\beta}$. We apply the algorithm of de Jong and Shephard for the generation of $\boldsymbol{\beta}$. A key aspect in this algorithm is rearranging the originally nonlinear state-space form representation of the TVPP model into a conditionally linear state-space form given the latent variable, $\boldsymbol{z}$. The detail of the sampling follows.

Sampling $\boldsymbol{z}$

We generate z_{it} from its conditional posterior distribution given other parameters. The conditional posterior distribution results in the truncated normal distribution $TN(\boldsymbol{x}_{it}'\boldsymbol{\beta}_t + \mu_i, 1)$. The range of the distribution is $z_{it} > 0$ if $y_{it} = 0$, and $z_{it} \leq 0$, otherwise. We use a rejection sampling where we draw the sample from the normal distribution and keep throwing the sample away until it falls into the corresponding range (Tierney, 1994). We generate z_{it} for $i = 1, \ldots, I$, and $t = 1, \ldots, T$, separately.

Sampling $\boldsymbol{\beta}$

We generate $\boldsymbol{\beta}$ using the well-established sampler for the state variables of the linear Gaussian state space model (de Jong and Shephard, 1995). We apply the Kalman filter and simulation

smoother for the state space model conditional on $\boldsymbol{z}$ and other parameters:

$$\begin{aligned} \tilde{\boldsymbol{z}}_t &= \boldsymbol{x}_t'\boldsymbol{\beta}_t + \boldsymbol{e}_t, \quad \boldsymbol{e}_t \sim N(\boldsymbol{0}, \boldsymbol{I}), \quad t = 1, \ldots, T, \\ \boldsymbol{\beta}_{t+1} &= \boldsymbol{\beta}_t + \boldsymbol{v}_t, \quad \boldsymbol{v}_t \sim N(\boldsymbol{0}, \boldsymbol{\Sigma}), \quad t = 1 \ldots, T-1, \end{aligned}$$

where $\boldsymbol{e}_t = (e_{1t}, \ldots, e_{It})'$, $\tilde{\boldsymbol{z}}_t = (\tilde{z}_{1t}, \ldots, \tilde{z}_{It})'$, $\tilde{z}_{it} = z_{it} - \mu_i$, and we assume that $\boldsymbol{\beta}_1 \sim N(\boldsymbol{m}_0, \boldsymbol{Q}_0)$, where $\boldsymbol{Q}_0 = \mathrm{diag}(q_{01}^2, \ldots, q_{0k}^2)$. This specification is exactly the standard linear state-space model representation (de Jong and Shephard, 1995, pp. 343). We apply the algorithm of generating the state variables to our model straightforwardly.

Sampling $\boldsymbol{\mu}$

We specify the prior for $\boldsymbol{\mu}$ as $\boldsymbol{\mu} \sim N(\boldsymbol{\mu}_0, \boldsymbol{V}_0)$, where $\boldsymbol{V}_0$ is a diagonal matrix. We define a matrix of dummy variables by , where each row corresponds to the unit and time (i, t), and each column to unit effect, for $i = 1, \ldots, I$. The i-th column of takes one, corresponding to the row (i, t), and zero otherwise. Then, we obtain the conditional posterior distribution $\boldsymbol{\mu} \,|\, \cdot \sim N(\hat{\boldsymbol{\mu}}, \hat{\boldsymbol{V}})$, where

$$\hat{\boldsymbol{V}} = \left(\boldsymbol{V}_0^{-1} + '\right)^{-1}, \quad \hat{\boldsymbol{\mu}} = \hat{\boldsymbol{V}}\left(\boldsymbol{V}_0^{-1}\boldsymbol{\mu}_0 + '\,\hat{\boldsymbol{z}}\right),$$

and each element of $\hat{\boldsymbol{z}}$ is $z_{it} - \boldsymbol{x}_{it}'\boldsymbol{\beta}_t$.

Sampling $\boldsymbol{\sigma}$

We set the prior for σ_j^2 as $\sigma_j^2 \sim IG(n_{0j}/2, S_{0j}/2)$, where IG denotes the inverse gamma distribution. The conditional posterior distribution is given by $\sigma_j^2 \,|\, \cdot \sim IG(\hat{n}_j/2, \hat{S}_j/2)$, where

$$\hat{n}_j = n_{0j} + T - 1, \quad \hat{S}_j = S_{0j} + \sum_{t=1}^{T-1} (\beta_{j,t+1} - \beta_{jt})^2,$$

for $j = 1, \ldots, k$.

Appendix C

APPENDIX TO CHAPTER 4

C.1 Sensetive Analysis for Effect of Changes in Economic Factors on Demoracy-at-Risk

In this analysis, following Figure 4.8, I conduct hypothetical scenario analyses where each economic factor takes values ranging from two standard deviations below the mean to two standard deviations above the mean, while other factors remain at their mean values. As for sensitive analysis, I set the threshold values for the upside and downside Democracy-at-Risk to be the democracy index when the probabilities in both tails are 5% and 25% in the baseline scenario. The specific values of the thresholds are summarized in the table below.

Table C.1: **Threshold Values for Upside and Downside Democracy-at-Risk**

Probability	Upper Threshold	Lower Threshold
5%	43.3	40.5
10% (Fig 4.8)	42.9	40.8
25%	42.3	41.2

Similar to Figure 4.8, the results in Figure C.1 present the symmetric effect of the level of income and the asymmetric impact of income inequality on the dynamics of democracy.

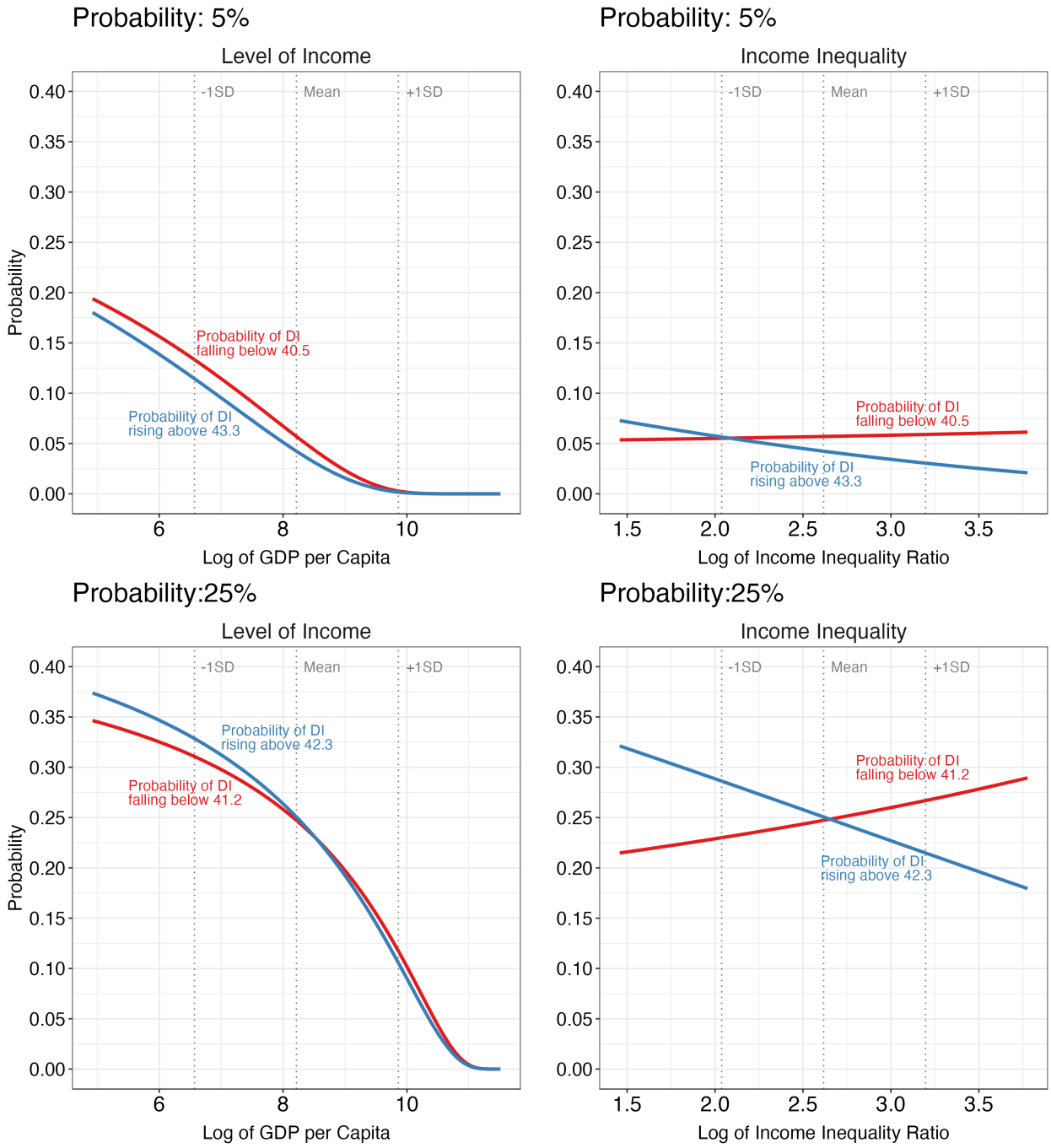

Figure C.1: **Effect of Changes in Economic Factors on Democracy-at-Risk.**

Note: The red line indicates the downside Democracy-at-Risk, the probability of the democracy index falling below 40.5 for 5% scenario and 41.2 for 25% scenario, and the blue line indicates the upside Democracy-at-Risk, the probability of the democracy index rising above 43.3 for 5% scenario and 42.3 for 25% scenario. The gray dotted lines indicate the mean values of each economic variable, one standard deviation below and above the mean.

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