

INEQUALITY DYNAMICS

A study on income and political inequality in the United States

A conceptual virtual lab

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Foreword

This research does not claim to represent the truth, rather a version of the truth; a series of hypotheses that when stranded together provide a hypothesis explaining why the phenomenon of inequality in the US has exacerbated through the past half a century. It aims at encouraging the debate on inequality by making explicit its possible structural causes in a transparent manner that both informs and encourages scrutiny. This is a fundamental feature of System Dynamics studies, to expose the possible underlying structure allowing debate over its assumptions and findings, building more consensus as the debate progresses. The threat of income inequality to democracy has been debated by prominent academics, although only having strong empirical evidence in the past few years. It is interesting to note that the debate on the influence of money over politics is not new, and has perpetuated at least since the times of Aristotle. This research is but a drop in the everlasting ocean of such debate.

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I would like to thank Prof. Yaman Barlas, as his criterion for choosing a topic was very simple yet so profound. He advised me to choose a ‘man in the street’ problem, meaning a persistent problem that many people of different backgrounds and education levels care about, have an opinion about, but can do little to change. I believe this research is a textbook example of a ‘man in the street’ problem, and I am grateful for his guidance.

In turning this problem to a research, I was guided, nurtured, encouraged, and supported by two of the smartest, most energetic, and ambitious people I have ever met; Professors Birgit Kopainsky and Paulo Gonçalves. They have been my mentors, putting up with my political rants and encouraging me despite my little background on the topic, providing me with priceless technical support and insights. I have to apologize to them however, because they were right, as always, in that my model and topic was way too big! I have no regrets, but it is always wise to acknowledge when one had made a mistake. I would like to cordially thank Professor Inge Bleighenbergh for her feedback on my proposal, as it helped me restructure my topic to its current form. I must also thank Professor Vincent De Gooyert for granting me an audience without prior appointment to help me with my methods chapter.

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I must thank my family (My mother, father, and brothers) as well as my close friends for encouraging me to embark upon this master’s program, and my team at P&G (especially Amr Nael, Omar Elsayad, and Naif Alansari) for supporting my decision to resign my extremely secure job and delve into the unknown. I believe I have become more open, mind and heart, more honest with myself, and have realized that my restlessness is endless, which is alright. I have come to realize that my struggles are unique, and at the same time they are not; it is from that notion that this research starts.

Abstract

Post-tax income inequality in the US has been rising since the mid-1970s at a rate higher than most industrial democracies. Government policy has contributed to, and failed to restrict this trend despite popular concern for the issue of increasing inequality, and against public preferences for progressive taxation. Recent empirical findings have detected a wealth-bias in US policy-making as a result of several factors including low voter participation by low-income earners, political party structure and practices, the role of money in elections, and in lobbying. This research aimed to structure the knowledge on how income inequality translates to political inequality, and vice versa, through a closed-boundary, white-box theory using System Dynamics. Its findings provide a theory explaining the success to the successful phenomenon observed in empirical data, using on a free-market approach to political campaigns and lobbying in the US. The heterogeneity of political behaviour across income groups are the main reason for this divergence in political influence, as well as incomes, of different income groups. Attitude changes towards political spending by low income earners in the US have been shown to be insufficient to reduce the trend of rising inequality. Testing two policies of campaign finance reform, the results of this study indicated that campaign finance reform will have unintended consequences shifting the money from campaigns to lobbying, reinforcing the idea that campaign finance and the lobbying industry exist on a continuum on which money is turned to influence.

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“Liberties protected by the principle of participation lose much of their value whenever those who have greater private means are permitted to use their advantages to control the course of public debate.” Rawls (1999, 197-198)

1. Introduction

1.1. Background

Income inequality in the United States has been disproportionately increasing versus other industrial democracies since the mid-1970s (Piketty et al, 2018; Forster & Levy, 2014), measured using the GINI Index, a standard measure for income and wealth inequality (Hacker & Pierson, 2010). Income inequality can be categorized into market inequality, and net inequality (Ostry, Berg & Tsangarides, 2014). The first being inequality in income before taxes and is dependent on the disparity in wages and capital income, as dividends on stocks and interest on bonds (Piketty et. al, 2016; Ferejohn, 2009). It is influenced by a variety of factors such as technology, globalization, and institutional factors such as regulation by the government or bargaining power of different groups, such as labour, and trade unions (Forster & Levy, 2014; Levy & Temin, 2007). Net inequality is influenced by the tax and transfer systems which temper market inequality by applying progressive taxation on higher incomes, and transferring benefits to lower-income citizens (Piketty, Saez & Zucman, 2017). Government policy, thus, has an important role in taming both market, and net income inequalities (Hacker & Pierson, 2010; Task Force on Inequality and American Democracy (TFIAD), 2004)

It has been observed that government policies in the US have exacerbated inequality for the past four decades, by deregulation (Bonica et al, 2013), and regressiveness in the tax system (Piketty, Saez & Zucman, 2017; OECD, 2011). Furthermore, institutional changes such as the grave decline in labour union memberships also reduced the bargaining power of wage earners (Levy & Temin, 2007) after an era of egalitarian growth and general welfare-state practices which began in the great depression and lasted until the 1970s (Levy & Temin, 2007). No significant changes in public opinion in regards to taxation occurred in the 1970s to justify the shift that occurred in government policy in regards to taxation (Hacker & Pierson, 2010).

The American public, in fact, has been preferring more redistribution (Page & Jacobs, 2009) and believed that the highest income earners pay too little taxes for at least two decades (Gallup, 2016), yet government policy has not changed to reflect such preferences. Recent empirical findings have shed light on a stark wealth bias in US policy-making when policy preferences of the poor diverged from the preferences of the wealthy government policy followed that of the wealthy (Gilens & Page, 2014; Bartels, 2008; Gilens, 2012; Flavin, 2015). Contrasting

theories on US politics, Gilens & Page (2014) found that economic elite and business-based interest groups are dominant in shaping US policy, compared to the median voters and public-based interest groups, raising important questions on democratic representation in the US. This may explain why progressive tax policies have been very difficult to enact in the US for the past few decades.

Income inequality translates to political inequality through four main channels, voter participation, political party structure and practices, campaign contributions, and interest-group lobbying of politicians (TFIAD, 2004). Lower-income citizens do not vote as much, nor are engaged in politics, as those with higher incomes (Bonica et al, 2013; Soss & Jacobs, 2009). The two dominant political parties, the Republicans and Democrats, have become excessively pro-business (Bonica et al, 2013) and greatly influenced by wealthy donors and within-party political activists (Soss & Jacobs, 2009). Campaign contributions to politicians come mainly from extremely wealthy donors and business interests (Bonica et al, 2013; TFIAD, 2004) and lobbying by business interests dominates Washington D.C. as opposed to mass-based interest groups (Hacker & Pierson, 2010; Hall & Miler, 2008). This suggests that money is a medium for influence of the two groups pointed to in Gilens & Page (2014).

The excessive amounts of money in political campaigns (Hall, 2016) and even higher sums spent on lobbying (Figueiredo & Richter, 2014) pose challenges for lower-income citizens to partake either in donating to politicians, or lobbying them as the cost of information is high (Hall & Deardorff, 2006), unbalancing democratic representation in the US (TFIAD, 2004). If government policy reflects the preferences of the wealthy Americans (Gilens & Page, 2014; Bartels, 2008; Gilens, 2012; Flavin, 2015), and money is the medium by which they influence government through campaigns and lobbying (Gerken & Tausanovitch, 2014), then government policies would generate more wealth for the wealthy giving them more influence over politicians who enact tax policy (Fuentes-Nieva & Galasso, 2014). This is a path dependent behaviour of 'success to the successful' as coined in Senge (1990). It suggests also that the problem of income inequality, which has been exacerbated by government policy, is unlikely to be resolved by government policy due to the government's wealth bias. The TFIAD (2004) argued that economic inequality threatens to solidify and exacerbate political inequality in terms of voice and influence; This collides with the 'one person, one vote' doctrine of US democracy.

Overcoming wealth bias in the political process needs a system-change that would reduce the influence of money in politics (Lessig, 2011), yet academia disproportionately focuses on campaign finance and campaign finance reform as opposed to lobbying when both are a continuum of converting money to influence over public officials, and are essentially privatized forms of a public function, funding the campaigns of elected officials and providing information that officials need to do their job (Gerken & Tausanovitch (2014). Calls for regulating campaign finance collide with constitutional concerns for free speech through donations to politicians and political expenditure (Dawood, 2015; Issacharoff, 2010), and proposals to constrain lobbying clash with as the right to petition an elected official (Gerken & Tausanovitch, 2014).

Categorizing campaign reform efforts into levelling-down (constraining private money's flow into politics) and levelling-up efforts (providing a publicly-funded alternative for private money in politics), Gerken & Tausanovitch (2014) emphasized on the need to broaden the scope of the debate on campaign finance reform to include lobbying, and proposed a levelling-up system of lobbying to counter inequality in petition by private interests. The 'Grant & Franklin project' by Lessig (2011) presents a levelling-up approach to campaign finance.

1.2. Problem formulation

Income inequality has been increasing in the United States for the past 40 years, more than it has in other industrialized democracies (Piketty et al, 2018; Forster & Levy, 2014), as shown in Figure 1 below from Forster & Levy (2014).

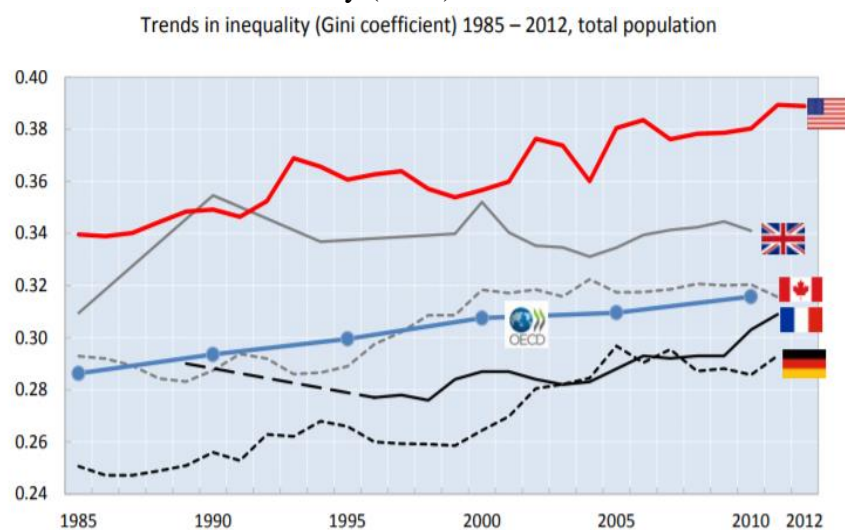


Figure 1 Inequality trends USA vs. Other OECD countries and OECD average

This has been a direct consequence of government policies, including tax policy (Piketty, Saez & Zucman, 2017; Bonica et al, 2013; OECD, 2011; Hacker & Pierson, 2010; Levy & Temin, 2007). The massive tax cuts enacted in the 1970s and through the 1980s in the US could not be traced to a change in voter preference (Hacker & Pierson, 2010). Figure 2 from the US Congressional Budget Office (2017) displays the trends in market inequality and net inequality (Please refer to chapters 2.2 & 2.3 for details on the difference between the two types). It indicates that Market inequality had risen, yet the effect of taxes and transfers has been muted in correcting for changes in wage and capital earnings to maintain a certain level of inequality.

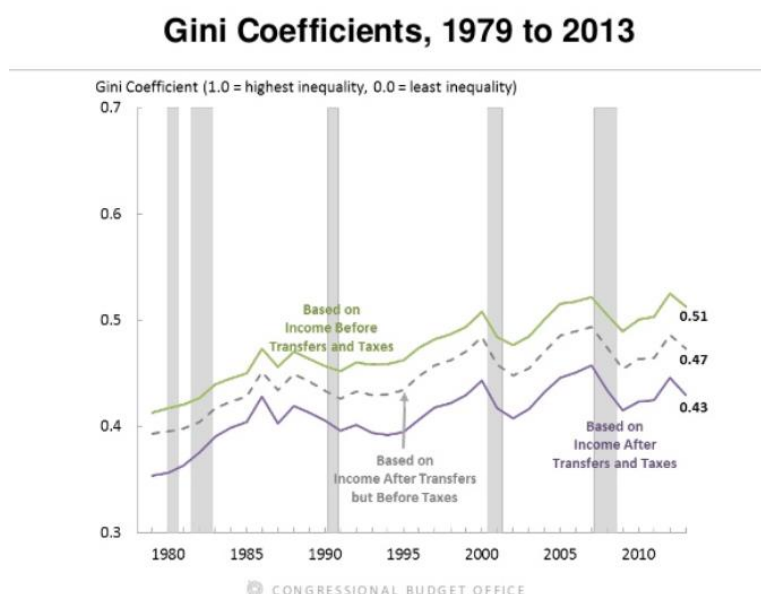


Figure 2 US historical trends in Market inequality vs. Net inequality - Source Congressional Budget Office (2017)

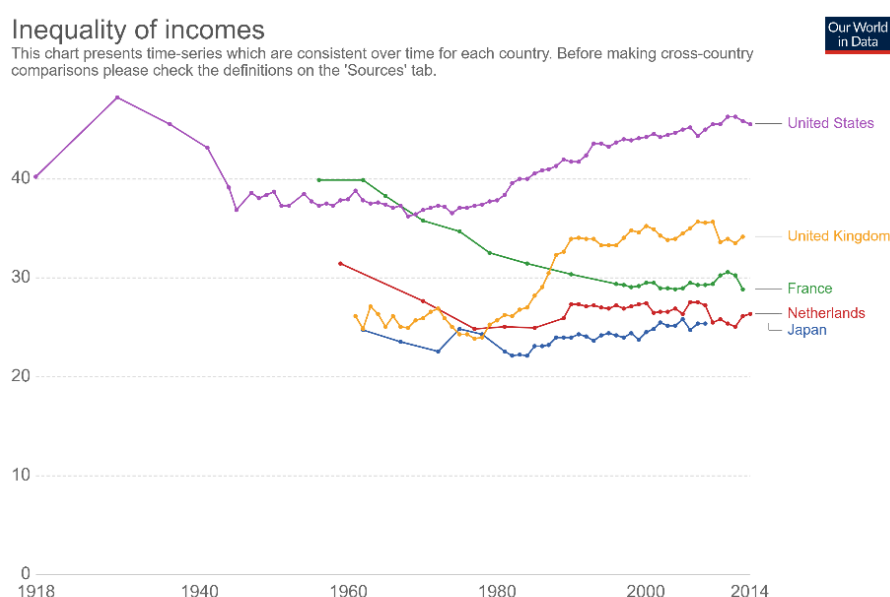


Figure 3 Net inequality trends in the US versus other industrial nations starting from the 20th Century – Source Roser & Ortiz-Ospina (2016)

Yet it is important to take these inequality trends in context. Figure 3 shows net inequality in the US compared to other OECD countries prior to the 1970s wave of tax cuts. Net inequality drastically declined in the wake of the great depression, which Levy & Temin (2007) explained was a result of the welfare state policies enacted in the ‘New Deal’ by the US Government during the great depression, policies that were reversed in the mid-1970s and 1980s.

Historical trends in polling data show that the preferences of American voters have been for more redistribution of income and wealth, as well as for higher taxes on the high-income earners and corporations (Gallup, 2016). *(Please refer to chapter 2.5 for further details)*. Recent evidence points out to the fact that US policy has been consistently following the preference of the wealthiest Americans and business-oriented interest groups (Gilens & Page, 2014; Bartels, 2008; Gilens, 2012; Flavin, 2015). When the preferences of the aforementioned groups diverged from those of the general public, policy followed the former.

Several factors combine to give unequal voice to the wealthiest Americans, including low voter turnout at the bottom of the income distribution, and political party practices which favour the wealthiest. Yet the most ubiquitous of factors is the influence of private money over politics in elections and lobbying (Lessig, 2011; Hacker & Pierson, 2010). Scarce research has combined both in a single framework (Gerken & Tausanovitch, 2014). Private funding of campaigns and supply of information to elected officials through lobbying are the means by which income inequality translates to political inequality in a vicious cycle (Fuentes-Nieva & Galasso, 2014)

Concentration of Income and Campaign Contributions in the Top 0.01 Percent of Households and Voting Age Population

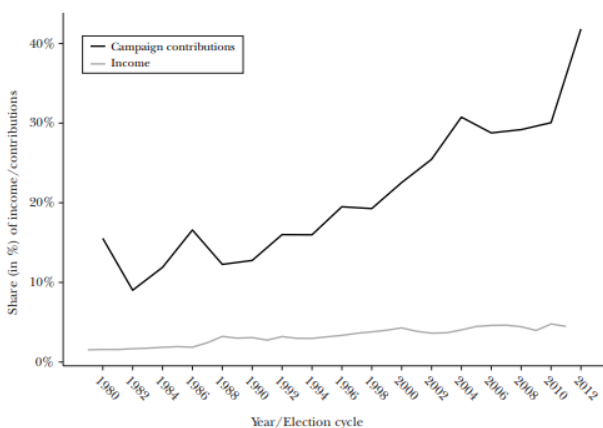


Figure 4 Historical trends of the concentration of campaign contributions at the top 0.01% income earners Source Bonica et al (2013)

Corporate PACs increasingly outspend Labor PACs in congressional elections

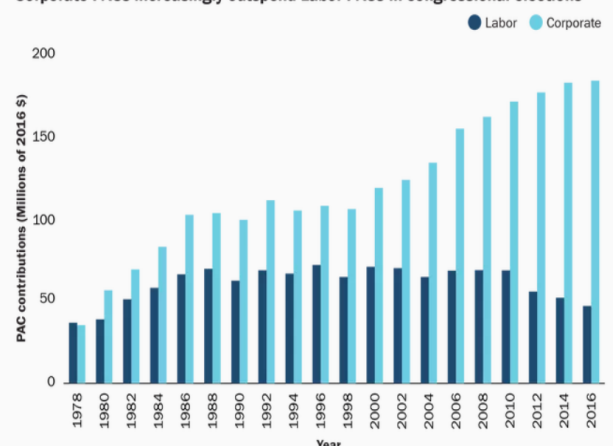


Figure 5 Historical trends of concentration of campaign contributions by business-oriented PAC Source: The Brookings Institution (2019)

Figure 4 & Figure 5 represent the concentration of campaign funds by the richest American households, and business (corporate) Political Action Committees (PAC) respectively. Note

that corporate PAC contributions are contrasted to labour union PACs as Hacker & Pierson (2010) pointed out to unions being the most significant organized group that represents the economic interests of the middle, and lower-income Americans. Figure 4 from Bonica et al (2013) shows that campaign contributions have grown to become extremely concentrated, with more than 40% of total campaign contributions come from the top 0.01% income earners. US Senate and House campaign expenditures have quadrupled (in real USD) between 1974 and 2016 (CFI, 2018). Figure 5 from Brookings Institution shows that in the late 1970s labour unions contributed on the same level as corporate PACs, yet were outgrown by corporate spending to a ratio close to 4:1 in 2016.

In terms of lobbying, Figure 6 shows growth in the lobbying industry since the late 1990s. No earlier datasets were found by the author on lobbying in the US, checking the US Senate Office of Public Records for earlier datasets, the earliest compiled by the Center for Responsive Politics (2019a, 2019b) graphed below:

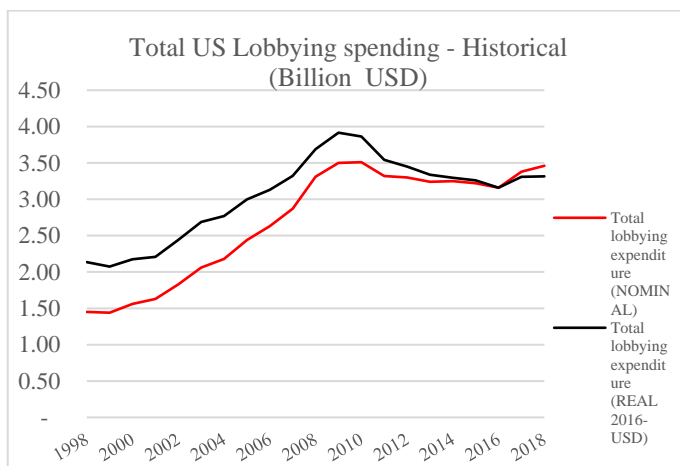


Figure 6 Growth of the lobbying industry in the US from 1998 to 2018 - Source Center for Responsive Politics (2019a)

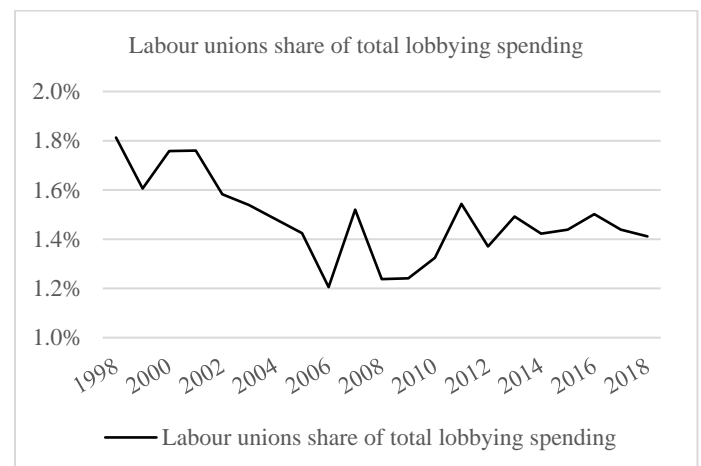


Figure 7 Decline in the unions share of lobbying as a % of total lobbying industry in the US from 1998 to 2018 - Source Center for Responsive Politics (2019b)

The lobbying industry has grown substantially to a multi-billion dollar industry, while Labour's share of that industry has been declining Figure 7, which may be explained by the declining membership rates of unions in the US (*Please refer to chapter 2.2 for more details on union densities and trends in the US*) thus the economic interests of the middle and lower-income groups have been systematically underrepresented in lobbying (less than 2% of total industry).

Given that government policy is needed to reduce inequality (Levy & Temin, 2007; Hacker & Pierson, 2010; Alvaredo et al, 2018), political capture presents the major obstacle to reducing inequality and a vicious cycle of influence and inequality (Fuentes-Nieva & Galasso, 2014).

Political scientists emphasize on majoritarian electoral democracy theories that focus on the median voter to constrain and correct inequality by voting-in officials who would enact redistributive policies (Bonica et al, 2013). Economists tend to downplay the role of government policy in shaping market forces which exacerbate inequality (Hacker & Pierson, 2010). Concurrently, Academics of Election law have recently began to recognize that lobbying is much more pervasive than campaign funding in exerting influence over politicians, yet there is still bias in calls for reform towards campaign finance reform, ignoring the role of lobbying in shaping political outcomes disproportionately favouring its private funders (Gerken & Tausanovitch, 2014). There seems to be a need for a synthesis of such multi-disciplinary accounts to explicitly delineate the interactions between income inequality and government policy, emphasizing on the role and function of money in US politics. This will help understand the mechanisms by which they affect one another and to advise on prospects for reform. Campaign finance reforms are usually unsuccessful and counterproductive due to the presence of legislative loopholes (Dawood, 2015) and money seems to always find a way around the rules (Lessig, 2011; Issacharoff & Karlan, 1998). The debate on lobbying regulation is far less structured than campaign finance (Gerken & Tausanovitch, 2014). The theory presented in this research will contribute to this debate by structuring knowledge present in the literature in a formal model, and testing the efficacy of reform proposals in the literature on the influence of money in US politics to overcome income inequality translating to political inequality, and hence reverse US income inequality trends observed for nearly half a century.

1.3. Research objective and questions

The overarching aim of this research is to synthesize an endogenous theory on income inequality and political representation in the US by explicitly mapping the dynamic interactions between income inequality and political activity of American citizens. This will provide an explanation for the observations of Gilens & Page (2014), Bartels (2008), Gilens (2012) and Flavin (2015). It will also contribute to the discussion on tax reform specifically, as the study focused on net inequality, inequality after taxes and transfers, but will extend to inform on regulatory and legislative reforms that generate market inequality as well. Tax policy is among a myriad of US policies that had changed since the 1970's to usher in an age of deregulation, and institutional failures (Levy & Temin, 2007; Forster & Levy, 2014; Hacker & Pierson, 2010). The theory of political capture developed in this research may speak, in a broad sense,

to the reason why such policies have been hard to reverse through legislation and executive action despite popular support.

This aim will be accomplished through two research objectives, the first is building a System Dynamics model to map the feedback mechanisms between inequality and political representation, explicitly mapping the means by which income inequality translates to political and representational inequality, outlining how representational inequality feeds back to exacerbate income inequality. The second objective is to use this model to investigate two approaches to campaign finance reform in the US, as it is argued to be the stepping stone to reforming the US political system to become more equal in representing the majority of citizens (Lessig, 2011). This research will accomplish these objectives by providing answers to the below research questions:

- RQ1: What are the feedback mechanisms by which net income inequality and the political system influence one another?
- RQ2: What are the implications of a free-market approach to the US political system, through elections and lobbying, on net income inequality?
- RQ3: What are the effects of campaign finance reform on reducing net inequality?

The first research question is explanatory as it aims to map the dynamic structure of interaction between income inequality and the US political system, a system which has a role of reducing inequality both in terms of income and representation.

The second research question is predictive as it aims to analyse the consequences of applying a free-market approach to political influence on political representation and hence government policy choices, which affect inequality. It focuses on the role of money in politics and how it translates income inequality to representational inequality.

The third research question is evaluative as it applies existing policy proposals to reform campaign finance laws, in order to analyse their efficacy in tempering the influence of unfettered money on US politics and policy.

1.4. Organization of study

This study is organized so that readers with little background knowledge on the topic can understand, relate to, and internalize the insights gained from this research. This explains the extensive literature review included in Chapter 2, starting with economics literature, moving to political economy, delving deeper into political science, and ending with election law; this only affirms the usefulness of System Dynamics as a tool for synthesizing cross-disciplinary, messy problems.

Chapter 3 gives a brief overview on System Dynamics and discusses the research strategy adopted, the methodology used in conducting SD research, as well as data collection and analysis methods. Chapter 4 gives an overview of the quantitative model built using SD, yet proceeds to explain the internal structure in the form of CLDs. The author decided not to include the model structure in the body of this thesis due to its disproportionately large size and detail complexity. CLDs, being useful tools for communication (Sterman, 2000), can aid the reader in understanding the dynamics of the problem without delving deep into the Stock & Flow details of each sector (Available in Appendices 1 & 2 in full detail). Chapter 4 aims to answer (RQ1).

Chapter 5 focuses on model calibration and model analysis to understand the implications of a free-market approach to the US political system, addressing (RQ2). Chapter 6 focuses on the two approaches to campaign finance reform as cited in Gerken & Tausanovitch (2014), whereby one employs a levelling-up approach, and the other a levelling-down approach to achieving more equality in the political economy of US elections, thus chapter 6 addresses (RQ3). Chapter 7 discusses some barriers and challenges to implementation of the studied policies. Chapter 8 concludes the research by revisiting the problem statement, research questions, model insights, tested policies, and implementation, conducting a critique of the study, and gives recommendations for future research.

2. Literature review

2.1. Inequality trends

Income inequality in the United States is amongst the highest both in OECD country rankings, and world rankings (Piketty, Saez, Zucman, 2017; Forster & Levy, 2014). Since the mid-1970s, both the pre-tax, and the post-tax national income shares of the top 10% has steadily grown while the share of the bottom 90% has declined, as is shown in Figure 8 & Figure 9.

From 1975 to 2014, the top 10% pre-tax income share of total national income has increased from 34.4% to 46.3% and their post-tax share from 29.7% to 39.1%. Concurrently, the share of the bottom 50% of income earners has declined from 20.1% to 12.6% in pre-tax income, and from 25.6% to 19.3% in post-tax income (Piketty, Saez, Zucman, 2017).

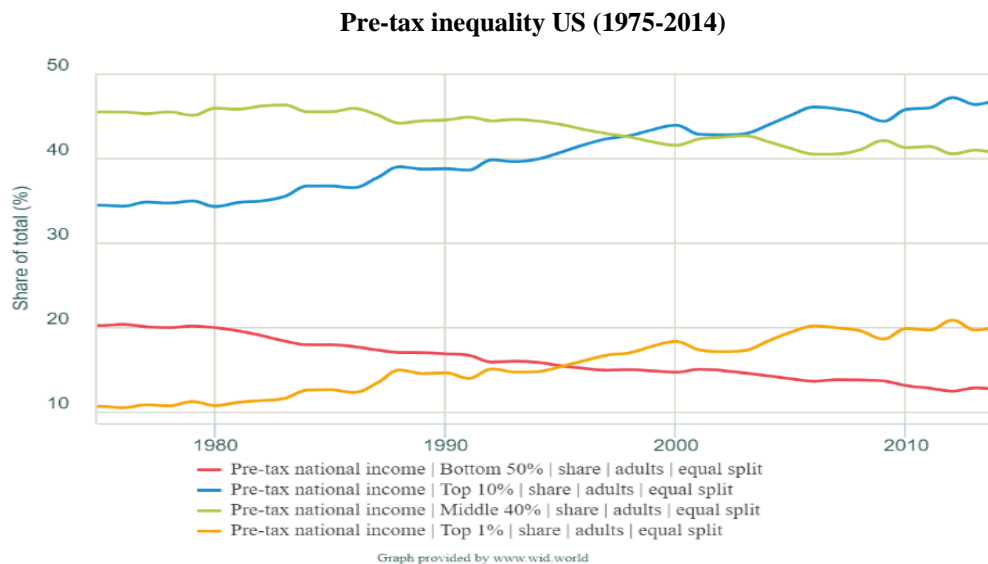


Figure 8 Pre-tax national income share by income group - Source World Inequality Database (2019)

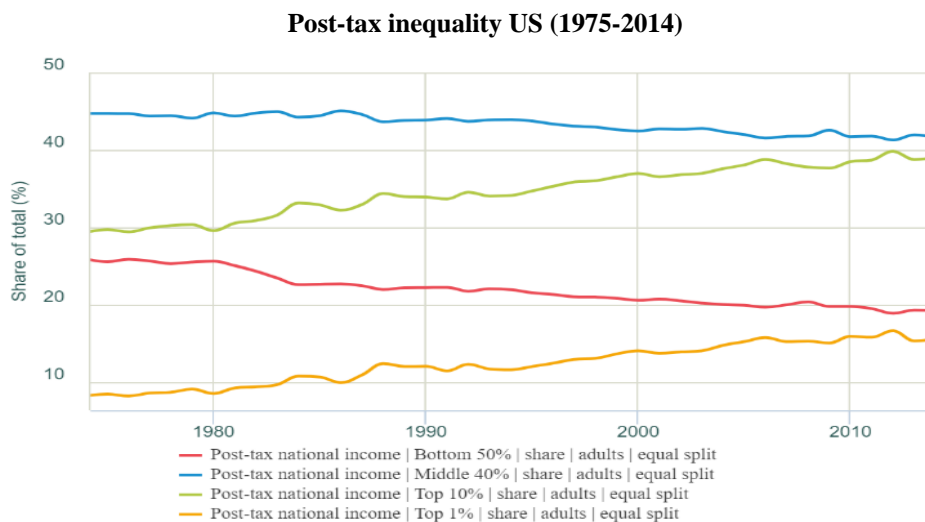


Figure 9 Post-tax national income share by income group - Source World Inequality Database (2019)

The above diverging trend translates to an increasing GINI index, a standard measure of income inequality capturing the dispersion of incomes in a population, as previously outlined in Figures 1, 2, & 3. (Please refer to Chapter 1.2 for details).

Hacker & Pierson (2010) have noted three features of the rising inequality in the US since the late 1970s. Firstly, the concentration of economic gains at the top of the income distribution. Secondly, such economic gains have been sustained, regardless of the party of the governing administration. Finally, the trickle-down effect of such gains, meaning their propagation to benefit society as a whole, has been minimal. The first and third features have been echoed in the OECD report on US inequality by Forster & Levy (2014).

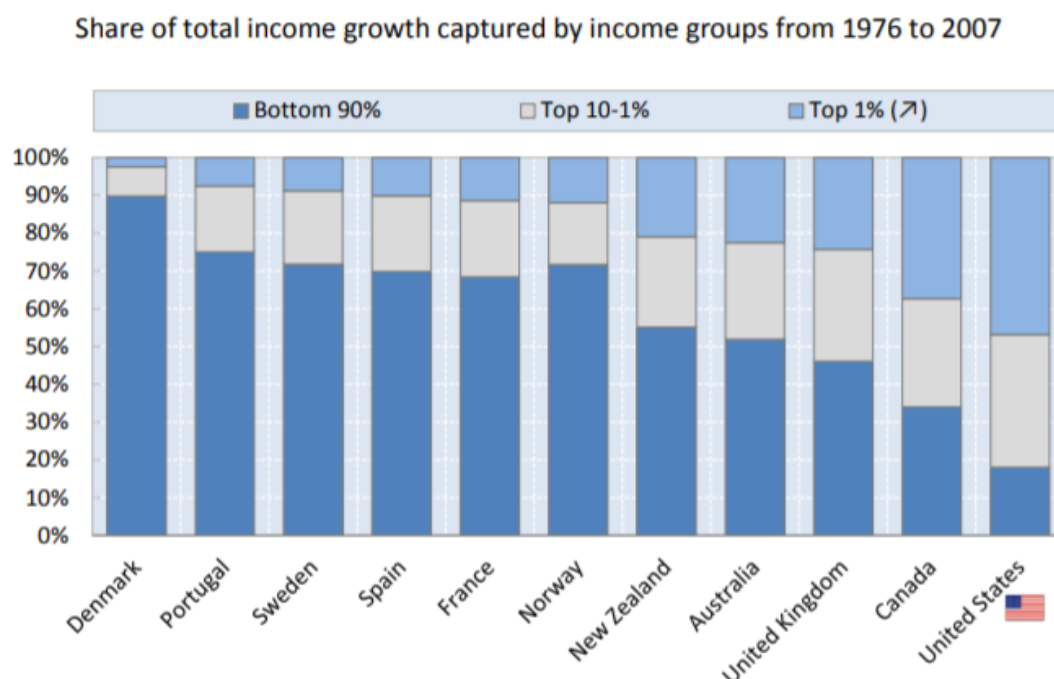


Figure 10 Share of Income growth captured by Top 1%, Top 10-1%, and the bottom 90% of income earners in the across OECD countries between 1976 and 2007- Source Forster & Levy (2014)

The rising trend has not been shared amongst OECD countries. This may be attributed to the fact that most of the fruits of economic growth in the US have been captured by the highest earners as shown in Figure 10. Yet it is important to distinguish between two types of income inequality to quantify the effect of redistributive transfers allocated by the government (Ostry, Berg & Tsangarides, 2014), and structure the discussion on its causes and consequences. The first is pre-tax, or market inequality, and the second is post-tax, or net inequality.

2.2. Market inequality

Market inequality is the measure of pre-tax inequality across income earners. It is influenced by the labour market, as a larger dispersion in wages and salaries leads to higher market inequality, and capital markets, those possessing equity will have greater returns when equity markets boom while others who rely primarily on their labour wage will not be affected.

For the bottom 50% of US income earners, real wages (wages corrected for inflation) have stagnated since 1980, while real wages of the top 10% have more than doubled. For the top 1% they have tripled, and for the richest 0.001% they have sextupled.

From the 1970s to the 1990s the increase in market inequality has been attributed to disproportionate increases in wages at the top of the income distribution, i.e. the working rich, yet from the onset of the 21st century most of the dispersion in incomes has been a capital-driven phenomenon. (Piketty et. al, 2016; Ferejohn, 2009).

The labour market, and consequently market inequality, is influenced by technological changes, globalization, and policy changes (Forster & Levy, 2014). With the rise of new technology-driven industries, those with high levels of education and, usually expensive to attain, skills earned higher wages. Those with obsolete skills earned less, giving an advantage to those who started off with more means (Ferejohn, 2009). This is referred to as “skill-biased technological change” (Levy & Temin, 2007). Globalization exacerbated that effect on the US labour market, as the liberalization of trade, de-industrialization, and financialization (shifting the focus of the economy to the financial sector) have led to the export of many jobs outside the US, while giving certain professionals, as financiers, massive gains (Ferejohn, 2009).

The US labour market underwent regulatory changes resulting in lower minimum to median wage ratios, thus a stagnating minimum wage, weaker employment protection laws, as well as drastic institutional changes such as the aggressive decline union membership (Levy & Temin, 2007; Forster & Levy, 2014). This decline is reflected in the starkly lower union densities since the 1980s from 20.1% in 1983 to 11.1% in 2015 (United States Department of Labor: Bureau of Labor Statistics, 2019). Levy & Temin (2007) argued that the institutional collapse of labor unions may be attributed to a shift in the US political environment over the 1970s and 1980s.

Government policies, institutions, and regulations shape how globalization and technological changes translate into inequality (OECD, 2011). To quote the TFIAD (2004),

“[...] the policies pursued by various governments matter. Regulations, tax policy, and social programs can be used to buffer rising socioeconomic inequalities in an era of globalization and demographic and technological change. Policies pursued — or not pursued — help to explain sharper socioeconomic disparities in the U.S. compared to more muted inequalities in Canada, Germany, France, and other advanced industrialized countries.” (p. 6)

Despite government policy affecting market, as well as net inequality, political accounts of inequality usually fail to take that into account, using pre-tax inequality synonymously with pre-government inequality (Hacker & Pierson, 2010).

2.3. Net inequality

Taxes and transfers are powerful redistributive tools and can reduce the effects of market inequality by taking higher taxes from the high-income earners and providing benefits to the rest of the population, yet their effectiveness is limited in the US (Forster & Levy, 2014; OECD, 2011). US Federal taxes have become less progressive since the 1970s, mainly due to the decline in corporate income taxes and the federal estate tax (Piketty & Saez, 2007). Despite the Reagan era being famous for its tax cuts on the wealthiest, in what was coined as “Reaganomics”, the first wave of tax cuts was enacted by a Congress in which the Democratic party had the majority and signed by US President Jimmy Carter (Hacker & Pierson, 2010). Despite income taxes seeming to have been very high in the 1960s, the average tax rates at the top were around 31% of total income due to lower taxes on capital gains, as well as deductions for interest payments and charitable contributions (Piketty & Saez, 2007).

Since the 1970s there has been a synergy between policies that increased US income inequality, between reducing the progressiveness of income and estate tax, and deregulation of financial markets. The most affluent, who typically have higher saving rates, were able to save more of their extra disposable income arising from the tax cuts to buy more financial assets (Saez & Zucman, 2016). Such is a case of a reinforcing effect, where net inequality exacerbated market inequality, as a result of government policy.

Average tax rate by pre-tax income group in the US, 1913–2014

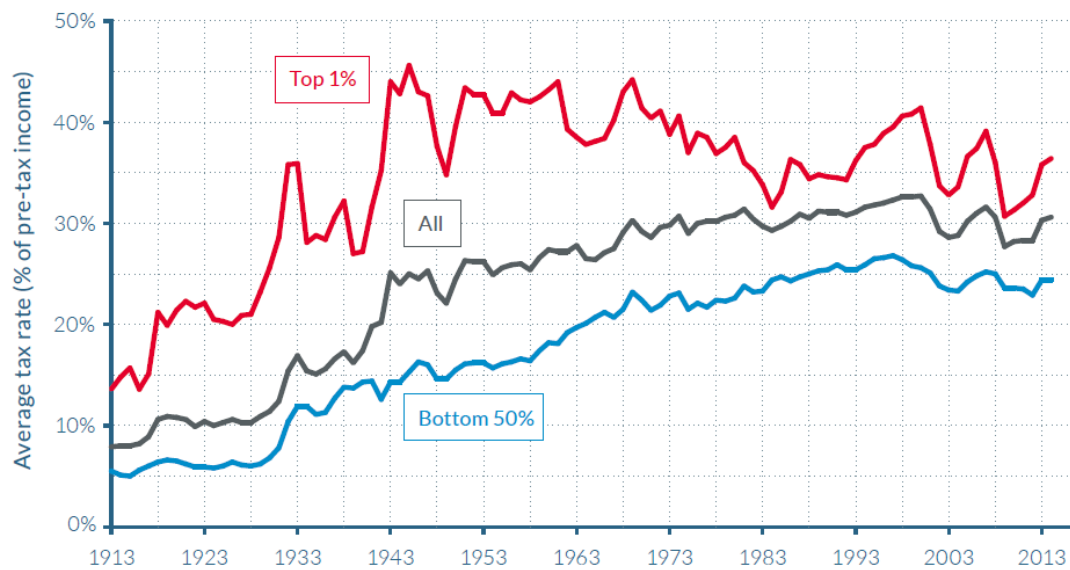


Figure 11 1913 to 2013 Average tax rates paid by the top 1% income earners versus full population, and the bottom 50% of income earners - Source Piketty, Saez, & Zucman (2017)

Figure 11 shows how average tax rates (including direct taxes as income tax, and indirect taxes, such as Value Added Tax) have increased for the aggregate population while at the same time fell for the top 1% of income earners from their 1970's levels over time. This shows that government tax policy has not been able to dilute the effects of increasing market inequality, which affirms the conclusion of Chapter 2.2, emphasizing the role of government policy over income inequality.

2.4. Tackling income inequality

Piketty, Saez & Zucman (2017) observed that pre-tax income inequality increased at a faster rate than post-tax inequality. They recommended that redistributive policies should not only focus on taxes and transfers. To quote the World Inequality Report by Alvaredo et al (2018),

“[...] there are clear limits to what taxes and transfers can achieve in the face of such massive changes in the pre-tax distribution of income as have occurred in the United States since 1980. [...] policy discussions should focus on how to equalize the distribution of primary assets, including human capital, financial capital, and bargaining power, rather than merely focus on ex-post redistribution.” (p86)

Their argument rested on broadening the scope of the debate to include not only the issue of the tax progressiveness, but to address regulatory, and institutional issues that would expand the policy space to reduce market inequality, as well as net inequality. Forster & Levy (2014) pointed out to four pillars to tackling high income inequality in the US: Investment in education and human capital, promoting inclusive employment (more and better jobs), tax reform (increasing progressiveness of tax system, raising taxes on capital gains, closing tax code loopholes to broaden the tax base, raising corporate taxes on offshore production to help create jobs domestically, and limiting corporate tax exemptions), and increasing access to public services such as healthcare.

It is clear that income inequality is a multidimensional issue requiring action on several fronts, having no silver bullet solution. The above arguments suggest short-term as well as long-term policies that can pull the struggling low-income Americans into higher-earning labor through better jobs, investment in education, and access to public goods while tempering the top earners' disproportionate gains through tax reform. They all point out to the need for an active effort by the US government to remedy inequality (Levy & Temin, 2007).

Taxes and transfers are the most direct and short-term effective policy levers to reduce inequality (Forster & Levy, 2014). Tax reform, especially tax progressiveness has proven as an effective tool to mitigate both types of inequality (Alvaredo et al, 2018). Increasing top marginal tax rates, the highest tax rates incurred on additional income exceeding a maximum threshold of total income, can disincentivise high-income earners from bargaining for higher pay as they keep less of any additional income. This will also limit the income they may invest in buying shares, or bonds which will reduce their capital gains, thus having a twofold effect on limiting inequality at the top of the income distribution (Piketty, Saez & Stantcheva, 2014).

Alvaredo et al (2013) also suggested that the salary increases for top earners come at the expense of other income groups, thus a decrease in the bargaining of top earners will result in higher salaries for the rest of the labor force. They noted that top marginal tax rates in the US had reached up to 90% between the 1940s and the 1970s without adversely affecting growth in the US economy. The reversal of tax progressiveness in the US since the 1970s has been mainly based on economic efficiency arguments.

Godar, Paetz & Truger (2014) made the case for progressive taxation in OECD by analyzing theoretical and empirical the arguments for, and against progressive taxation. Their findings may be summarized in the quote below,

“All in all, therefore, the case against progressive taxation turns out to be substantially weaker than claimed by standard mainstream approaches. Both from a theoretical and an empirical point of view, the negative effects on growth and employment and the erosion of the tax base may not be large.” (Godar, Paetz & Truger, 2014, p13).

Ostry, Berg & Tsangarides (2014), in their report to the International Monetary Fund on redistribution, inequality, and growth, affirm that historically, redistribution and lower net inequality are fundamentally pro-growth. They argued that any negative incentives resulting from higher redistribution efforts are outweighed by the positive effects of equality on overall economic growth.

With increasing focus on redistribution, and on progressive taxation by economists, it is paradoxical that tax reform, to make taxes more progressive, has not recently gained political traction in the US. One is led to question whether the American people, whose policy preferences ought to be reflected government action, are against progressive taxation?

2.5. Popular opinion regarding inequality and taxation

According to the TFIAD, Americans accept inequality as long as they believe everyone has a chance of getting ahead; the role of government is to preserve equal opportunity, such that economic advancement is determined by effort and individual talent. (TFIAD, 2004).

Ferejohn (2009) argued that a central argument supporting the need for inequality is that it motivates people to work harder to better their chances in becoming those who they look up to or envy, which increases the productivity of society. Yet he observed that income and class mobilities in the US have declined in past four decades, while income inequality rose.

Page & Jacobs (2009) found evidence that the majority of Americans, a little over two thirds, for decades have believed that income inequality is too high, and have been calling for further redistribution of income and wealth despite the widely held belief that American voters do not care much about inequality, or that American voters are tax-averse. This was concluded from analysing eleven surveys between 1984 and 2007, which indicate a consistent mismatch between voter preference and government policy over time.

Figure 12 shows polling results on the fairness of the distribution of money and wealth in the US, dating back to the 1980s. Nearly two-thirds of Americans have consistently believed that the distribution of money and wealth in the US is unfair.

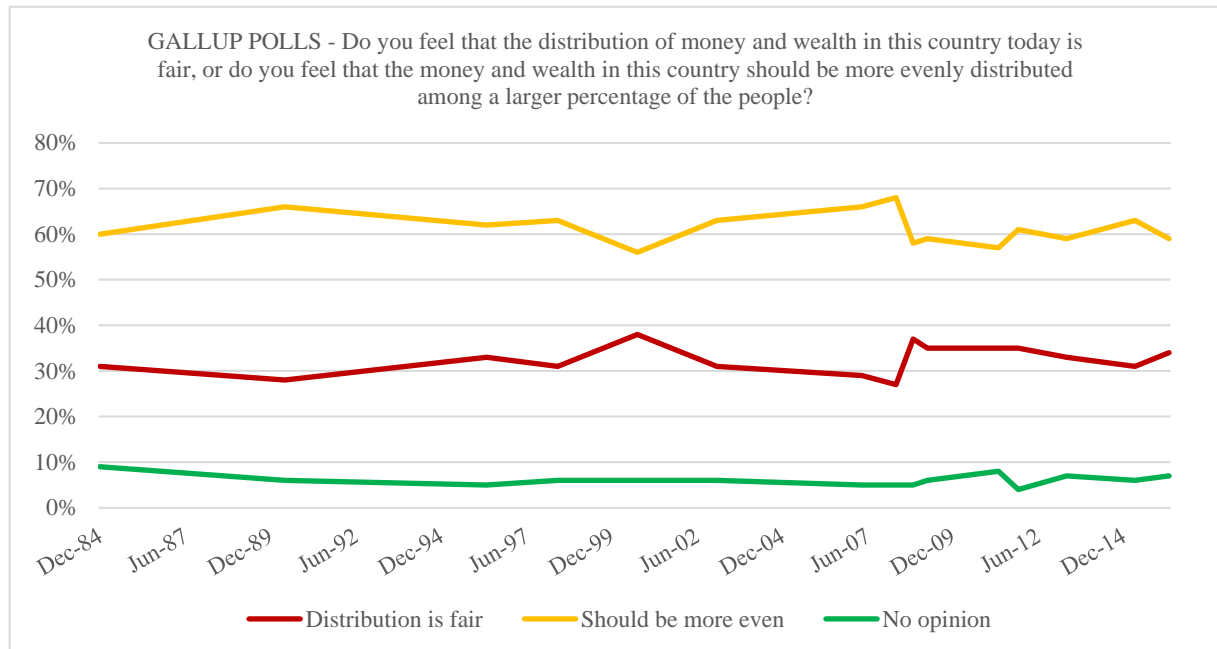


Figure 12 Historical trends in Popular US opinion about the fairness of income and wealth inequality in the US - Source Gallup (2016)

Furthermore, Figure 13 shows the poll results of a question that has been asked repeatedly from 1939 to 2016 by GALLUP Polls on the redistribution of wealth by the US. From 2011 to 2016, 52% of Americans believed the government should redistribute wealth by increasing taxes on the rich.

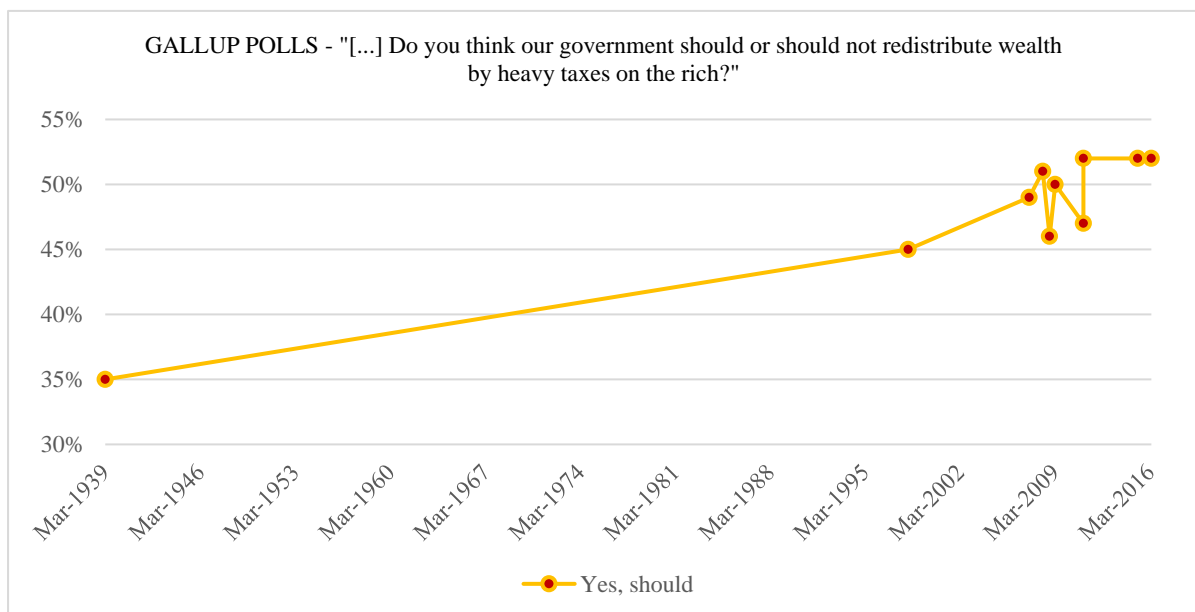


Figure 13 Historical trends in Popular US opinion about taxing the richest Americans to redistribute income and wealth - Source Gallup (2016)

Figure 14 & Figure 15 indicate that two-thirds of Americans think that upper-income people pay too little Federal taxes (at least for the past 27 years). The same case has been for corporations at least for the past 15 years. This poses a question on why is there a mismatch between voter preference, and government policy?

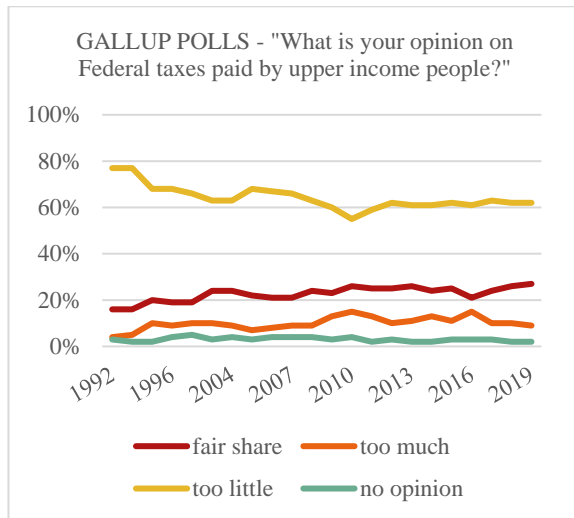


Figure 14 Historical trends in popular US opinion on the fairness of Federal taxes paid by upper income Americans - Source Gallup (2016)

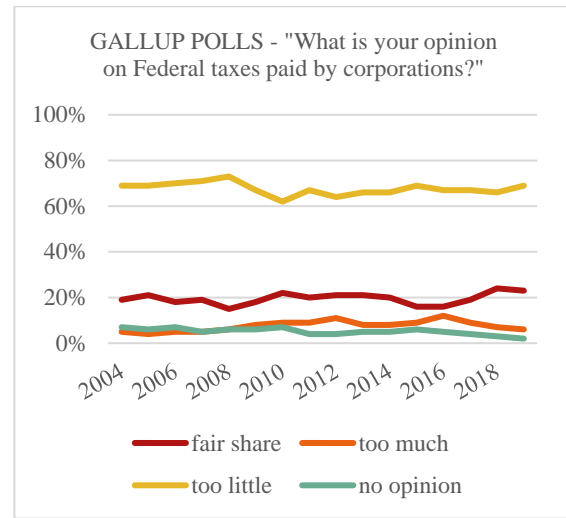


Figure 15 Historical trends in popular US opinion on the fairness of Federal taxes paid by American corporations - Source Gallup (2016)

The American Political Science Association's TFIAD (2004) noted the growing cynicism in US population towards government responsiveness to voter preference citing that,

"[...] Citizens are much less likely than they were several decades ago to trust government to "do the right thing." Between the mid-1960s and the mid-1990s the proportion of Americans who felt that "the government is run by a few big interests looking out only for themselves" more than doubled to reach 76 percent, while the number who believed that "public officials don't care about what people think" grew from 36 percent to 66 percent. More than six in 10 respondents to a 1995 survey cited too much influence by special interests as a reason for not trusting government." (p5)

If voters in the US have been calling for more distribution, it would be reasonable to expect that government policy would respond, but as discussed in chapters 2.2 and 2.3 government policy has contributed to increasing income inequality in the US since the 1970s.

2.6. Democratic representation and policy choices

Chomsky (2017) argued that any democracy faces a dilemma, if the poor became equally franchised as the rich, they would gather and decide to take the property of the rich through land reform. He claimed that both Aristotle and James Madison (one of the founders of the USA and the framer of the American constitution) struggled with this debacle, yet resolved it by adopting two opposite solutions.

According to Chomsky, Aristotle's solution was reducing inequality (to disincentivize the poor from taking property away through land reform), while Madison's was reducing democracy by consolidating political power with the senate whose members were not elected at the time (Chomsky, 2017). The US Senate could only be elected after the ratification of the 17th amendment in 1913 (United States Senate, 2019a). Up until that point, the senate was composed of wealthy property owners. The incongruity of those two solutions suggests there is a continuous tension between democracy and equality.

In an exhaustive effort to categorize the American political system in terms of the competing theories of US policy-making, Gilens & Page (2014) contrasted four overarching perspectives in the political science literature noting that all perspectives had empirical support. The main contribution of their study focused on the concept of 'independent influence' over policy. Independent influence means that when the policy preferences of the four actors diverged, the policy choice of government would follow the policy preference of the dominant actor(s).

They cited that an empirical challenge was finding a large enough dataset to compare policy cases where there was divergence, as in most cases there is convergence in the preferences of the actors, lending empirical support to all four theories (Gilens & Page, 2014). They collated a unique data set of 1779 US policy cases between 1981 and 2002 to accomplish this. Their categorization can be summarized in the influence matrix below (Table 1):

Theory\ Actor	Influence of each actor over government policy			
	Median voters	Economic Elite	Mass-based interest groups	Industry-based interest groups
Majoritarian electoral democracy	High	Low	Low	Low
Economic elite domination	Low	High	Low	Low
Majoritarian pluralism	Low	Low	High	Low
Biased pluralism	Low	Low	Low	High

Table 1 Influence matrix of the four dominant theories of US politics by Gilens & Page (2014)

The results of the study may be summarized as Gilens & Page (2014) stated,

“[...] These results suggest that reality is best captured by mixed theories in which both individual economic elites and organized interest groups (including corporations, largely owned and controlled by wealthy elites) play a substantial part in affecting public policy, but the general public has little or no independent influence.” (p572).

This means that if the general public, fundamentally the voters or the mass-based special interest groups such as labour unions, pursued a policy in conflict with the economic elite and the business-oriented groups, the latter prevailed. Gilens & Page (2014) also noted that proposed tax increase policies opposed by special interests and the top 10% of income earners were scrapped more than 82% of the time. They also discovered status-quo bias, as in Gilens (2005), in that tax cuts and exemptions were not easy to pass either, with a 44% failure rate (Gilens & Page, 2014).

Bartels (2008) analyzed the voting patterns of US senators from 1989 (101st Congress) to 1994 (103rd Congress) on all issues considered for roll-call voting, as well as four selected highly salient issues including minimum wage, abortion rights, civil rights, and government spending to find a substantial bias to affluent constituency noting,

“Indeed, my analyses indicate that the views of constituents in the upper third of the income distribution received about 50% more weight than those in the middle third, with even larger disparities on specific salient roll call votes. Meanwhile, the views of constituents in the bottom third of the income distribution received no weight at all in the voting decisions of their senators. Far from being “considered as political equals,” they were entirely unconsidered in the policy-making process.” (p253)

It is worth noting that the above three Congresses had Democratic party majorities in both the house and the senate. Hacker & Pierson (2010) argued that despite the Democratic party positioning themselves as the more egalitarian party in the US, partisanship of government had no effect in pursuing policies to effectively lower the trend of increasing US income inequality since the 1980s. Bonica et al (2013) observed an ideological shift in both parties, Democrats and Republicans alike, accepting a form of free market capitalism characterized by deregulation, less progressive taxation, and less redistribution by government.

Gilens (2012) reaffirmed the wealth bias of political decisions in the US, analyzing 2245 policy choices between 1964 and 2006, on economic policy, foreign policy, social welfare, and moral

issues. He found that when the preferences of the top earners diverged from those of less affluent, the policy choices of the poor had no effect whatsoever on government policy choices.

Flavin (2015) echoed Gilens & Page (2014), Gilens (2012) and Bartels (2008) in finding a stronger proximity of government policy decision to wealthier Americans by studying state liberalism versus political ideology of constituency, in addition to finding a positive effect of stricter lobbying regulations on equality of citizen political views.

In conclusion, recent evidence points out to a wealth bias in policy choices of the US government, through which income inequality translates into representational inequality. This may explain why progressive taxation and policy reforms for increased distribution of income and wealth have not been pursued despite their popularity amongst the majority of American voters. The next section focuses on the means by which income inequality translates to representational inequality.

2.7. Means of influence

Tax legislation usually originates at the executive branch, the President and the Treasury Department. It then passes to congress' Committee on Ways and Means, then is voted on in congress. If it passed congress it is handed to the Senate for consideration and amendment by the Senate Finance Committee (SFC). After amendments are made by the SFC, the senate votes on the bill which, if passed, is sent to the President for signing or vetoing (U.S. Department of The Treasury, 2010).

US Congress, including the senate, and the US President are all elected officials. To analyse how income and wealth influence politics, one needs to examine US elections, as well as the channels by which citizens and groups may exert influence over their representatives while in office. The author focused on the US Senate in the model because it has the final legislative say in whether a bill gets approved and sent for signing by the President, thus it has higher power in tax law.

The TFIAD (2004) cited four main channels by which income inequality affects political inequality in the US: through inequality in voting, political parties' structure and practices, campaign contributions, and interest group influence over Washington D.C. Solt (2008) demonstrated that higher income inequality increased voter apathy by reducing political

participation and interest in political discussion. Soss & Jacobs (2009) showed that between the 1970s and 1990s, US voter participation had declined steeply amongst the poor eligible voting population, reducing political accountability of officials and reinforcing the marginalization of non-voters, as politicians could ignore them without facing a backlash of being voted out of office. Bonica et al (2013) also observed the low-income Americans have very low voter turnout rate.

Freeman (2003) argued that decline in poor voter turnout had pushed the median voter upwards in the income distribution, and thus resulted in policies that favoured the more affluent. Furthermore, Solt (2010) noted that American states with higher income inequality voted less and that poorer citizens voted less than affluent citizens, examining 144 US gubernatorial elections using three data points, 1990, 1990, and 2000. Thus, increasing inequality has been observed to lower voting rates and voter participation. Higher political engagement and activism by the more wealthy have also had consequences on the party structure of both the Republicans as well as the Democrats, explained next (Solt, 2010; Soss & Jacobs, 2009).

Changes in party ideologies, and the practices that ensued from them contribute to the failure of the political system to respond to higher inequality, whether through convergence of Republicans and Democrats on tax issues and deregulation (both have been demonstrated to be direct drivers of increasing inequality), or the redistributive role of the government (Bonica et al, 2013). Soss & Jacobs (2009) observed that since the 1970's party leaders have been losing control over political candidates' policy choices to interest groups, Political Action Committees (PAC), and off-centre (polarized) high socio-economic status activists in the respective parties. This resulted in a divergence of political parties from the centrist opinion, and increasing polarization in congress.

The importance of polarization lies in its consequences. High polarization of the parties results in deadlock, where no agreement can be reached between the two parties, which gives way to 'policy moderation' which means large compromises in legislative bills to get enough legislators to vote for it, rendering the bill less effective (Bonica et al, 2013). Furthermore, in issues where moderation is not possible with one party refusing to compromise, deadlock leads to policy drift, meaning the failure to update policies and legislation. If both parties could not agree on updating legislation in the face of a changing technological and trade reality as a result of polarization and the ensuing deadlock, inequalities are exacerbated by outdated laws and policies, which may get exploited by special interests, regardless of which party gets a voting

majority in the legislatures (Bonica et al, 2013; Hacker & Pierson, 2010; Richter, Samphantharak & Timmons, 2009).

So far, the first two effects of income inequality on political representation in the US, as set forth in the report of the Task Force on Inequality and American Democracy, have been described. They have substantial consequences in terms of modelling the system structure binding economic inequality and the political system in the US, the first Research Question of this study (RQ1). First, increasing inequality translates to lower voting and participation rates. Secondly, shifting political party dominance over the legislature has had little effect on government policies which perpetuated inequality, and has been excluded from the modelling effort as they have converged on tax policy since the mid-1970s. Hacker & Pierson (2010) argued that industry leaders and wealthy individuals allocated vast resources to politics, through campaigns and lobbying but also to shape the political climate. The next two chapters focus on the second two channels of influence, described by the TFIAD (2004), in detail, as they reflect the role of money in US politics.

2.8. The role of money in elections

Campaign finance may be defined as money spent by political parties, candidates, and other organizations to influence voters (Munro, 2018).

There is substantive evidence establishing a causal connection between campaign spending and votes gained by partisan candidates running for office in the US. Given that the US has two major parties, it has been observed that the party spending more on a certain race usually gets more votes, and thus a larger share of the legislature seats (Hall, 2016; Ferguson, Jorgensen & Chen, 2016).

Gilens (2015) cited that winning a seat in the US house of representatives cost on average one million US dollars and ten million US dollars in the senate. Although money's role in securing votes for a political candidate has become undeniable (Hall, 2016), it is not purely deterministic, as elections are always fraught with uncertainty, thus the highest spender may not win the race 100% of the time. Data from the year 2000 to 2018 collated by the Center for Responsive Politics show that the higher-spending candidate of the US Senate races wins roughly 80% of the time, and 90% of the time in the US House of Representatives (Center for Responsive Politics, 2018).

Concurrently, there is widespread belief amongst the American population the money in politics biases political outcomes to favour those who supply it, and that lobbyists are the agents through which such money influences politicians (Hasen, 2012). With heavy reliance on money to run for elections or re-election once in office, employing expensive consultants and media campaigns, US politicians devote tremendous amount of time fundraising (Hall, 2016). With reliance on money comes dependency on donors (Lessig, 2011). Dependency on private donors to fund campaigns grants unequal access to those who donate, especially large donors (TFIAD, 2004; Kalla & Broockman, 2016).

Bonica et al (2013) noted that the top 0.01% income earners capture around 5% of total US income, but contributed 40% of all campaign contributions given to politicians in the year 2012 (from less than 20% in 1980). They argued that Democrats as well as Republicans rely substantially on big donors, and have been so at least since the 1990s, noting that the Democrats' views on redistribution have been influenced by this dependency. This view echoes Lessig (2011) who argued that the Democratic party became pro-business, nearly as much as the Republican party.

On the other hand, there is a debate in the literature on whether donors make contributions for ideological consumption, as in they give money to politicians who share their world-views in support and solidarity, or invest in politicians in pursuit of favourable policies (Bonica et al, 2013). Kalla & Broockman (2016) noted that access-oriented donors, disclosing their donation behaviour to Congress members when requesting a meeting, had a higher chance of getting their sought audience.

It is still an unresolved puzzle whether campaign donations translate to influence over legislators. In the seminal paper of Ansolabehere, Figueiredo & Snyder (2003), though arguing for a consumption model of political giving by individuals, they pointed out to a side effect of their observed concentration of individual donations in the upper-income distribution. It could lead, they suggest, to political candidates skewing policy to appeal to their donors, giving more weight to the donors' voices as opposed to the rest of the population.

Stratmann (2005) reversed the conclusions of Ansolabehere, Figueiredo & Snyder (2003) analysing the same dataset but critiquing their methods, citing that campaign contributions do influence a legislator's voting behaviour in office on bills that would affect her donors. Gordon, Hafer & Landa (2007) also found evidence supporting an investment hypothesis of political giving by corporate executives.

Dawood (2015) noted that most empirical studies attempt to trace a connection between campaign contributions and roll-call votes on the congress floor, finding little systematic evidence that money influences legislator actions. She also affirmed that the political process is multi-stage, some aspects of which are nearly impossible to measure empirically such as closed-door bargaining between legislators, and agenda-shaping, which echoes Gilens & Page's (2014) 'second face of power', quoting the authors,

“[...] Our findings speak most directly to the “first face” of power: the ability of actors to shape policy outcomes on contested issues. But they also reflect—to some degree, at least—the “second face” of power: the ability to shape the agenda of issues that policy makers consider. [...] Our results speak less clearly to the “third face” of power: the ability of elites to shape the public's preferences. [...] But it cannot have greatly inflated our estimate of average citizens' influence on policy making, which is near zero.”
(Gilens & Page, 2014, p576)

So far, there seems to be enough evidence linking campaign spending to winning elections, but rather conflicting evidence on whether the donors to politicians' campaigns have substantial influence over such politicians? They seem to have substantially better access to such politicians. Further complicating the issue is the question of why donors contribute to their politicians? In attempting to address (RQ1), a prudent assumption was made in assuming all campaign contributions are made on a consumption basis. Electoral outcomes are also assumed to be a function of campaign expenditure (*Please refer to Appendix 2 for details on model assumptions*).

To complicate things further, the relationship between donors and congress is not always direct, Lessig (2011) argued that between donors and congress lies the lobbyist who acts as a facilitator, sometimes a bundler of donations, offering legal expertise as well as other services to the legislator free of charge to the legislator. Hall & Deardorff (2006) emphasized on the need to extend the debate on unequal political participation to include lobbying, the second channel by which money can influence politicians while they are in office.

2.9. The role of money lobbying

Richter, Samphantharak & Timmons (2009) noted that most research on the influence of money in politics focuses disproportionately on campaigns and access issues, while the

spending on lobbying exceeds that on campaigns. On the aggregate level, lobbying spending continues to exceed all special interest groups' campaign contributions by a multiple of five (Figueiredo & Richter, 2014). Isacharoff (2010) affirmed that lobbying is more influential over legislation than campaign contributions as the proportion of money spent by corporations on lobbying, as opposed to elections through corporate Political Action Committees (PAC), reflects the business understanding of how to best advance their interests. Ansolabehere, Figueiredo & Snyder (2003) displayed a similar opinion citing,

“[...] many interest groups are showing by their behavior that lobbying is more important than campaign contributions. Of course, access itself does not guarantee influence, but only the opportunity to provide information that might influence legislators.” (p126)

Gerken & Tausanovitch (2014) argued that lobbying and campaign finance are the two means by which money is translated to influence in US politics, and rejected the opinion that they are isolated systems operating independently, proposing both activities lie on a continuum of political influence by private interests. Lobbying is explicitly defined in definitions (7) and (8) of section (3) of the Lobbying Disclosure Act of 1995, as any contact or efforts in support of a contact (such as planning, preparation, research, and background work) with a legislative or executive official in pursuit of lobbying activities encompassing communications pertaining to formulation, modification, or adoption of a Federal legislation, rule, regulation, policy, position of US government, or the administration or execution of a Federal program or policy, among other items (United States Senate, 2019b).

In order for a member of the constituency, individual or group, to present a case to their Congress member they need an audience and information to back up their arguments. Such audience is a function of access (Kalla & Broockman, 2016) and information is costly (Hall & Deardorff, 2006), giving an unequal advantage to certain individuals and groups to make their case to Congress members, and the opportunity to present self-serving information or focus the attention of their legislators on specific cases, thus crowding-out the focus of the legislator on other public matters (TFIAD, 2004).

Hall & Deardorff (2006) contrasted the dominant paradigms explaining lobbying behaviour being 'lobbying as exchange', and 'lobbying as persuasion'. In 'lobbying as exchange', money translates to favourable voting, on legislative bills, by the legislator. In 'lobbying as persuasion', money expended in lobbying aims to convince legislators to adopt the policy

positions of the lobbyist's client. They argued that enforcement challenges arise in exchange theories, as any enforceable written agreement between lobbyists and legislators to exchange money for votes on bills would be illegal. Furthermore, lobbying as persuasion contradicts with empirical evidence that lobbyists contribute most to politicians who already agree with the lobbyists' clients. They proposed a third "lobbying as a legislative subsidy" paradigm in which lobbyists support legislators with similar mindsets, quoting the authors,

"The main idea is that lobbying is primarily a form of legislative subsidy—a matching grant of costly policy information, political intelligence, and labor to the enterprises of strategically selected legislators. The proximate objective of this strategy is not to change legislators' minds but to assist natural allies in achieving their own, coincident objectives. Their budget constraint thus relaxed by lobbyists' assistance, already likeminded legislators act as if they were working on behalf of the group when in fact they are working on behalf of themselves. In this sense, our theory is "budget-centered" rather than "preference-centered." (Hall & Deardorff, 2006, p69).

Within their framework, they contend that campaign contributions are signals of common purpose between groups who lobby, yet they are not the only way by which groups can gain access to legislators. Public interest groups who are widely respected and trusted can reinforce a legislator's legislative enterprise even if they do not offer re-election assets such as campaign contributions. This means that highly salient issues which have public support can lead to legislators granting access to public interest groups in order to make progress on the target policy of interest, which results in winning political points with the constituency (Hall & Deardorff, 2006). If firms and groups lobby those who share their world views, then we should expect mass-based interest groups to lobby like-minded, working-class legislators and politicians who sympathize with less affluent on economic issues.

2.10. Money as an entry ticket/ barrier

Gilens (2015) argued that a Congress composed of more representatives from modest backgrounds would shift policy in favour of the middle class and poor Americans. Carnes & Lupu (2016) noted that the lack of working-class American politicians has led to a bias in policies of taxes, wages, and welfare towards the conservative positions that appeal to most affluent citizens. Working-class has been defined by the authors as blue and pink-collar jobs including manual labour, service industry, and clerical jobs.

They cite three reasons why a certain group may be underrepresented in political office: the lower likelihood of members of said group being qualified, the lower likelihood of them running for office, and the lower likelihood for them to win. The results of their analysis, the largest experimental study ever conducted on the role of voters in the descriptive underrepresentation of working-class citizens in democratic office, support the view that working-class Americans are not biased against voting for working-class candidates. They suggest that neither qualifications or the likelihood of winning are the culprits of underrepresentation, and point to other factors that could explain the phenomenon such as money, time, attitudes like cynicism, and institutional factors such as political parties and political gatekeepers. Such factors can act as early screening filters which prevent working-class potential candidates from ever running in the first place (Carnes & Lupu, 2016). The effects of institutional factors echo the argument of Soss and Jacobs (2009) that the two political parties, Democrats and Republicans, are greatly influenced by affluent activists and interests.

Marble & Lee (2018) categorize three main factors a potential candidate for office considers namely material, ideological, and psychological factors. Using a survey experimental approach, they found that the material considerations are the highest deterrent for individuals to run for office, namely campaign fundraising burdens.

Lessig (2011) reiterated the conclusions of Hall & Deardorff (2006) that the structure of the US political economy gives an advantage to the interests that can afford expensive campaigns, and expensive lobbyist organizations that support the lobbyists who can help raise campaign money and aid legislators through staff, political intelligence, as well as expert technical and policy-specific advice. Gerken & Tausanovitch (2014) argued that lobbyists provide political information on the electoral implications of a legislator's support for certain bills through polling results, and have access to data, analyses by experts, lawyers, and consultants,

rendering their services highly valuable for legislators. On whether mass-based interest groups can counterweigh this bias towards wealthy interests, Hall & Deardorff (2006) were sceptical stating,

“[...] Groups that are better able to pay the costs of information-gathering, policy analysis, and lobbying will be advantaged in addition to whatever advantages they might accrue from better grass-roots organization and more contributions to congressional campaigns.” (p81).

Hall & Miler (2008) observed that mass-based, or public-based, interest groups provide only a modest counterweight to lobbying by private-based interest groups. This may be attributed to the disproportionate resources of private groups as opposed to the resources of public-based groups.

In summary, money's role in US politics and legislation has become undeniable and has become common knowledge to most voting-age Americans. Despite cumbersome empirical challenges justifying arguments against the existence of a connection between money's role in influencing politics and the US government policy, political economists are advancing innovative tools to isolate the causal connections between money and policy reaching both intuitive and worrying conclusions about the state of American democracy. When money is the oxygen of US elections (TFIAD, 2004), and privately funded lobbying provides information, a valued commodity for legislators amongst many other costly services (Gerken & Tausanovitch (2014), a question presents itself: what are the implications of the pervasiveness of money in US politics?

2.11. The marketplace of political influence

“[...] 75 percent of Americans believe “campaign contributions buy results in Congress.” Three to one, with Republicans (71 percent) just as convinced of this as Democrats (81 percent).¹ Puzzles plus money produce the view that the money explains the puzzles.” (Lessig, 2011, p88).

Costs of campaigns in the US and money spent on campaigns has dramatically increased over the years (Hall, 2016; Dawood, 2015; Lessig, 2011), while regulation for campaign finance has been gradually decreasing with several cases for campaign finance regulation struck down by

the US Supreme Court (Dawood, 2015). Gilens (2005) argued that high-income Americans have a higher propensity to donate and donate substantially larger amounts as we ascend the income distribution, which reflects different patterns of consumption or investment in politics across the population (*Please refer to Chapter 2.8 for a discussion on consumption vs. investment theories of political spending*).

A free market, in operational terms, is a minimally regulated system of economic exchange (Orlitzky, 2018) in which the invisible hand of the market acts as the regulator between demand and supply via price adjustments (Yamaguchi, 2019; Sterman, 2000). It is from that definition of a free market that political campaigns are conceptualized as a marketplace in this research. Yamaguchi (2019) argued that market mechanisms, the interaction between forces of demand and supply, underlie commodity markets, labour markets, and financial capital markets, among many others.

Characterizing demand as the money spent by politicians to attract votes, while supply to be the number of voters who respond to such campaigns by going to the ballot, the author argues that there is a price mechanism mediating between politicians and voters through campaigns to balance the forces of demand and supply. The price in question would be the price per vote mobilized as a result of running a political campaign. Again money does not translate to winning all the time, and there is uncertainty in converting campaign funds to votes (*Please refer to chapter 4.3.1. for details on uncertainty in campaign contributions translating to votes*).

Increases in the price, i.e the cost of mobilizing a vote, would pose entry barriers for potential candidates who cannot raise enough money to mobilize sufficient numbers of voters, even if the voters are likely to vote for them. There are few exceptions of course, as was the case with Alexandria Ocasio Cortez, the youngest woman to ever serve in Congress, winning a seat in Congress for New York's 14th district in 2018, relying primarily on individual small donations less than 200 US Dollars per donation, to cover 60% of her total campaign funds (Center for Responsive Politics, 2019c), rejecting corporate finance and contributions from lobbyists (New York City Campaign Finance Board, 2019). But such cases are extremely rare and are not the general rule in US congress as pointed out by the TFIAD, on the mechanisms and consequences of money's influence in US politics, stating,

“[...] today, politicians are not usually directly bribed by political contributors or moneyed interests. Research does not support the idea that specific votes in Congress

are directly determined by campaign contributions. What wealthy citizens and moneyed interests do gain from their big contributions is influence over who runs for office and a hearing from politicians and government officials once they are in positions of authority. Access for the few can thereby crowd out attention to the many [...] Big contributors have the power to discourage or perhaps suffocate unfriendly candidates by denying them early or consistent funding.” (TFIAD, 2004, p12)

Furthermore, the lobbying industry is a multi-billion dollar industry (Hall & Deardorff, 2006) supplying government officials, especially legislators, with an expensive commodity, information (Gerken & Tausanovitch (2014). Campbell (2010) argued that one of the reasons inequality has risen in the US over the past four decades is the informational advantage of the rich, who can afford the high costs of information to mobilize and lobby their politicians. Demand for lobbyists may be characterized as all money paid to professional or corporate lobbyists by individuals or organizations to support in lobbying activities to influence government officials or policy (*Please refer to chapter 2.9 for the definition of lobbying*). Supply of lobbyist services, therefore, may be characterized as all services provided by lobbyists to their clients who pursue said influence over government. Mediating between demand and supply is yet another price mechanism. Increases in the price of lobbyist services thus would also create barriers that disfavour individuals and groups that cannot afford the costs associated with lobbying services.

‘Success to the successful’ is a systems archetype of competition between two, or more, activities for a limited resource, or support, where the success of one activity begets more success; and the failure of the other activity begets more failure (Senge, 1990). If the free markets of political campaigns and lobbying activities provide an advantage to the most affluent Americans, it might help explain the observations of Gilens & Page (2014), Gilens (2012), and Bartels (2008). Assuming the affluent campaign donors and clients of lobbyists are rational actors pursuing their self-interests within the legal framework regulating such markets, may lead to a ‘success to the successful’ behaviour over time compromising the notion of ‘one person one vote’. To quote an Oxfam report that referred to such phenomenon as ‘political capture’,

“[...] Wealth begets wealth, and once the political and institutional system is rigged in favor of an elite, the consolidation of their privileges cascades down through different mechanisms. This ‘privilege cascade’ affects elements that otherwise should be

conducive to fair opportunities and protection for all members of society. What, by some measure, looks and sounds meritocratic is a result of rules that are biased in favor of the elite.” (Fuentes-Nieva & Galasso, 2014, p19)

Furthermore, the TFIAD (2004) affirmed that there is clear path dependence in the political system due to the convergence of interest groups and political parties in the US.

“[...] The problem today is that the mechanism for a broad and inclusive democracy – political parties – caters to some of the same narrow segments of American society that also disproportionately deploy interest groups on their behalf. Advantage begets additional advantage.” (TFIAD, 2004, p10).

Soss & Jacobs (2009) noted a bias in the literature of voting behaviour studies, both empirical and theoretical, overemphasizing on the individual voter, and cited the presence of feedbacks between policy and politics.

It is from that conceptualization that this research aims to answer (RQ2), to understand the implications of a free-market political economy of US elections and policy-making after identifying the reciprocal relationships between income inequality and political representation (RQ1). If money distorts the political system (Dawood, 2015), what reforms can be implemented to minimize the influence of money over politics, and what challenges are expected to be faced by reform efforts?

2.12. Reforming the US political system

“When wealth captures government policymaking, the rules bend to favor the rich, often to the detriment of everyone else. The consequences include the erosion of democratic governance, the pulling apart of social cohesion, and the vanishing of equal opportunities for all. Unless bold political solutions are instituted to curb the influence of wealth on politics, governments will work for the interests of the rich, while economic and political inequalities continue to rise [...] and will lead to ‘opportunity capture’ – in which the lowest tax rates, the best education, and the best healthcare are claimed by the children of the rich. This creates dynamic and mutually reinforcing cycles of advantage that are transmitted across generations.” (Fuentes-Nieva & Galasso, 2014, p2)

Calls for campaign finance reform, and lobbying regulation argue that money's role in politics must be tempered to protect the democracy of the US (Dawood, 2015; Lessig, 2011), and democracy by its definition would translate public preference into policy (Ferejohn, 2009). This includes enacting tax reform to reduce net income inequality (*Please refer to Chapter 2.5 for historical trends in American popular opinion about redistribution*). Richter, Samphantharak & Timmons (2009) noted that most research on the influence of money in politics focuses disproportionately on campaigns and access issues, while the spending on lobbying exceeds that on campaigns multiples of times. Gerken & Tausanovitch (2014) argued that too much focus is given to studying campaign finance and the role of money in elections, while lobbying is essentially ignored, adding that virtually all lobbying regulation in the US focuses on increasing transparency and preventing bribery, ignoring the issue of disproportionate influence gained by private interests who lobby, and in fact can afford the bill of the expensive services lobbyists provide to legislators. They also argue that campaign finance and lobbying lie on a continuum of influence over elected officials, where private money supports public functions (Gerken & Tausanovitch, 2014).

Issacharoff's conclusion on money in politics that it flows through the path of least resistance, such that any attempts to limit the influence of money will be faced with new challenges as money seeps through the cracks back into the system (Issacharoff, 2010).

Regulating campaign finance and lobbying is a constitutionally complex topic, as the US Supreme Court observes the First Amendment Rights of free speech, and interpret campaign contributions as well as campaign expenditures as a form of free speech (Dawood, 2015; Gerken & Tausanovitch, 2014; Lessig, 2011). Furthermore, attempting to regulate lobbying collides with the right to petition a citizen's elected representatives (Gerken & Tausanovitch, 2014). Issacharoff (2010) questioned the efficacy of the concept of corruption in the context of campaign finance and finance reform under current US constitutional law. He argued that the US Supreme Court considers process but not outcomes in the potential of money corrupting the political system, and emphasized that the problem of money in politics lies in its potential for political capture, echoing James Madison's words in the 'Federalist no. 10', and the erosion of public faith in the political system as a result of such capture. Thus the US Supreme Court's focus, in the issue of regulating campaign finance, considers process only rather than outcomes of unfettered money-giving to, or spending on politicians, therefore it does not address the core of the problem of having too much money in politics (Issacharoff, 2010).

There are generally two approaches for attempting to reform campaign finance laws, the levelling-up, and the levelling-down approaches (Gerken & Tausanovitch, 2014). Levelling-down approaches impose limits to reduce the influence of private groups and individuals on politicians, while levelling-up approaches focus on creating a public alternative to private funders.

Given the disproportionate focus given to campaign finance reform, this research will test two policies for campaign finance reform, a level-up approach, of Lessig (2011), and a level-down approach of contribution limits, to test their efficacy in a holistic system combining the markets of campaign finance and lobbying (RQ3). It will act as an assessment of whether campaign finance reforms are sufficient to counter income inequality's translation to representational inequality, and will help structure the debate on reforms targeting money's role in politics.

In conclusion, there is a wealth of evidence that government policy has contributed, both in active as well as passive ways, to the rise in income inequality in the US over the past four decades. There is also an abundance of evidence that points to a wealth bias in the US legislative process, the process which has the power to enact policies that reduce income inequality. This chapter outlined the means by which money plays a salient role in the US political process in elections, as well as in lobbying elected officials. Several factors combine to give an advantage for wealthy Americans in influencing elected officials, namely that poorer citizens are less likely to vote and thus exercise power over their legislators, political parties have become disproportionately pro-wealthy citizens, campaign contributions are highly concentrated, and lobbying efforts by big business dwarfs lobbying spending by organizations representing the interests of the less well off. Calls for reform in the political system focus on campaign finance reform, arguing that liberating US legislators from the dependency, for campaign funds, on private donors will enable them to pursue policies that fit with the general public's welfare even if they contradict with the interests of the richest Americans. Mapping the feedback relationships between inequality and the political system will help assess the efficacy of such arguments.

3. Methods

3.1. System Dynamics (SD)

System Dynamics is a field, philosophy, theory of action, approach, tool, and a worldview (Sterman, 2002) developed by Jay W. Forrester in the late 1950s and disseminated to the general audience in his Harvard Business Review paper (Forrester, 1958). He developed the field based on four foundations of System Dynamics, as reiterated by Richardson (2011): the theory of information feedback systems, knowledge of decision-making processes, an experimental model approach to complex systems, and the digital computer as a method for simulating models.

System Dynamics provides a theory of structure and behaviour of complex systems with four hierarchical levels: the closed boundary; the feedback loop as a building block; stocks and flows; goals, observed conditions, and actions based on gaps between goals and observations. It also aims to understand complex phenomena through causal models, using feedback loops as a system's building blocks (De Gooyert, 2019).

Feedback loops are either reinforcing, as in self-amplifying, or balancing, as in self-correcting (Sterman, 2000). Utilizing a feedback approach results in an endogenous explanation of behaviour over time, where behaviour is generated within the closed boundary of the model (Richardson, 2011). The emphasis of System Dynamics on modelling for problems rather than attempting to model the system stems from the endogenous hypothesis. Every variable included in the model can be endogenized (Sterman, 2002), thus without having a clearly articulated problem a modeller has no basis for structural exclusion, and thus boundary determination, which compromises the success of a System Dynamics modelling effort (sterman, 2000).

Although Forrester emphasized on formal, quantitative modelling in his four 'foundations' System Dynamics studies have evolved throughout the years to encompass purely qualitative work, which has considerable advantages. Some of the advantages of qualitative System Dynamics have been outlined by Coyle (2000), in that it distills knowledge into a comprehensive diagram (usually a Causal Loop diagram), acts as a boundary object, leads to feedback loop identification thus useful insights about the system in question, and can be used for scoping a problem for later development into a Stock and Flow Diagram. Qualitative System Dynamics is argued to be suitable for theory-building studies, but is rarely adequate

for theory testing, because simulation is the only way to overcome dynamic complexity and learn about the real system (Sterman, 2000).

System dynamics is multidisciplinary by nature and has been widely used for building models that cross the disciplinary boundaries to gain holistic insights allowing for better policy design, and more favoured policy outcomes (Sterman, 2000). System Dynamics models are classified as white-box models where behaviour is explicitly linked to its causal structure, allowing for experimentation, learning, policy design, and policy testing to change the system behaviour (Barlas, 1996).

3.2. Fit between SD and study

As outlined in previous chapters, economists have consistently downplayed the role of politics and public policy in shaping economic outcomes for US citizens, while political scientists have overemphasized on majoritarian electoral (median-voter based) paradigms of American politics, and underemphasized the role of money in politics (Hacker & Pierson, 2010). System Dynamics is a useful tool for synthesis as it can combine different theoretical strands in a single holistic model (De Gooyert, 2016), and promotes the integration of cross-disciplinary knowledge in a formal model to derive holistic insights.

The theory of political capture is argued to be a dynamic mechanism that transmits inequalities across generations in a vicious cycle (Fuentes-Nieva & Galasso, 2014), which justifies using system dynamics, as it is an ideal tool to study vicious circles (Sastry, 1997). Characterized by dynamic complexity, in the existence of feedback, delays inherent in the market mechanisms, and nonlinearity resulting from accumulations (stocks), the political economy of US elections and lobbying is a messy problem where System Dynamics can be of use to better understand and frame the problem, as well as for policy analysis and testing.

The use of System Dynamics to study income inequality is scarce, and is usually a small part of a larger economic model such as Yamaguchi (2012) and Block, Hu & Pickl (2013). To the knowledge of the author, System Dynamics has never been used to study the issue of political capture. This is perplexing because theories on political capture imply path dependence, which is generated as a result of reinforcing feedback, one of the building blocks of SD. This research is a stepping stone towards implementing SD to analyse income inequality and test policies

that take into account the structure of the political system, and possible unintended consequences of political reform.

3.3. Research strategy

Broadly speaking, this research employed a mixed methods strategy, combining qualitative and quantitative methods to delineate the system structure, analyse the model to explain the generated behaviour, and tested two policies that have been proposed in the literature to generate different system behaviour.

System Dynamics is a pragmatist approach, a consequence of its assumptions about model validity and purpose which agree with the relativist/ holistic philosophy of science (Barlas, 1996; Barlas & Carpenter, 1990). Given that pragmatism is philosophically consistent with mixed methods strategy of research (Denscombe, 2007), and that System Dynamics research has historically been conducted both using qualitative, and quantitative methods (De Gooyert, 2019), choice of quantification is a question of fit between the research aims and choice of method.

Had the research aims been solely about exploration and theory building, qualitative methods would have been sufficient to explore, and map the system structure. Yet theory testing, and policy analysis comprised a major aspect of the research aims from the onset, justifying a quantitative approach to complement the qualitative causal theory of the problem.

Considering research strategies specific to System Dynamics research, as set forth in De Gooyert (2019), this research can be classified as lying somewhere on the continuum between ‘conceptual virtual laboratory’, and ‘phenomenon-driven explanation’, though the dominant strategy is ‘conceptual virtual laboratory’. Recent empirical findings and knowledge accumulation on the topic of inequality and the political dynamics of US policy-making enabled synthesizing theory from theory, an attribute of ‘conceptual virtual laboratory’. Concurrently, before claiming the synthesis of existing theories is responsible for the reference mode of behaviour, this research aims to use previously hypothesized causal relationships, test their logical consistency, and assess the viability of selected policies presented in the literature. It may be argued to be one step behind formal calibration and mid-way between explicit ‘conceptual virtual laboratory’ and pure ‘phenomenon-driven explanation’. It’s contribution to the debate on inequality by giving a ‘white-box hypothesis’, as explained by Barlas (1996), on

the dynamics of income inequality and political influence in the context of a mix between economic-elite domination theories and biased-pluralistic theories of American politics.

This research began with qualitative causal mapping using a Stock and Flow Diagram (SFD), followed by quantifying the SFD, testing, and reverting back to qualitative methods for structure refinement, quantifying, testing, then Causal Loop Diagramming (CLD) for communication. Due to the relatively large size of the model, Chapter 4 is presented using a CLD, while Stock and Flow structure is presented in Appendix 3. Quantitative methods were dominant, as the numerical input was imperative to contrast the heterogeneity of the actors involved, the top income earners in the US versus the rest of the population, and the resulting dominance in the system which has significant policy/ policy analysis implications.

3.4. Research process: P'HAPI

This study followed the approach developed by Moxnes (2009) for conducting System Dynamics research, which he coined as P'HAPI (Problem formulation, Hypothesis, Analysis, Policy, Implementation) consisting of five steps beginning with problem formulation to guide the scope of the research represented in a reference mode of behaviour consisting of a set of data series for inequality, campaign contributions, and lobbying expenditure, as well as tax rates (*Please refer to chapter 1 for details on the problem definition*).

The next step was the formulation of a dynamic hypothesis that explains the reference mode of behaviour, which was a quantitative System Dynamics model (Chapter 4). The author then conducted a series of experiments in the third step, Analysis, to test the structural and behavioural validity of the model as set forth in Barlas (1996) (Chapter 5).

This was followed by testing two policy proposals in the literature (Chapter 6), in the arena of campaign finance reform to test their effects on the system in question. The study ends with a reflection on the tested policies and considerations on implementation and obstacles to implementation (Chapter 7).

It is worth noting that given the research strategy leaning towards 'conceptual virtual lab' than a 'phenomenon-driven explanation', adherence to the reference mode was not as rigid as in typical System Dynamics studies that employ calibration and Thiel statistics, as set forth in Sterman (1984), as the aims of the research were synthesis and generalization. The calibration of the model was designed to reflect the heterogeneity between the two agents considered in

the model, the top 10% of income earners, and the bottom 90% of the income distribution in the US, such that they displayed different behaviours in response to states of the system in the model.

Below is a map of the modes of scientific inquiry utilized throughout the course of this research, superimposed on the stages of SD research by Moxnes (2009):

P'HAPI stage	Milestones of stage	Mode of scientific inquiry	Comments
Problem Identification	Identify and frame the issue	Inductive	Data on income inequality was observed and a puzzle was detected: income inequality in the US has been steadily increasing since the mid 1970s, yet policies to reduce it have not been effective even though American voters want it reduced. This is an inductive effort because the data has been observed from several sources and interpretations of such data. Given that observations preceded theory it may be classified as inductive (Saunders et al, 2019).
	Reference mode of behaviour		
Dynamic Hypothesis	Identify key elements to be modelled	Abductive	After the 'surprising fact' has been observed and established, in the paradoxical statement above, possible explanations of why such phenomenon has occurred, were hypothesized (Schwaninger & Hamann, 2005).
	Generate an initial dynamic hypothesis		This included the interaction of different aspects of the political process in the US that influence policy, namely the legislative body that issues tax laws, the campaigns they run to get elected, the population of voters who get politicians into office, the lobbying they receive from different factions of American society, and so on. Such aspects were formalized as sectors in the SD model, and their dynamic interaction was the initial dynamic hypothesis.
	Model formulation	Deductive	As per Schwaninger & Hamann (2005), integrating theories is a deductive process because statements about the causal relationships between variables, for example the interaction between demand and supply, or the effect of campaign spending on votes gained by a politician is derived from existing theories which are considered to be universally true. It does not make a difference how such theories were derived. For example the work of Gilens & Page (2014) concluding that the dominant paradigms in American politics are 'economic elite domination' and 'biased pluralism' was fundamentally empirical, as all the four paradigms (theoretical) contrasted in Chapter 2.6 have been supported by empirical evidence. Furthermore, Sterman (2000) commodity market model (a theory in and of itself) developed using

			System Dynamics, employing the three modes of scientific inquiry, was integrated with a purely deductive work of Hall & Deardorff (2006). The key point is that the theories and causal relationships synthesized in this research are considered to be true, such that their consequences are also true. This is an attribute of deductive thinking (Schwaninger & Hamann, 2005).
Analysis	Direct structure tests	Inductive	Generated data from the model, which was formulated deductively, was analysed inductively to understand the dynamic behaviour generated from the causal relationships in the formal model, as set forth in Axelrod (1997).
	Structure-oriented behaviour tests		This stage started with partial-model testing as per Homer (1983) conducting structure and behaviour tests as per Barlas (1996). When a sector failed a test, the author would revert to the deductive model formulation, and test again, in an iterative fashion. After partial model testing was completed the full model was analysed.
	Behaviour tests		
Policy	Policy design	Deductive	The author chose to test two policies in the literature, one in placing contribution limits on political candidates, and the other in revamping the campaign funding system to that of voter vouchers. Since these policies were already suggested in the literature, their adaptation into the model started, as with the model formulation, from existing theories with the aim to analyse their implications, thus the modeller formulated them with a clear theory in mind rendering the process deductive.
	Policy analysis	Inductive	By conducting policy tests as set forth in Barlas (1996), inferences were made from the simulated results to judge the adequacy and effectiveness of the policies proposed in the literature.
Implementation	-	-	This is a discussion of the possible implications and challenges of employing the analysed policies.

Table 2 Modes of scientific inquiry employed in P'HAPI by Moxnes (2009)

3.5. Data collection and analysis

Given the nature of this study being theoretical research, the model has been built from literature, using peer-reviewed journals as sources of papers, and consulting specific chapters from books on an as-needed basis. Calibration of the model was approached so as to reflect qualitative statements by several authors, emphasizing on the heterogeneity of economic, and political attitudes of the top income earners in the US versus the rest of the population, as well as the nature of the political system in terms of voter behaviour and donor behaviour.

Given the synthesis purpose of this study, data across disciplines was researched for themes including campaigning for political elections in the US, the lobbying industry in the US, progressive taxation, income inequality, and political inequality. A snowballing approach was employed to find relevant articles using Google Scholar. Once a paper was found that met quality criteria, published in a peer-reviewed journal with a moderate number of citations, meaning the number of times such article was cited (the older the paper, the higher the threshold for citations was for it to qualify as a quality paper), it was added to the list of readings. This data collection process was conducted in cycles, the author would read for a week, take notes, and model. Then continue reading for another week, and revert back to modelling. Eventually, the reading was conducted on an as-needed basis once the overall structure of the model began to emerge.

When there was high uncertainty in the data, qualitative or quantitative, the assumptions were approached with prudence, made explicitly clear, and quantified conservatively. For example, to contrast the difference in propensity to donate to politicians, Agent (X) was assumed to have double the propensity of Agent (Y). This is a conservative assumption as Bonica et al (2013) found that 40% of all campaign contributions come from the top 0.01% income earners. The usefulness of using conservative assumptions is that if the expected behaviour was generated using such underestimates of inequality in attitudes, this builds confidence in the applicability of the model to describe the real system.

Model analysis was conducted based on Barlas (1996) and Homer (1983) (*please refer to Appendix 7 for details on partial model testing experiments*). The purpose of model validation tests was to build confidence in the model structure, and behaviour generated from that structure to be able to derive valid conclusions from running scenarios and policy tests. (*please refer to Chapter 13: Appendix 4 for full model tests as per Barlas (1996)*). When ‘intended rationality’ tests based on Homer (1983) were conducted on sectors of the model, unanticipated behaviour in such tests triggered a new ‘focused cycle’ of literature review where the author would seek data on specific relationships within a sector, or linking the sector in question with other parts of the model. Model analysis is discussed in full detail in Chapter 5 explaining the base-run which provides a dynamic hypothesis on the feedback relationships between income inequality and US political system, followed by a set of five scenarios outlining possible futures for the US tax policy in light of the model built. For the full range of tests conducted on the full model, as well as intended rationality tests, please refer to Appendices 4 & 7 respectively.

4. Model description

4.1. Model overview

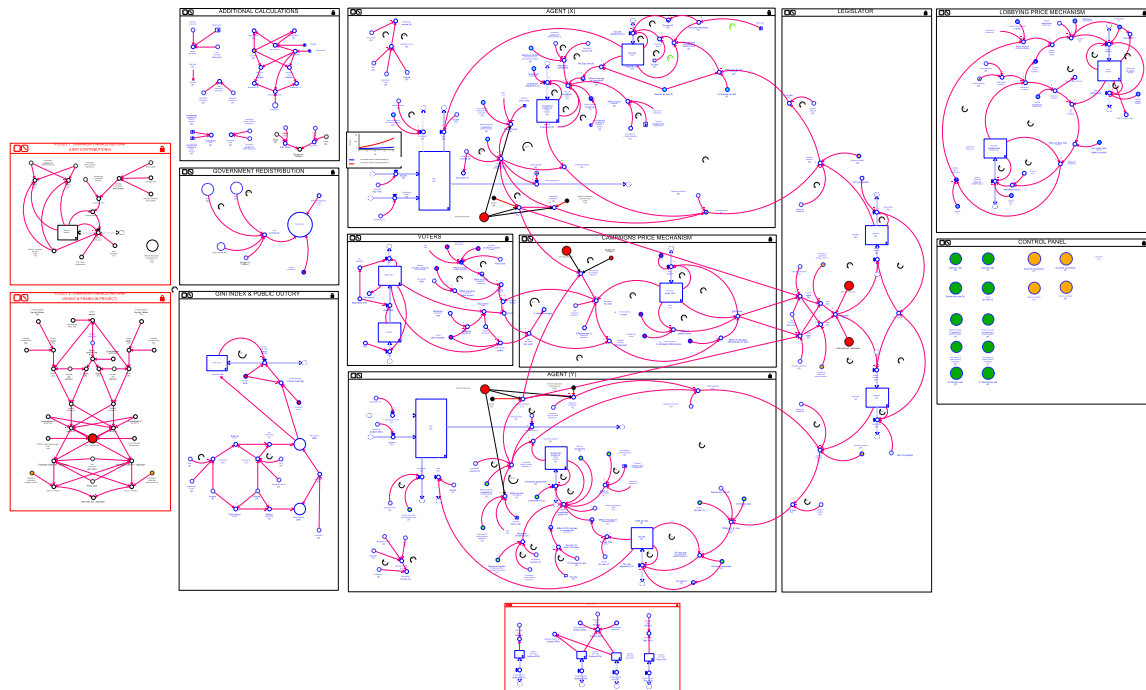


Figure 16 Model Overview

The model was designed to represent two self-interested heterogeneous agents, Agent (X) representing the top 10% of income earners who captured almost 50% of US national income, and Agent (Y), the bottom 90% of US income earners. Both agents contribute to campaigns and lobby their legislators in office. The bicameral nature of the US legislative system has been simplified to include only the Senate because the US Senate has the upper hand over the lower chamber in determining tax policy, through amending or rejecting a tax bill. The year 1981 was chosen as the starting time for simulation as it was the time of the first wave of massive tax cuts of the Reagan era.

Given that market inequality has been excluded from the focus of this study, market incomes and thus market inequality are exogenous in this model. Yet in the discussion part of this research, the author describes how insights from analysing Net inequality within a free-market framework presented in this study could inform on market inequality and means to address it. Furthermore, the tax goals of Agent (X) and Agent (Y) are determined exogenously as the purpose of the model is to understand the dynamic behaviour generated from the competition

between the two agents, having different policy objectives (in this study the policy in question is tax rates), rather than determining how such objectives are formulated.

Figure 16 shows the SFD of the model built for this study. It provides the answer to (RQ1) outlining the feedback relationships between income inequality and the US political system (*details on the sectoral structure of the model are provided in Appendix 1 & 2*). For simplicity, and for the purpose of effective communication, the remainder of this chapter uses CLDs to explain the feedback structure of the model. The following chapter outlines model assumptions, followed by the dynamic hypothesis (Chapter 4.3).

4.2. Model assumptions

(Please refer to Appendix 2 for more details on model assumptions)

1. **Agents are rational**, self-interested utility maximizers
2. **Agents are heterogeneous**, expressing different attitudes in regards to political spending across the income distribution
3. **Winning elections is proportional to campaign expenditure**, the more a political candidate raises, the more vote shares she can get because she can advertise and convince the voters to give her their votes
4. **Campaign contributions are made on a consumption basis**, although the debate is unresolved between investment versus consumption motives, this assumption is more conservative than incorporating an investment motive as it portrays citizens to have no intention to explicitly get something in return for getting a legislator in office by paying for his campaign
5. **Legislature campaigns are a free market subject to the forces of demand and supply**, the costs of campaigns are dependent on the supply of votes versus the demand for votes expressed in total campaign spending
6. **Lobbying expenditures are made on an investment basis**, given lobbying on tax issues has a monetary return for those who lobby
7. **Lobbying efforts operate in a free market subject to the forces of demand and supply**, as the lobbying industry has doubled in size (in US Dollars) over the past 20 years, it is possible to model it as a market with demand represented in lobbying expenditure, and supply as number of registered lobbyists.

8. *Agents lobby those who already share their worldview,* not try to convince or win over legislators from the other camp (Agent (X) versus Agent (Y))
9. *Policy is shaped by the legislative enterprise of active legislators,* number of legislators who were supported into office by an agent is complemented and reinforced by lobbying expenditure from the same agent, which results in valuable services provided by lobbyists (legislative subsidy) to comprise a 'legislative enterprise'.
10. *Inequality reduces participation rates of eligible voters in legislature elections,* due to apathy, disengagement effects, as well as cynicism.
11. *Public outcry delays, and dilutes policy that would increase inequality,* when a policy is unpopular by the population it is enacted more slowly and is tempered to prevent mass protest and to appease the population.

4.3. Dynamic hypothesis

This chapter provides the detailed answer to (RQ1), formulating a dynamic hypothesis for the interaction between income inequality and the political system.

Figure 17 represents the competition between the top 10% income earners (Agent (X)) in giving campaign contributions, and the bottom 90% of income earners (Agent (Y)). As stated in the model assumptions (*Please refer to Chapter 4.2 and Appendix 2 for details*) a consumption-based approach was used for campaign contributions, meaning that agents do not aim to get any benefit from donating to the campaigns of their favoured legislator candidates, they donate because they support their politician's stances and positions in regards to societal issues and give money as a form of empowerment to their politicians to help them win elections.

4.3.1. Campaigns

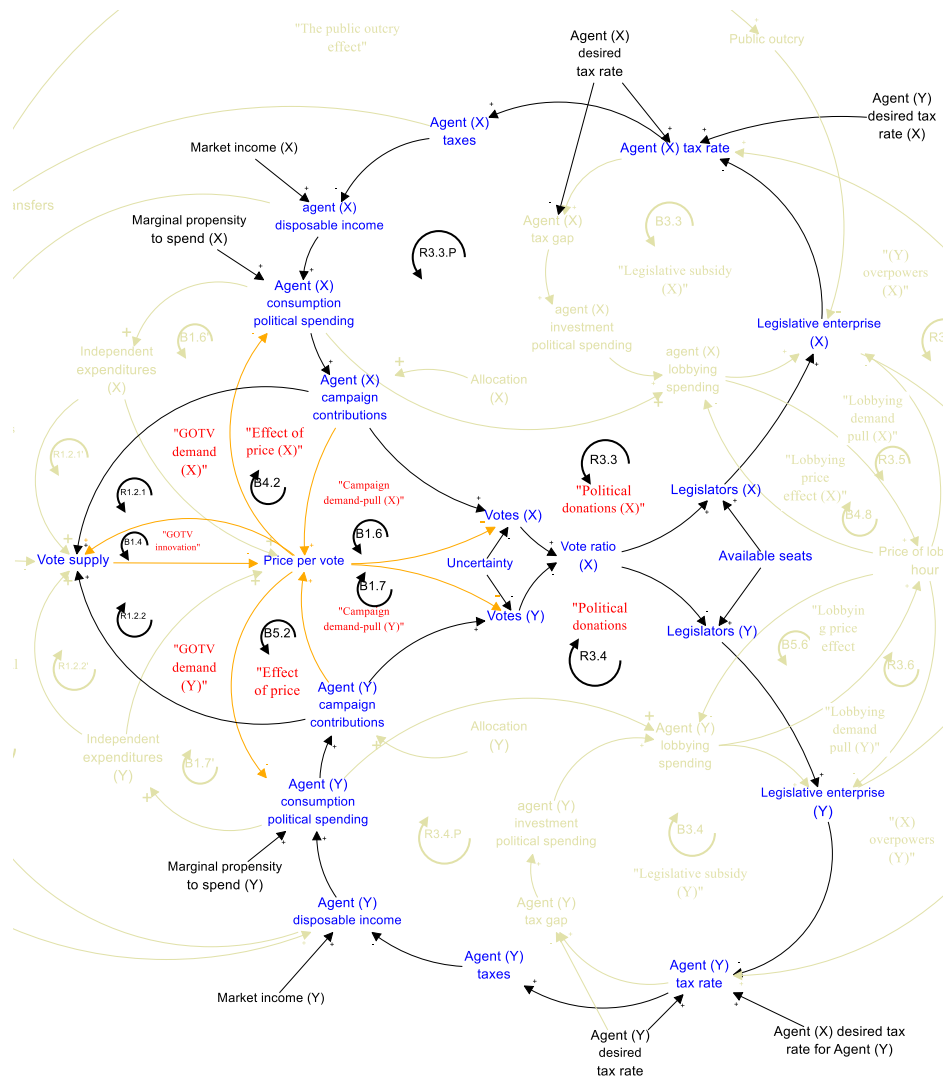


Figure 17 Competition between Agents in Funding campaigns for politicians through consumption political spending

There are two reinforcing loops competing for a limited number of legislator seats, “available seats”, that become available every two years. Even though the US Senate has 100 members each spending a six-year term, the elections are staggered, meaning that a third of the chamber (33.3 seats) is elected every two years. In continuous time, this means that 16.7 seats are available every year. Each agent is able to fund into office a number of candidates proportional to his campaign contributions. This is the role of vote ratio, which compares the number of votes gained by Agent (X) versus those gained by Agent (Y) as a result of their campaigns. If Agent (X) spent twice as much money on campaigns, for a given price per vote, the vote ratio should be 0.66 and thus Agent (X) will gain two thirds of the 16.7 seats available in that year.

There is, however, an uncertainty in translating campaign funds to votes. The relationship between amassing campaign donations and winning votes is proportional, because then a candidate is able to advertise and use expensive consultants to run campaigns that would convince voters to give him their voice, yet it doesn't occur deterministically. Sometimes the candidate who wins is not the highest spending candidate, thus the higher the uncertainty the lower the number of votes a higher-spending candidate gets, thus the variable "Vote ratio (X)" takes into account vote uncertainty and adjusts the vote distribution based on such uncertainty (*Please refer to Chapter 12.3 in Appendix 3 for details on model formulation*).

This structure comprises a 'success to the successful' behaviour, as the agent with higher legislators has a stronger legislative enterprise and is able to cut taxes for themselves, increasing their disposable income, and thus contributing more to candidates who share their worldview, thus cutting taxes further, in a vicious cycle (R3.3) and (R3.4).

The first aspect of heterogeneity between Agent (X) and Agent (Y), is their "marginal propensity to spend on political campaigns", meaning how much of their disposable income are they willing to donate to politicians? It is a consequence of the assumption that campaign contributions by individuals and groups are a form of political consumption. It is assumed that Agent (Y) has a lower propensity to consume political 'goods', thus their contributions are typically lower per person as those of Agent (X). Another aspect of heterogeneity is reflected in the agents' response to inflation in the cost of campaigns (represented here in the variable "price per vote").

Loops (B1.6) and (B1.7) represent the demand-pull inflation of campaign spending. If demand increases, as in if agents started contributing more money to political campaigns, the price per vote gained as a result of the campaign will increase because demand is increasing for a given supply of votes. If both agents increased their contributions at the same rate, to keep with an increasing price, their relative votes gained would be constant.

Yet price has a negative effect on consumption (Yamaguchi, 2019) and it is assumed that the two agents are heterogeneous in their response to an increase in price. Agent (Y) has a higher "price elasticity of political spending" (*Please refer to Chapter 12.4 & 12.5 of Appendix 3 for details*), meaning that for a given increase in price, the reduction in Agent (Y)'s consumption political spending will decline more than that of Agent (X).

Loops (B4.2) and (B5.2) represent this response to price. When agents reduce their consumption, demand for votes will decrease, stabilizing the price per vote; that is why they

are balancing loops. If one agent is more averse to contributing given an increasing price, that agent would experience declining vote share. This is at the heart of the heterogeneity between the two agents, but there is another aspect of political spending, that of investment in politics through lobbying.

4.3.2. Lobbying

The second aspect of an agent's 'legislative enterprise' is how much lobbying spending that agent expends to support, or subsidize as Hall & Deardorff (2006) coined it, the legislators with whom they agree and share worldviews.

It has been explained in the previous segment that agents donate campaign money to legislator candidates with whom they agree, a form of political consumption spending. Lobbying such candidates when they get to office is assumed to be an investment in politics as it is a goal-oriented process which aims to increase disposable income by reducing taxes. Since a monetary benefit is expected to be gained from lobbying one's legislators, it fits with the description of investment-based political spending of Gordon, Hafer & Landa (2007).

The higher the tax gap for an agent, the difference between an agent's desired tax and actual tax rate, the higher that agent will lobby to increase the legislative enterprise and thus achieve their desired tax rate, i.e. tax gap becomes zero. This is described in Figure 18, in loops (B3.3) and (B3.4). The legislative enterprise is composed of both the number of legislators

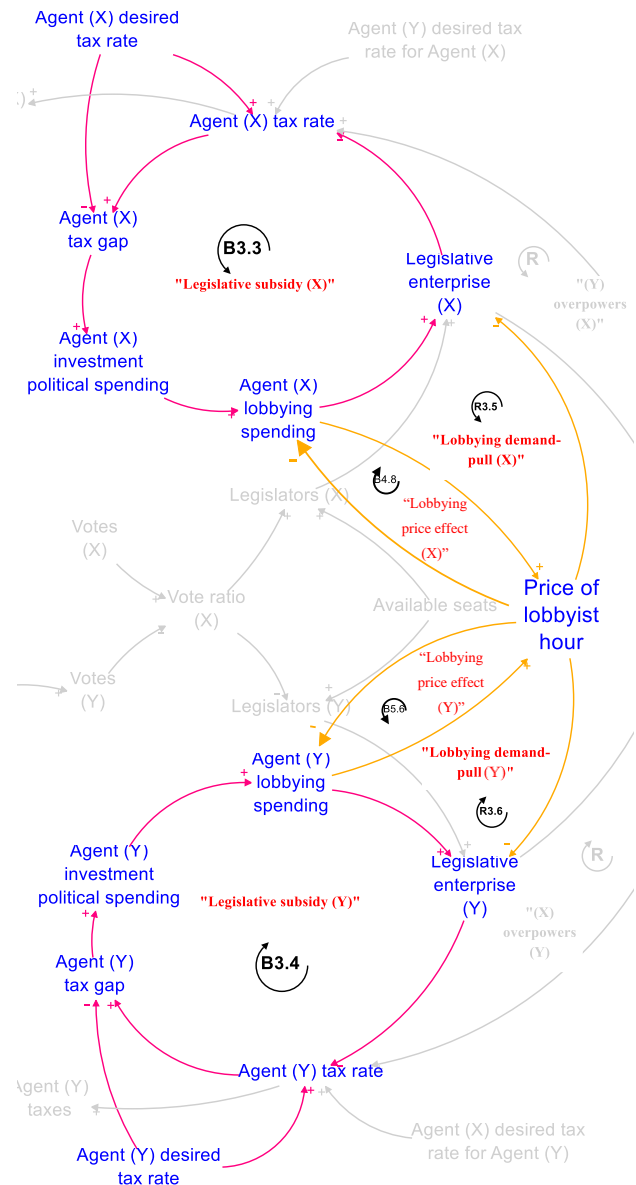


Figure 18 Lobbying as a goal-seeking investment in politics - Competition between Agents (X) & (Y)

from each agent, and how much lobbying is expended on an agent's legislators (a product of the two variables).

Agent (Y) faces challenges in lobbying for tax policy because the population of Agent (Y) is much larger in size and face collective-action problems (difficulties in organizing themselves and pooling their resources) due to such size, what is referred to in the literature as the 'free-rider problem' (Gilens & Page, 2014). A consequence of this is that smaller groups can lobby more efficiently as they resolve collective action problems easier than the multitude of larger-member groups. As per Hacker & Pierson (2010) labour unions lobby for the economic interests of the working class, but union membership rates have drastically declined in the past few decades.

Furthermore, as the demand for lobbyists increases, the price of a lobbyist-hour, the unit of choice for this price mechanism, increases. This reduces the effectiveness of any dollar spent on lobbying by an agent, having a negative effect on legislative enterprise for a given amount of lobbying spending by an agent (R3.5) and (R3.6).

This has a reinforcing effect as it would preserve a tax gap for agents, due to the weaker legislative enterprise, justifying more lobbying spending, which further pushes the price up. This price inflation intensifies the challenges faced by Agent (Y) in organizing and raising sufficient funds to lobby their legislators, who have a lower cap on their lobbying expenditure due to the collective action problems discussed above.

Finally, increases in the price of lobbyist-hour lead to a reduction in lobbying spending because the effectiveness of any single USD spent on lobbying decreases with a rising price. The same is true for the reverse, where a declining price of lobbyist-hour makes it more appealing to those who are willing to spend on lobbying. Agent (Y) typically has a more severe response to price, as they have lower disposable income to spend on politics. It is also well documented that the more wealthy, because they can afford it, are more likely to lobby despite the increase in price (Hall & Deardorff, 2006). This effect is modelled in loops (B4.8) and (B5.6) in Figure 18.

4.3.3. Legislative enterprises

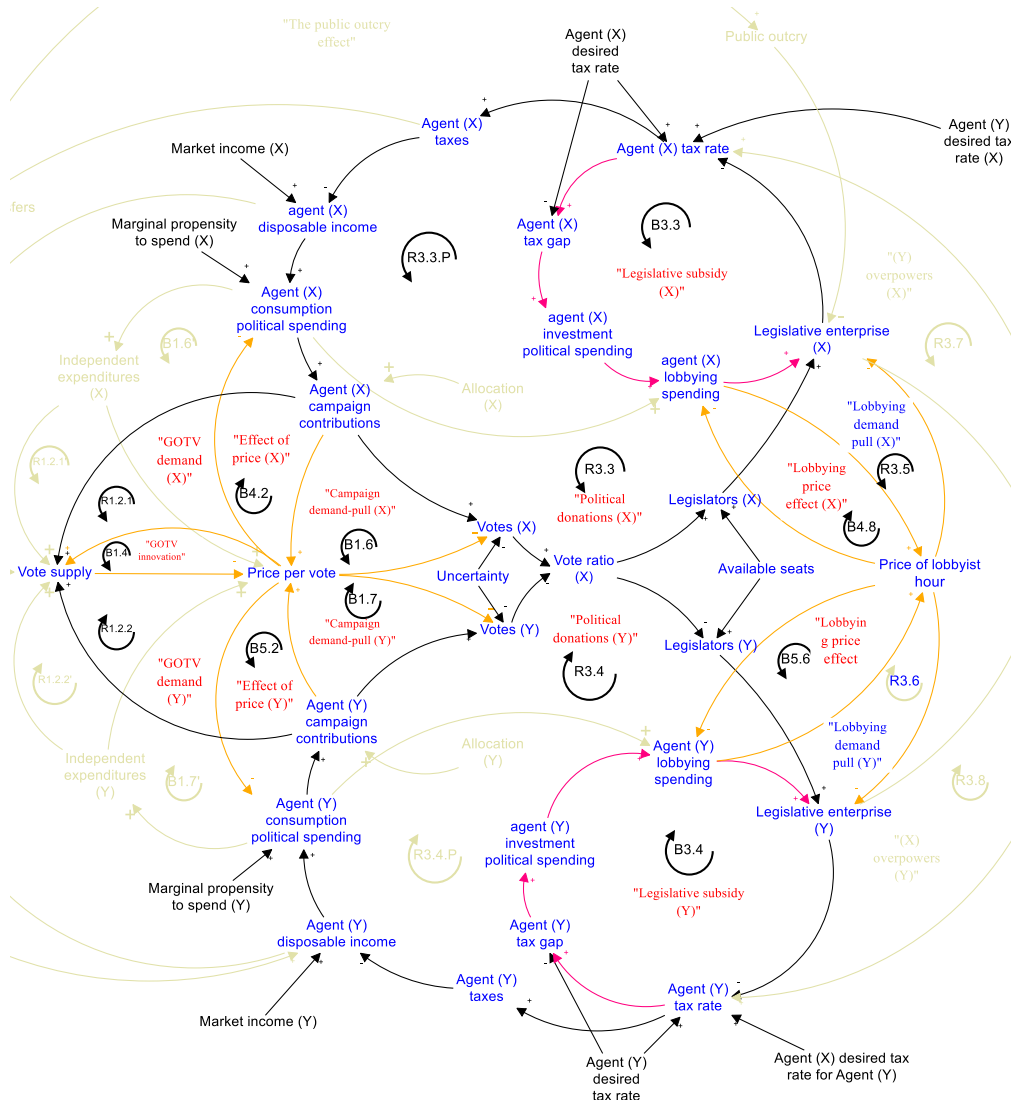


Figure 19 Combining elected officials and lobbying subsidy to form two 'legislative enterprises' based on Hall & Deardorff (2006) theory 'Lobbying as a legislative subsidy'

Figure 19 displays the main loops that contrast the two ways American citizens participate in politics through money. The reinforcing loops, “Political donations (X)” (R3.3) and “Political donations (Y)” (R3.4) represent the consumption aspect of political spending, a function of disposable income. The two balancing loops, “Legislative subsidy (X)” (B3.3) and “Legislative subsidy (Y)” (B3.4) represent the goal-seeking investment in politics.

Both types of spending represent a demand: (R3.3) and (R3.4) represent the demand for votes, while loops (B3.3), and (B3.4) represent demand for lobbyist services. Both types of demand cause inflation in the price of the demanded ‘political good’ when supply is constrained. A

Legislative enterprise is a concept outlined by Hall & Deardorff (2006), and is operationalized in this model as the product of the number of legislator seats possessed by an Agent in office, multiplied by a measure of that agent's lobbying intensity. The next chapter shows how the two agents compete, through their legislative enterprises, to determine their own tax rate, as well as the tax rate of the other agent.

4.3.4. Competition between the two agents

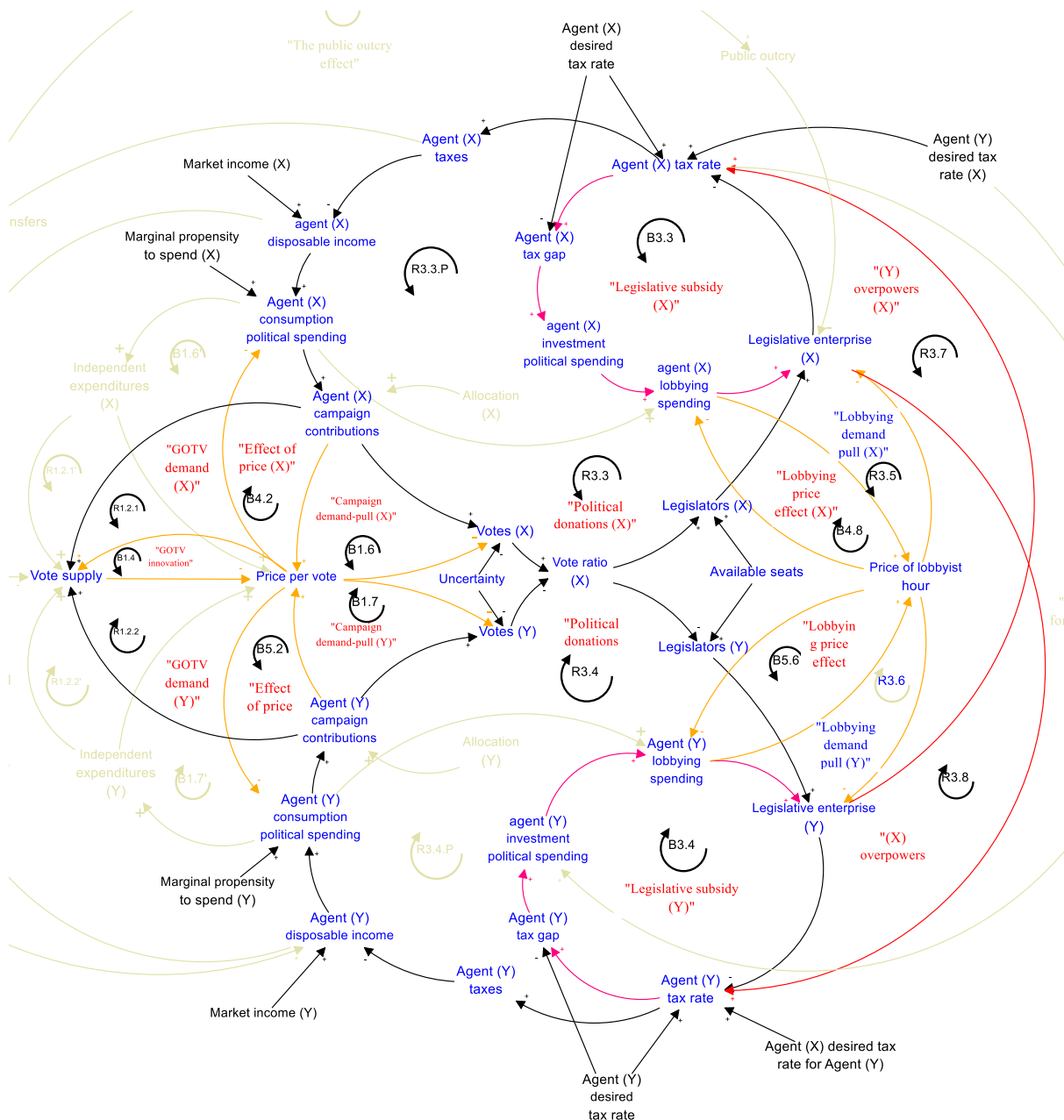


Figure 20 Competition between the two legislative enterprises of Agents (X) & (Y)

The competition between the two agents occurs through the legislative enterprises; the agent with a higher legislative enterprise can impose their goals on the other. If Agent (Y) had a stronger legislative enterprise, they will impose higher taxes on Agent (X), and vice versa.

This is demonstrated in the additional goals added to the CLD in Figure 20, “Agent (Y) desired tax rate for Agent (X)”, and “Agent (X) desired tax rate for Agent (Y)” shown in the colour black above. Having this competition introduces two new reinforcing loops, “(Y) overpowers (X)” (R3.7), and “(X) overpowers (Y)” (R3.8). They are reinforcing because if Agent (X), for example, had a higher legislative enterprise, they will not only be able to cut taxes for themselves; they will also be able to raise taxes on Agent (Y), if they so desired, further weakening the position of Agent (Y).

Given that votes are won proportional to campaign contributions, which are spent by the candidates, then the dominance of loop (R3.8), for example, will lead to a vicious cycle by which Agent (X) will gain more votes and reinforce their legislative enterprise further thus cutting taxes for themselves. Lower taxes will lead to more income and more campaign contributions which will lead to more votes and yet more seats. If Agent (X) raised taxes on Agent (Y), Agent (Y) will spend less on campaigns and lose seats. This is the second facet of ‘success to the successful’ in the competition between the two agents.

4.3.5. Redistribution and lobbying for transfers

One aspect missing from the CLD in Figure 20, is that Agent (Y), being rational, has an interest in lobbying for higher taxes on Agent (X) through (B5.7), because Agent (Y) benefits more from government transfers, a form of redistribution. Transfers come from tax money, thus higher taxes on Agent (X) will result in higher transfers for Agent (Y). In the base-run, the competition between the agents may be conceptualized as competition between (B3.3) vs. (B5.7), as well as (R3.3) vs. (R3.4). Loop (B5.7), as well as government redistribution (R5.3) are shown in Figure 21. Redistribution is calculated as a fraction of total tax revenue collected by the government. Agent (Y) also pays taxes and feeds them into the redistribution system, but for the sake of simplicity, such loop was not included in the CLD in Figure 21. Redistribution creates a reinforcing effect whereby Agent (Y), receiving more income, can spend more on consumption-based political spending, strengthening their ‘legislative enterprise’ and raising taxes on Agent (X).

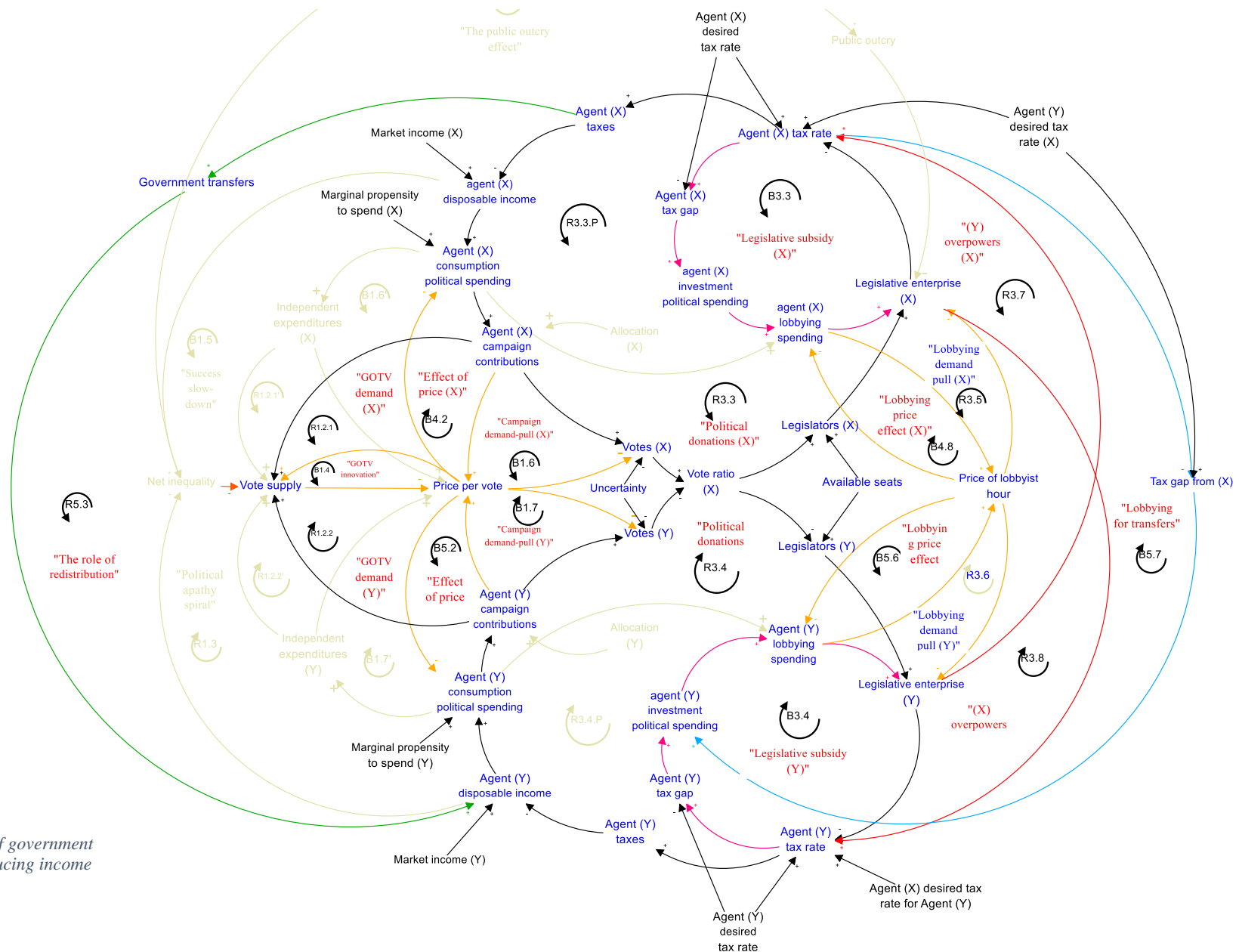


Figure 21 The role of government redistribution in reducing income inequality

4.3.6. Inequality

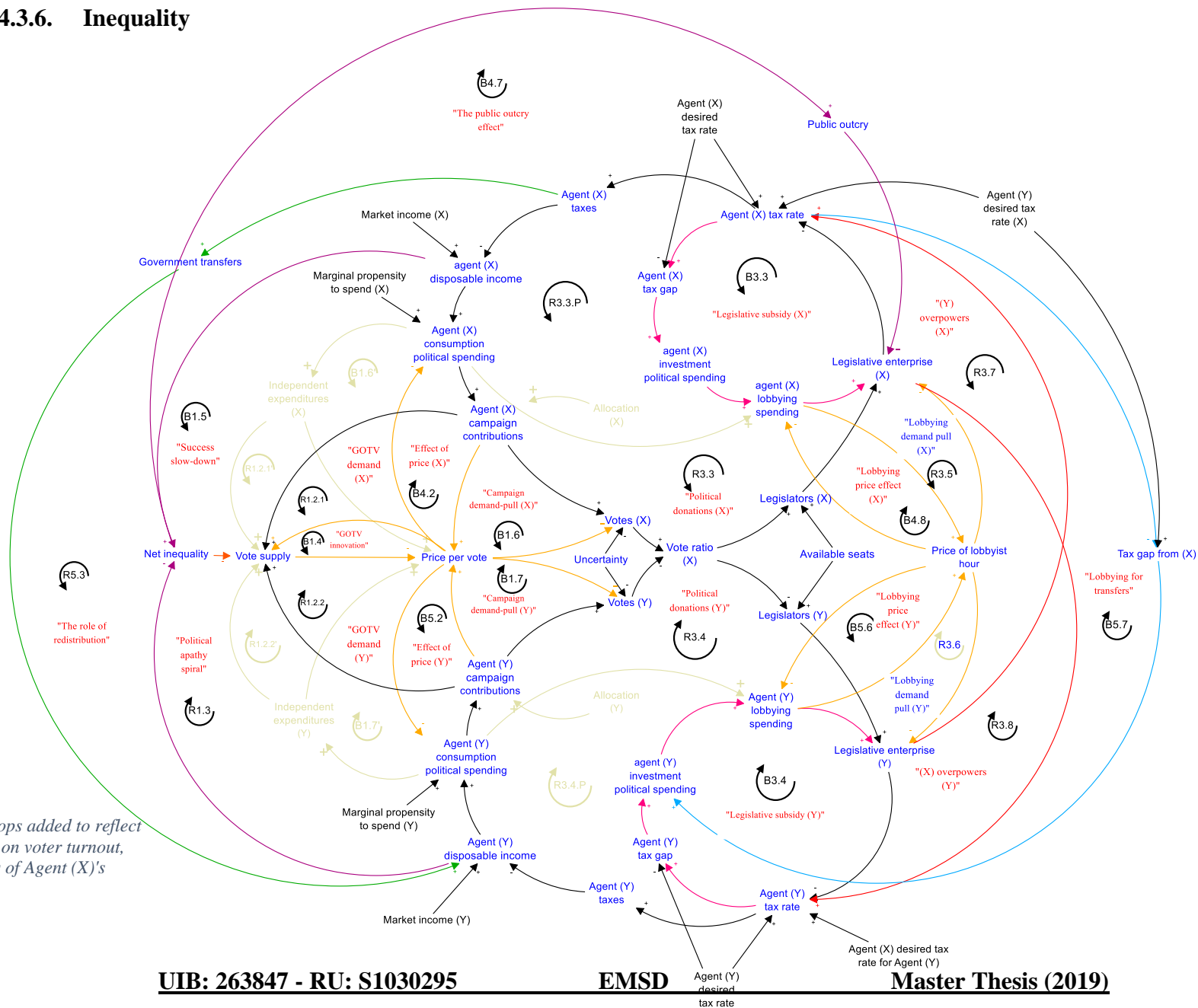


Figure 22 Inequality loops added to reflect the effects of inequality on voter turnout, and on the effectiveness of Agent (X)'s legislative enterprise

The final set of feedbacks described in this dynamic hypothesis are those of inequality (Figure 22). Inequality is calculated using a simplified version of GINI coefficient, comparing the disposable income of both agents, taking government transfers into account.

Inequality lowers voter participation, especially at the bottom end of the income distribution, thus lowers vote supply. When supply is low, price is driven up which can be explained by political candidates running massive media campaigns to Get Out The Vote, mobilizing voters on election day.

Decreasing supply of votes causes an upward pressure on price, which reduces the vote share of Agent (Y) especially because Agent (Y) responds to increases in price more aggressively than Agent (X) (via loop (B5.2)). This reduces the vote share of Agent (Y) and thus their legislative enterprise, which results in lower disposable income, and consequently a rise in inequality (R1.3).

Concurrently, the increase in price lowers votes, hence seats in the legislature, and legislative enterprise of Agent (X), which increases taxes on them and thus reduces their disposable income, reducing inequality (B1.5). It is worth noting, though, that this loop will not be dominant because for it to dominate, Agent (Y) needs to deactivate loop (R1.3) such that Agent (X) has a disadvantage due to price while Agent (Y) builds up their legislative enterprise. This, in the current system structure is not going to spontaneously happen because price increases apply to both agents simultaneously.

Finally, increasing inequality builds up public outcry, which in turn creates the opportunity for Legislators of Agent (Y) to gain momentum in countering the legislative enterprise of Agent (X), because of the salience of the issue to the public and public support. This is the “Public outcry effect” (B4.7) which balances inequality by giving “Legislative enterprise (Y)” an edge.

This chapter provided a dynamic hypothesis for the feedbacks between the political process in the US and income inequality. It aimed at answering (RQ1), mapping the feedback structure by which income inequality and the US political system interact, resulting in the persistence of increasing inequality since the early-1980s. Market income for both agents, and hence market inequality, has been exogenously plugged into the model as this research emphasizes on the political processes that influence redistribution, and thus net inequality, rather than the myriad of factors influencing market inequality (*Please refer to chapters 2.2 & 2.3 for details*).

5. Model analysis

As per Moxnes (2009), after formulation of the dynamic hypothesis comes analysis to build confidence in the dynamic structure through a series of tests. The author used Barlas (1996) as the guideline for model testing classified as direct structure tests, structure-oriented behaviour tests, and behaviour pattern tests. Given that this is a theoretical model built from literature, emphasis was given to the first two categories of tests. Full calibration of the model was determined to be beyond the scope of this project as the purpose of this research was to synthesize theories and test the implications of such synthesis, as well as its underlying assumptions, on generating behaviour that falls in line with the predictions of the synthesized theories. Thus the validation process of this model covers the first two tests set forth in Barlas (1996). The author iterated between testing and calibration for the base-run. With sufficient testing, confidence was built in the validity of the model which was calibrated mainly to reflect the heterogeneity of the two actors in how they behave within the US political system structure. The next chapter discusses the base-case (base-run) calibration in further detail followed by the base-run results, and in-depth analysis of the results answering (RQ2). This is followed by five scenario experiments, looking beyond the base-run time horizon, exploring possible futures for the problem of income inequality and political representation in the US (*For direct structure tests and structure-oriented behaviour tests please refer to Appendix 4 (Chapter 13)*).

5.1. Model Calibration

As outlined in Chapter 4.2, the agents are heterogeneous, and the purpose of this model is to synthesize theory from theory creating a ‘Conceptual Virtual Lab’ as outlined in Chapter 3.4. Thus the calibration of this model did not aim to replicate a reference mode of behaviour. The calibration, therefore, was to reflect the heterogeneity of the agents within the system structure built from theory synthesis, to test the outcomes of such synthesis, as per Barlas (1996) and De Gooyert (2019). Table 3 shows a list of key parameters, and initial values that require emphasis to understand how the heterogeneity between the agents was modelled. Appendix 6 (Chapter 15) elaborates on other key variables not displayed in Table 3.

Variable	Units	Agent (X)	Agent (Y)	Description	Justification
Income	USD/year	Exogenous data series reflecting actual market incomes of US citizens from 1981 to 2018		Smoothed exogenous data series of market incomes in the US over time. They are sourced from the World Inequality Database (2019)	The scope of this model focuses on Net inequality (<i>please refer to chapters 2.2 and 2.3 for details on the difference between market and net inequality</i>) and to Chapter 1.3 for the logic behind this boundary choice
Fraction consumption from disposable income	dmnl	0.84	0.92	This represents the percentage of consumption of goods and services by the top 10% income earners versus the bottom 90%. It has been empirically found that consumption rates at the top of the income distribution are lower due to higher saving rates (Alvaredo et al, 2018), about twice that of the average. Based on Saez & Zucman (2016), the average saving rate of the bottom 90% is almost zero. The author was more conservative in assuming they save more (the national average is around 8% since 1980 based on the St. Louis FED (2019), while that of the top 10% is taken to be double that, also a conservative estimate.	It is assumed that the bottom 90% consume more than the top 10% as a percentage of their disposable income. This means that the poor retain less from their disposable income (as a %) to spend on politics.
Marginal propensity to spend on political campaigns	dmnl	0.001	0.0005	It is assumed that the top 10% have double the propensity to make political contributions. It is a well documented fact that high income earners donate more as per Gilens (2005) and Ansolabehere, de Figueiredo & Snyder (2003)	This is a conservative because as noted in Chapter 1, there is extreme concentration in the sources of campaign contributions. The parameters were chosen so as to create a total pattern of

					campaign contributions that is consistent with growth in campaign spending in the US over the past 40 years.
Price elasticity of political spending (Campaigns)	dmnl	0.1	0.2	This is the response of each agent to changes in price in the context of campaigns. Lower elasticity means that the effect of increasing price will not change the agent's spending as much as the other agent. It also means that if price is falling, the agent with a lower elasticity will not be encouraged as much as the other agent to spend more.	Using only double the elasticity for Agent (Y) may be considered a conservative estimate because of the low documented rates of contribution by the bottom 90%, especially the bottom 50% of US population. (see TFIAD (2004))
Price elasticity of lobbying spending	dmnl	0.1	0.3	This is the elasticity of lobbying spending. A higher elasticity means that with increases in price, less lobbying spending is made, and with decreasing price, more lobbying spending is made. Agent (Y) has higher elasticity than Agent (X)	It is well documented that the general public lobby less than the wealthy business interests (Hall & Deardorff, 2006). Also from the graphs in Chapter 1 (problem definition), three times the elasticity is considered a conservative estimate
Investment decision AT	year	6	6	This is the adjustment time of the investment allocation to politics via lobbying. Conservatively it is assumed to be equal to the term of the senator, such that every new term (or new senator) the agents decide how much they are going to lobby them.	This is a reasonable assumption, as Hall & Deardorff (2006) argued that people lobby those they agree with, and in this model, the author assumes the assessment of how much the agents and the legislators agree is conducted on a term-basis.

Minimum investment	USD/year	8 million	4 million	Minimum sums of money spent on lobbying by the agents	They were chosen arbitrarily as such amounts are very hard to estimate. Most data on tax-lobbying counts the number of lobbyists and number of mentions, rather than track how much money was spent lobbying on taxes (from Opensecrets.org). The focus of the study is how they grow over time rather than the exact amounts.
Maximum investment fraction of remaining income [after consumption spending]	dmnl	0.2%	0.1%	This is a cap at total aggregate lobbying expenditure by an agent. The numbers were chosen a lot smaller than documented 'personal saving rates', from which personal investments are made, because even though it is modelled as an investment in this study, the author does not claim it to be equivalent to traditional investments such as equity.	This is required because it would be unrealistic for an agent to spend all their discretionary income on politics. Besides, the author did not include any savings to omit the capital gains effect referred to in chapter 2.2.
Initial seats	seat	50	50	This represents the number of senators who sympathize with the case of each agent and share their worldview, such that they received campaign contributions, and are lobbied by the respective agents.	Although this was never true of the US senate, it is conservatively assumed that seats in the senate were split equally between the top 10% of income earners, and the bottom 90%.
Influence uncertainty	dmnl	0.1	0.1	This variable represents the uncertainty that a legislator who was supported by an agent to get to office will in fact advance the policies of that agent	It would be unreasonable to assume full determinism, in that Agent (X)'s legislators, for example, will act in the interest of Agent (X) 100% of the time. As SD models pose agency questions,

					this parameter accounts for the free agency of legislators in the political process. <i>(For sensitivity analysis on the consequence of varying influence uncertainties please refer to Chapter 13.2.2)</i>
Outcome uncertainty	dmnl	Function of public outcry	0.1	This variable represents the ability, not willingness, of the legislators of a certain agent to enact the policy that an agent desires for themselves (the tax rate goal (outcome of legislative process))	There are multiple factors that affect the ability of a legislator to enact policy. In this model, it is assumed that public outcry reduces the ability of Legislators (X)'s legislators to enact tax cuts for Agent (X), increasing outcome uncertainty for the policy preference of Agent (X).

Table 3 Key elements of model calibration

Finally, it is assumed that the agents have different tax goals constant throughout the simulation run. As a result of these goals, and initial tax rates, the agents compete in the political marketplace to impose their goals on one another. **For the base run, Agent (Y)'s tax rate meets their goal, and Agent (X) shares the same tax goal for Agent (Y), rendering 'Tax rate (Y)' in equilibrium for the full duration of the simulation run.** This simplifies the dynamics of competition, such that all spending by both agents is in the purpose of influencing the tax rate of Agent (X).

5.2. Model behaviour: Base-run

In light of the assumptions outlined in (Chapter 5.1), the base-run results are shown below, followed by feedback explanation of the results. To aid the reader in following the analysis of the base-run, Figure 24 shows the full system feedback structure explained in Chapter 4. The reader is advised to refer to this structure when interpreting Chapter 5.2.3. Some minor loops have been omitted from Figure 24 to avoid crowding. Such loops will be shown as simplified CLDs or SFDs within Chapter 5.3.2.

5.2.1. Additional base-run key assumptions

Please refer to appendix 6 (Chapter 15) for more details on the values and logic of key parameters.

- (Y) Desired tax rate (X) = 0.6
- Desired tax rate (X) = 0.25
- Initial tax rate (X) = 0.35
- Probability of outspending resulting in seat win = 0.8
- Influence uncertainty = 0.1
- (X) desired tax rate (Y) = 0.25 (thus equilibrium for Agent (Y)'s tax rates)

5.2.2. Base-run results:

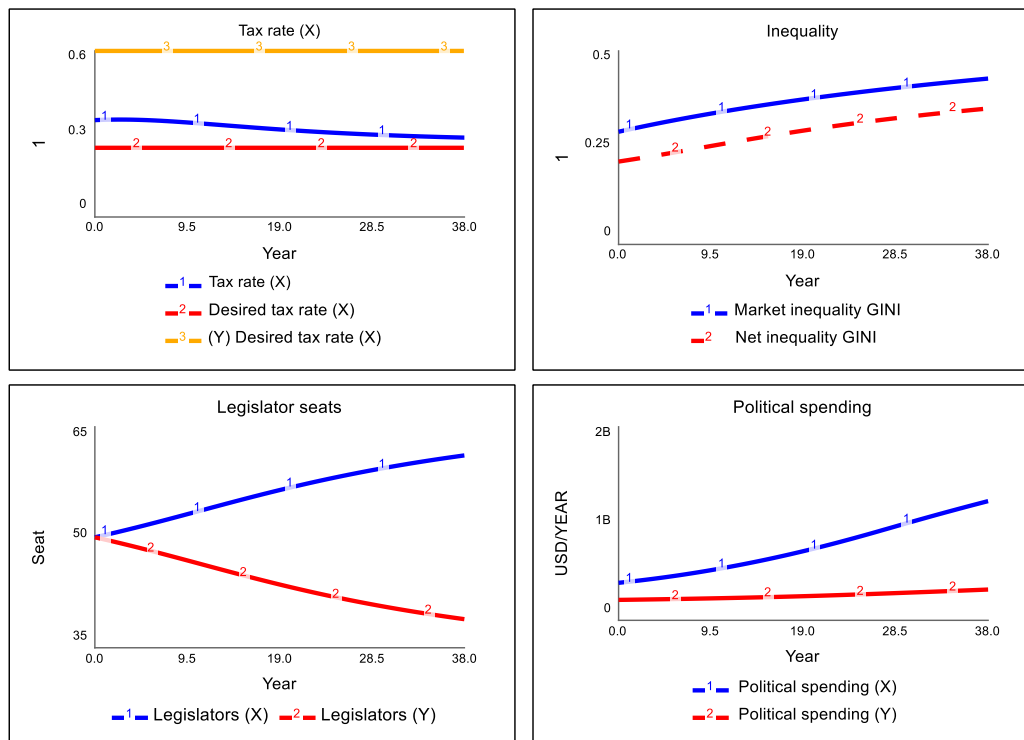


Figure 23 results of base-run

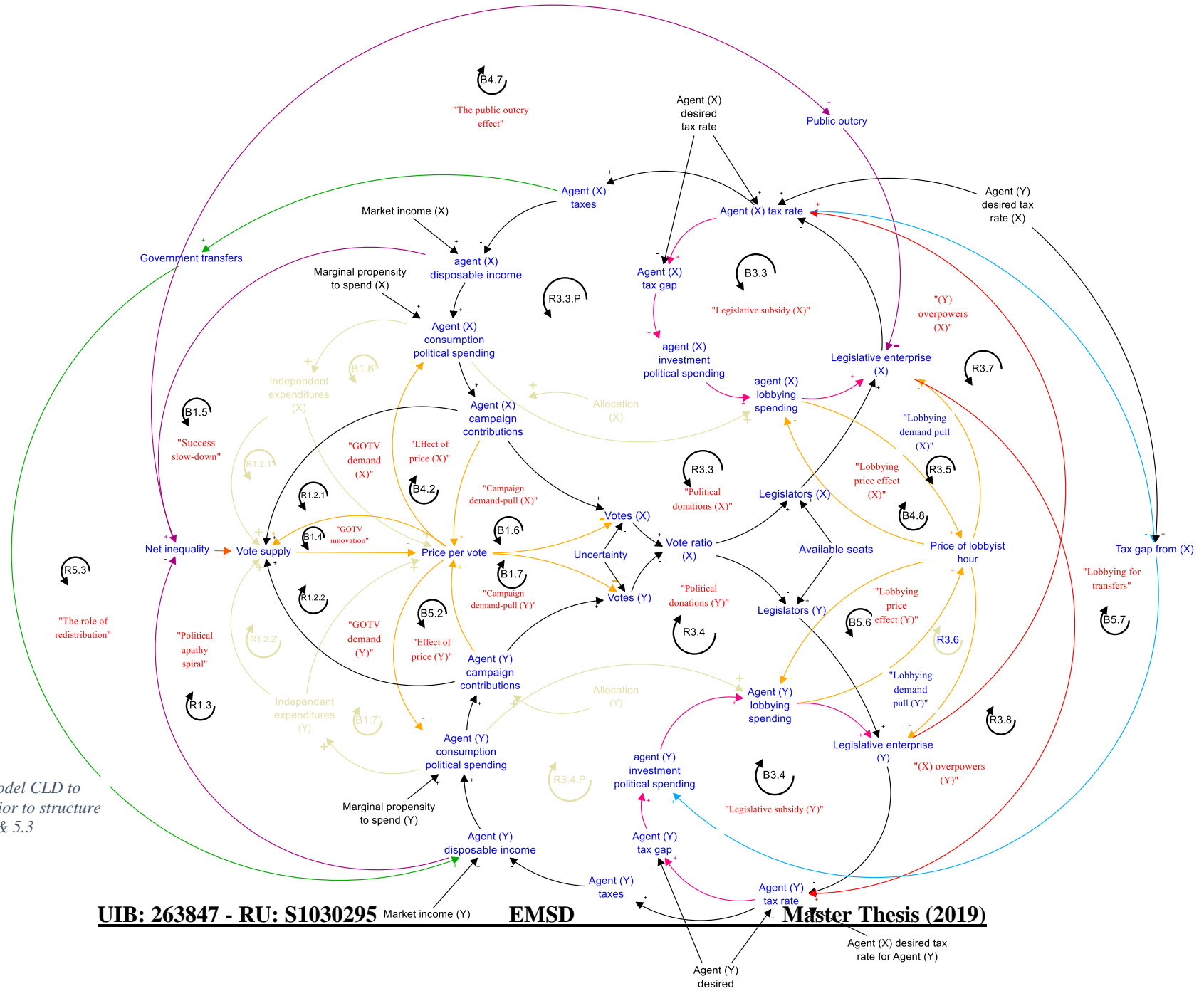


Figure 24 Full model CLD to help relate behavior to structure in Chapter 5.2.3 & 5.3

5.2.3. Interpretation of base-run results:

5.2.3.1. Bifurcation in the US Senate and political campaigns

Income inequality resulted in a bifurcation of legislator seats in the US senate. There is an underrepresentation of Agent (Y) in the legislature, because Agent (X)'s campaign contributions far exceed those of Agent (Y), loop (R3.3) dominates (R3.4). This can be inferred from figure 25, where based on the 'Consumption share', which tracks the ratio of 'Consumption portion of political spending (X)' over total consumption. at $t=0$, 'Consumption share (X)' is equal to 0.65 growing to 0.79 at $t=38$. Given that in the base run no contribution limits are applied, all consumption political spending was translated to campaign contributions, which were spent on campaigns to convince voters to vote for candidates of each agent.

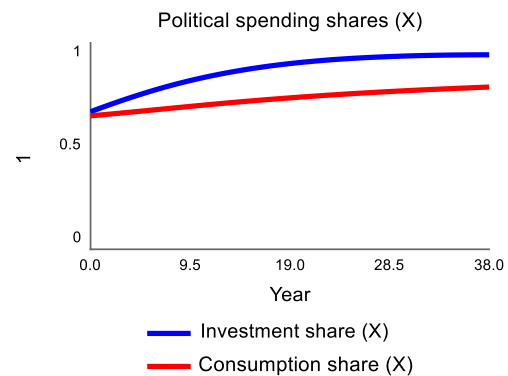


Figure 25 Political spending share (X) in base run

In terms of votes, given 'Probability of outspending resulting in seat win'=0.8, the uncertainty of campaign spending converting to votes is 0.2. Thus at $t=0$, 'Vote ratio (X)' was equal to $0.8 \times 0.65 = 0.52$, more than half the votes were won by Agent (X), increasing to 0.63 of all votes at $t=38$. Two main factors resulted in this increase in vote share, the first is price related (higher price causes less consumption political spending represented by loop (B4.2), 'Effect of price (X)', the second is tax-related (less taxes for Agent (X) increased disposable income which increased consumption political spending (R3.3), 'Political donations (X)'). Agent (X) has a lower 'Price elasticity of political spending' compared to Agent (Y). Initially, vote supply is equal to the 'Total demand for votes', which can be observed in 'Aggregate campaign effectiveness' the supply-demand balance of the campaigns price mechanism, in figure 26.

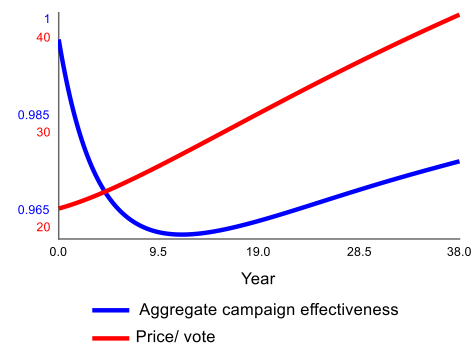


Figure 26 Supply-demand balance and effect on price

If supply was less than demand, 'Aggregate campaign effectiveness' would be less than 1. At $t=0$, it was equal to 1. Furthermore, the shape of 'Aggregate campaign effectiveness' graph is

a result of the changes in supply and demand, outlined in detail in Figure 27. Note that price kept increasing because supply is less than demand throughout the simulation run.

First of all, the first-derivatives of the variables ‘Total demand for votes’ and ‘Total vote supply (per year)’ were calculated for the purposes of this analysis. The results of such calculations are presented in figure 27. Note that the units of such rates will be (vote/year/year).

At $t=0$, the rate of change in demand was higher than that of supply, which is why ‘Aggregate campaign effectiveness’ in Figure 26 declined as soon as the simulation started. After which, the rate of increase in demand was higher than that of supply, so ‘Aggregate campaign effectiveness’ fell until around $t=13$. This was followed by a rate of increase in supply exceeding that in demand which caused the graph of ‘Aggregate campaign effectiveness’ to increase from $t=10$, to $t=38$.

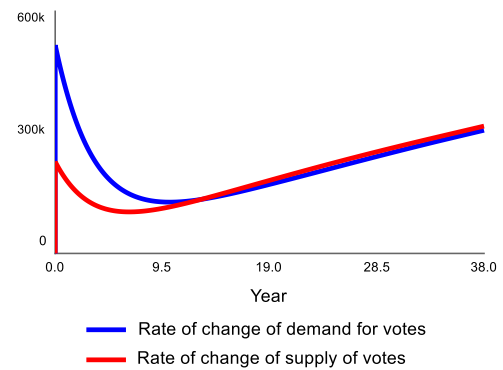


Figure 27 rates of change of demand vs. supply for votes

Next, we must elaborate on why such changes occurred in demand and supply. At the heart of the campaigns price mechanism is ‘Aggregate campaign effectiveness’, the supply-demand balance of political campaigns. Two balancing loops work to stabilize it, (B1.3), and (B1.4) shown in Figure 28.

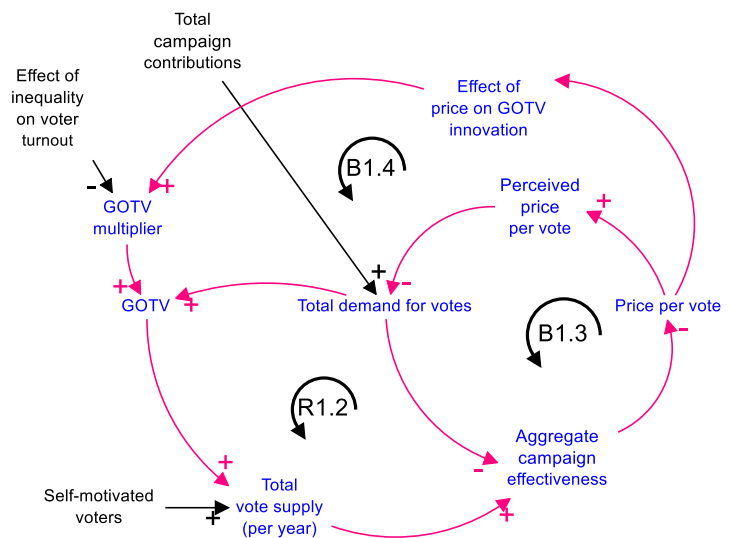


Figure 28 Campaigns price mechanism, outlining loops (B1.3), (B1.4), and (R1.2)

In the case at hand, campaign contributions were observed to increase over time which means that supply-demand balance was pushed below 1 as demand was increasing faster than supply (Figure 27). This created upward pressure on price. (B1.3) reduced demand to stabilize the supply-demand balance by increasing price, while (B1.4) increased supply by responding to price increases through innovations to Get Out the Vote (GOTV), which is the mobilization effect of campaigns whereby politicians run campaigns to motivate voters to go to the ballots on election

day. At $t=0$, given that discretionary income of both agents began to increase, demand increased. Supply has two components, the self-motivated voters, and the GOTV. Self-motivated voters are a fixed % of voting population, who are politically active by default and do not require GOTV campaigns to mobilize them. GOTV voters, however, respond to political campaigns and vote according to mobilization efforts by politicians and political parties, and are demotivated to participate with high inequality, the higher the inequality the more demotivated to vote they get. These two effects combine in the ‘GOTV multiplier’ which determines how much of an expected vote supply (mobilized by political campaigns) actually materializes come election day. If inequality had no effect, ‘GOTV’ would equal to ‘Total demand for votes’, which in addition to ‘Self-motivated voters’ would make supply exceed demand, pushing price down. ‘GOTV’ is equal to ‘Total demand for votes’ multiplied by ‘GOTV multiplier’.

Throughout this simulation run, ‘GOTV multiplier’ was below 1, which means that (B1.4), although helps counter the effects of inequality on voter turnout, was insufficient to balance supply with demand. (B1.3) reduced ‘Total demand for votes’ to bring it closer to supply, and at the same time reduced ‘GOTV’, which is a function of ‘Total demand for votes’. Two other loops also reduced demand to bring ‘Aggregate campaign effectiveness’ closer to 1, namely loops (B4.2) and (B5.2), which represent the reluctance of agents to make campaign contributions as price increased. Yet despite these four balancing loops, Campaign contributions continued to increase, partly because of market incomes, and partly because of the rise in discretionary income for Agent (X) through loop (R3.3).

It has been explained so far what happens in the price mechanism of campaigns, outlining the interactions between demand and supply of votes. It was also explained that Agent (X) has lower price elasticity of political spending, thus with the observed increases in price, Agent (Y) became more averse to donate to their politicians, due to the feeling that their contributions wouldn’t matter in an ever-increasing price in the market of campaigns.

This partly explains the bifurcation in legislator seats between Agent (X) and Agent (Y). Of course one should not forget that market inequality and disparity in market incomes had a strong influence over disposable income per agent, and hence ‘Campaign contributions (X)’ exceeding those of Agent (Y). The overall run results of Figure 23 show that disposable income for Agent (X) had increased throughout the simulation run partly because of tax cuts. To explain such tax cuts, we move to analyse the legislative enterprises in the following section.

5.2.3.2. Legislative enterprise and tax rates

At $t=0$, the two agents had equal seats in the senate. But lobbying spending of Agent (X) was double that of Agent (Y). since an agent's 'legislative enterprise' is the product of seats and lobbying spending to support such seats 'legislative subsidy', the legislative enterprise of Agent (X) was twice as big as that of Agent (Y). Furthermore, 'Influence uncertainty' was assumed to be 10%, and public outcry was relatively low at 20%, which is why 'L.E. ratio (X)', which captures the legislative enterprise of (X) as a percentage of the sum of both agents' legislative enterprises, was less than 0.66, and was equal to 0.61.

This ratio of legislative enterprises acts as the weight by which tax rate goal is determined, such that the goal of each agent is weighed by their legislative enterprise. Given that initially 'L.E. ratio (X)' was equal to 0.61, then Agent (X)'s desired goal was given a weight of 61%, while the goal of Agent (Y) was given a weight of 39%. As the legislative enterprises changed (due to changes in seat composition or lobbying spending), these weights changed, as is shown in Figure 29.

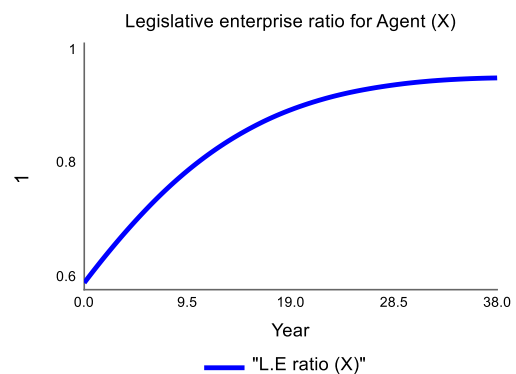


Figure 29 Legislative Enterprise ratio of Agent (X)

At $t=0$, investment in politics by Agent (X) was double that of Agent (Y). By $t=38$, investments of Agent (X) are around 8.5 times those of Agent (Y), as shown in Figure 30. This is because loop (B3.3) dominated loop (B5.7).

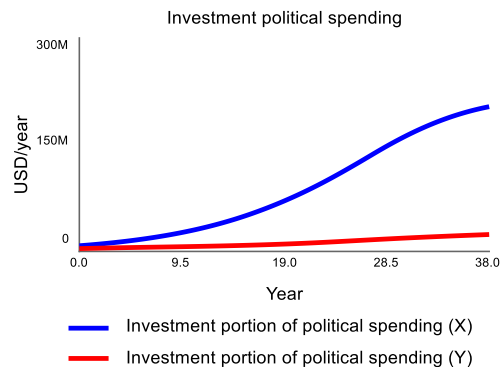


Figure 30 Investment in politics of the two agents

This helps explain why, along with the bifurcation of seats such that seats of Agent (X) are around 62 seats at $t=38$, 'Tax rate (X)' had fallen to reach 0.285 (from 0.35 at $t=0$).

'Tax rate (X)' had increased from $t=0$, to around $t=5.5$, because the legislative enterprise of Agent (Y) was large enough to give weight to their desired tax rate for Agent (X). Figure 31 shows the change in 'Effect of L.E. ratio on tax goal (X)'. At $t=0$, 'Effect of L.E. ratio on tax goal (X)' was 0.386, which is the weighted average of both agents' tax rate goals for Agent (X). This caused 'Tax rate (X)' to increase slightly in pursuit of such goal.

Despite the increase in 'L.E. ratio (X)' over time, as previously shown in Figure. 29, the effect of 'L.E. ratio on tax goal (X)' decreased, since it is a weighted average of each agent's tax goal 'Tax rate (X)' with their legislative enterprises as the weight. 'Tax rate (X)' responded to the declining goal and declined through loop (B4.5) shown in Figure 32.

Loop (B4.5)'s dominance was reduced over the simulation-run time because of loops (B4.7) and (B4.9). With market incomes diverging (exogenous), and 'Tax rate (X)' falling, net inequality increases, causing an increase in 'Public outcry'. This caused 'Outcome uncertainty (X)' to increase, which made changing tax policy more difficult in two ways.

Through loop (B4.9), 'Tax rate AT (X)' increased as 'Legislators (X)' proceeded more slowly in pursuing their goals. The other effect is through what Gilens & Page (2014) observed as 'status-quo-bias', which gives more weight to the stock value of 'Tax rate (X)' compared to the 'Effect of L.E. ratio on tax goal (X)'. In other words, as public outcry increased, it became more difficult to enact policies that would cut taxes on Agent (X), even if 'Legislative enterprise (X)' was higher than that of Agent (Y). This is because 'Legislators (X)' would fear the public backlash from enacting such policies. Figure 33 shows how 'Tax rate goal (outcome of legislative process) (X)' was always higher than 'Effect of L.E. ratio on tax goal (X)' because of the increasing public outcry, which resisted further tax cuts on Agent (X).

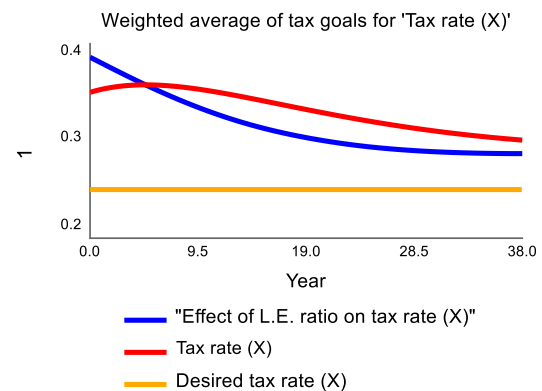


Figure 31 Effect of L.E. ratio on tax goal (X) contrasted with Desired tax rate (X)

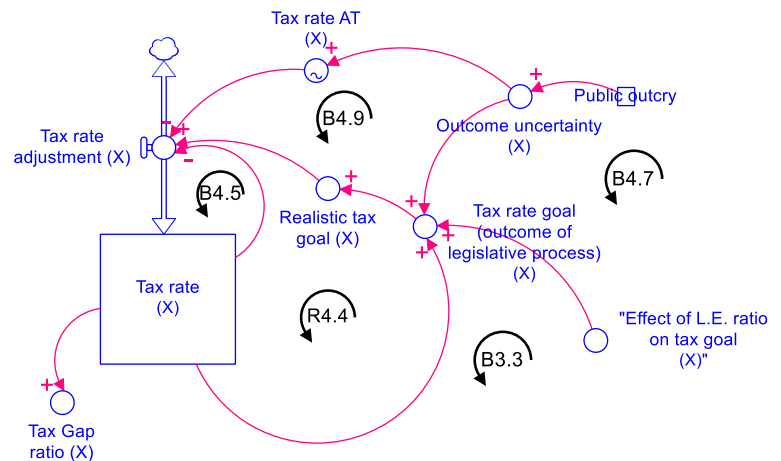


Figure 32 Tax rate adjustment loops for Agent (X)

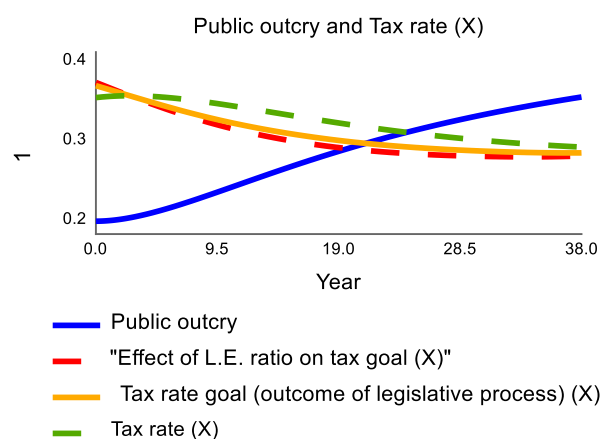


Figure 33 Effect of public outcry on tax rate of Agent (X)

‘Investment portion of political spending (X)’, via loop (B3.3), showed an S-shaped pattern which may seem odd at first glance because (B3.3) is balancing. This has to do with the structure by which political investment in lobbying is set up in this model, shown in Figure 34.

The goal for political investment ‘Indicated investment portion (X)’ is determined through a non-linear function in ‘Tax gap ratio (X)’ which compares ‘Desired tax rate (X)’ to actual ‘Tax rate (X)’. The effect of ‘Tax gap ratio (X)’ is multiplied by the stock of ‘Investment portion of political spending (X)’ to determine the new goal for investment (The goal is anchored in the stock). This is the action of loop (R4.1).

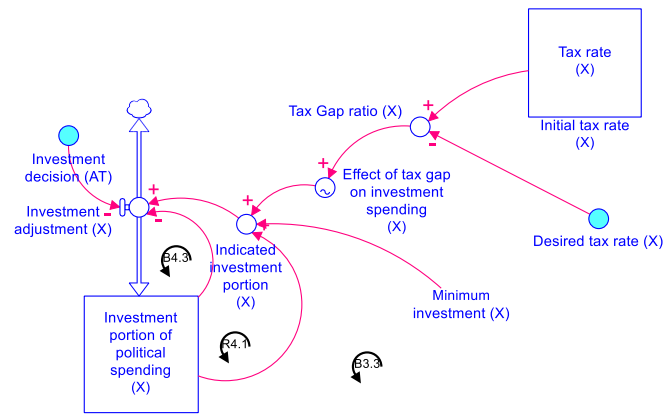


Figure 34 Structure determining political investment of Agent (X)

Thus as long as there is a tax gap, between desired and actual tax rate of Agent (X), and based on the size of this gap, the investment either escalates upwards, or downwards. When the gap is small enough, loop (R4.1) causes investment to scale down. After around $t=27$, ‘Tax gap ratio’ was small enough to start reducing the ‘Effect of tax gap ratio on investment spending (X)’.

This caused (B4.3) to dominate (R4.1), and the rate at which the ‘Indicated investment portion’ increased was lower than the rate at which ‘Investment portion of political spending (X)’ increased, causing investment to converge towards the goal as shown in Figure 35, a consequence of the non-linearity in investment response to ‘Tax gap ratio (X)’. Investment political spending had effects on the recipients of such investments, the lobbying industry, which has a price mechanism similar to the one explained in Chapter 5.2.3.1. The next Chapter explains such mechanism in detail.

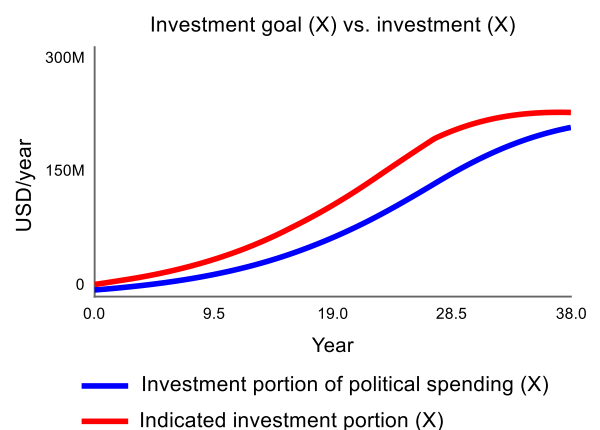


Figure 35 Convergence of investment with indicated investment

5.2.3.3. Divergence of agents' political spending and the lobbying industry

Lobbying spending began to increase almost immediately after $t=0$, which caused 'Total demand for lobbying' to increase as shown in Figure 36. This caused 'Labour ratio (lobbyists)', the supply-demand balance, to drop below 1, which exerted upward pressure on 'Price of lobbyist-hour'. Two balancing loops were activated by this increase in price, the first being loop (B2.2), which aimed to reduce demand (calculated by dividing lobbying spending over a perceived market price of lobbyist-hour), and loop (B2.3) which increased supply in response to the increasing price.

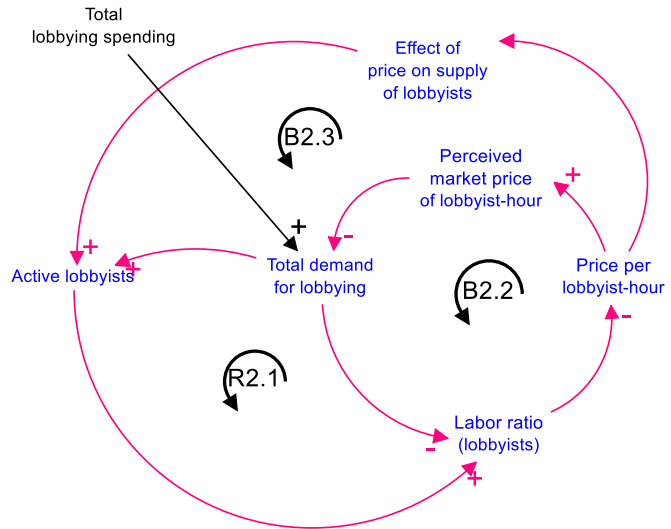


Figure 36 Lobbying price mechanism

For nearly 2.3 years, the increase in price, as well as increased lobbyist-supply (through recruitment) were not sufficient to overtake the rise in demand for lobbyists as a result of the surge in investment spending by both agents, which is why 'Labour ratio' continues to fall until $t=2$ (Figure 37).

Before $t=2.3$, loop (B2.2) dominated (B2.3) as it is a faster loop ($AT=1$), while (B2.3) perceived changes in price at a slower pace ($AT=6$). Exacerbating the delay in (B2.3), recruitment and training of lobbyists to meet the increase in demand occurs at another delay ($AT=2$). Thus in (B2.3) there was a higher perception delay, in addition to an action delay. This reflects in Figure 37, where before $t=2.3$ 'labour ratio' was decreasing to reach a minimum when (B2.3)

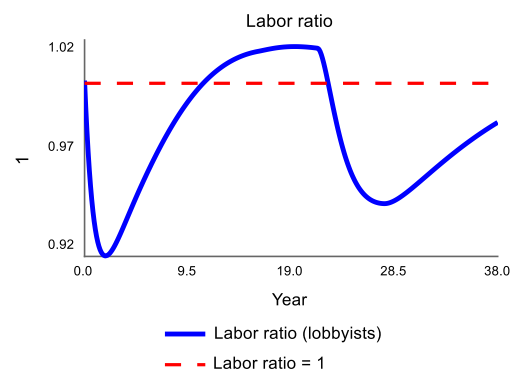


Figure 37 Labour ratio of the lobbying industry over time

reached a value sufficient to bring 'Labour ratio' upwards. The contrast between the action of loops (B2.2) and (B2.3) can be inferred from Figure 38. Until $t=2.3$, (B2.3) was insufficient to overtake an increasing demand (demand increased as a result of increases in lobbying spending

due to loops B3.3 and B3.4). This is why in Figure 37, until $t=2.3$ 'Labour ratio (lobbyists)' was declining'. This was compensated for by loop (B2.2), indicated by an increasing price until $t=2.3$, represented by the blue line (right axis) in Figure 38, which gives an indication to how loop (B2.2) changed behaviour over time. The increase in price reduced demand, while supply built-up through loop (B2.3).

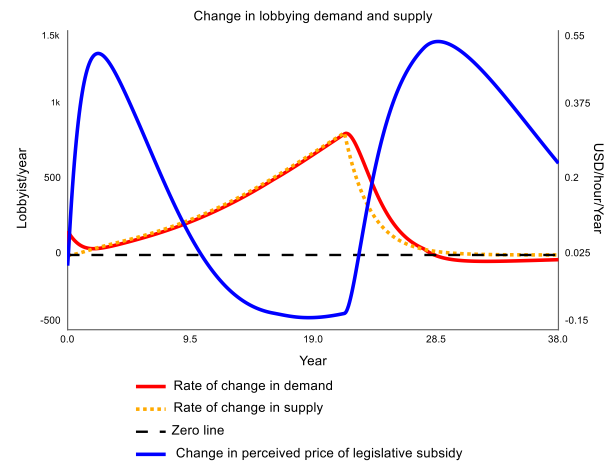


Figure 38 % changes in demand, supply, and price

At $t=2.3$, two things happened, firstly the rate of change (increase) of supply overtook the rate of change of demand for lobbyists, which is why 'Labour ratio (lobbyists)' reached its minimum point at $t=2.3$ and began to increase afterwards. Secondly, because change in price is, as previously mentioned, an agile loop with an AT of 1 year, as soon as 'Labour ratio (lobbyists)' began to rise, the effect of labour ratio on price reversed, and 'Perceived market price of lobbyist hour' began to follow in decline. It declined in order to bring the system to equilibrium at Labour ratio=1. This did not happen because (B2.3) is sluggish (AT=6), and continued to increase supply of lobbyists beyond the required supply to balance 'Labour ratio (lobbyists)'.

This explains why at around $t=11.6$, the rate of change of price was almost zero, as there was no need to reduce price further to balance 'Labour ratio (lobbyists)', while demand and supply were equal. Yet the rates of change of supply and demand were unequal (Supply exceeding demand indicated by the yellow line being above the red line, after $t=2.3$, in Figure 38) which is why labour ratio continued to rise beyond 1 after $t=11.6$. Supply kept on increasing as it was responding to a delayed price signal, recruiting more lobbyists. Price thus started to decrease (change in price becomes negative) rather than increase decreasingly. This is because there was an excess of supply compared to the demand for lobbying (coming from investment political spending).

This continued until around $t=21.7$, where the supply limit was reached at 10,000 lobbyists (this was selected to be the limit put on the lobbying industry). At that limit, lobbyists were only recruited to replace the attrition rate of retiring lobbyists.

When the supply limit was reached, 'Lobbyist adjustment' suddenly dropped within less than one year, which immediately pushed price upwards. It is as if loop (B2.3) suddenly weakened

which pushed (B2.2) to dominance. (B2.2) made price increase until the end of the simulation. Beyond $t=21.7$, demand was higher than supply (labour ratio <1), and demand was increasing at a rate higher than supply, which is why 'Labor ratio (lobbyists)' kept decreasing until $t=27.7$. At around $t=27.7$, as a result of loop (B2.2) working with (B4.8) and (B5.6), loops that reduced investment political spending because of the increase in price, the rate at which demand was increasing became less than that of supply because price was increasing at a higher rate than the rate of increase in lobbying spending. That was why 'Labor ratio (lobbyists)' reached a minimum point at $t=27.7$. Between $t=27.7$ and the end of the simulation run at $t=38$, the aforementioned balancing loops pushed 'Labour ratio (lobbyists)' upwards, through reducing demand. This exerted a negative pressure on price thus price fell, and rate of change of demand became negative for the same reason.

5.2.3.4. Conclusions from base-run

The main difference between agents is their heterogeneity, and that heterogeneity caused them to spend differently on politics, whether on consumption or investment basis. Their spending patterns from the base run caused inflation in prices in both campaigns and lobbying, to which Agent (Y) was at a disadvantage because of their higher elasticity of political spending (both in terms of campaign contributions and on lobbying). The scenarios set up in Chapter 5.3 consider attitude changes of Agent (Y), analysing their consequences on representation and income inequalities in the political system. The next section explains the scenarios run with this model to explore the possible futures of income and political inequality in the US under different circumstances.

5.3. Scenario experiments

This chapter analyses five selected scenarios of attitude change by Agent (Y), to test whether they can reverse inequalities in representation and in net incomes. In all scenarios, the changes are introduced at $t=38$, the end-time of the base-run, and end at $t=76$ (double the duration of the base-run). The calibration of such scenarios is presented in Table 4 below. For a given attribute, the first row describes its value in relation to that of Agent (X), followed by its numerical quantity in the second row. A comprehensive explanation of the scenarios follows the table.

Attitude parameter	Units	Base-run	SC-1	SC-2	SC-3	SC-4	SC-5
Marginal propensity to spend on politics (Y)		X/2	X	X	2X	2X	X
	Dmnl	0.0005	0.001	0.001	0.002	0.002	0.001
Price elasticity of political spending (campaigns) (Y)		2X	X	X	X/2	X/2	2X
	Dmnl	0.2	0.1	0.1	0.05	0.05	0.2
Price elasticity of lobbying spending (Y)		3X	X	X	X/2	X/2	3X
	Dmnl	0.3	0.1	0.1	0.05	0.05	0.3
Investment AT (Y)		X	X	X	X	X/2	X
	Year	6	6	6	6	3	6
Fraction redistribution							
	Dmnl	0.5	0.5	0.625	0.5	0.5	0.5

Table 4 Calibration of Scenarios 1 through 5

5.3.1. Scenario Descriptions

5.3.1.1. Scenario 1

This scenario represents a change in attitude of the bottom 90% of income earners in the US towards political spending. It suggests that all attitudes would become equal amongst the 2 agents, in terms of willingness to spend as a fraction of their disposable incomes, responses to change in price of campaigns or lobbying, and activeness in lobbying their legislators. Redistribution by the government is kept constant, as was in the base-run, for this scenario.

5.3.1.2. Scenario 2

This scenario is identical to SC-1, with one exception; The government decides to raise redistribution by 25% at $t=38$, supporting the population with transfers and enabling them, especially Agent (Y) since it is given on a per capita basis, with more disposable income.

5.3.1.3. Scenario 3

Agent (Y) surpasses Agent (X) in terms of attitudes towards politics, meaning that they are twice as willing to make campaign contributions (as a % of their disposable incomes), they are less averse to changes in price of both campaigns and lobbying thus their 'Price elasticity of

political spending (campaigns) (Y)' and 'Price elasticity of lobbying spending (Y)' are both half those of Agent (X). For this scenario, it is assumed that both Agents lobby their legislators with the same vigorousness indicated in the same 'Investment AT (Y)' as that of Agent (X). Redistribution is reverted to its value at the base-run.

5.3.1.4. Scenario 4

This scenario is identical to SC-3, with one exception; the 'Investment AT (Y)' was halved to be half the adjustment time of Agent (X), this means that lobbying activity of agent (Y) became much stronger than that of Agent (X) such that loop (B5.7) was twice as fast as loop (B3.3).

5.3.1.5. Scenario 5

This scenario uses the same parameters as the base-run, with two changes. First Agent (Y) was as willing as Agent (X) to spend on campaign contributions. Secondly, it tests the outcomes if all eligible voters decided to vote starting $t=38$. This was achieved by disabling the inequality loops (B1.5) and (R1.3), such that inequality's effects on voter turnout were eliminated. This means that in this scenario, voters try to resolve their grievances with the campaigns system and their underrepresentation by going to the ballots, as well as by spending more on politics, yet their price elasticities remain unchanged compared to the base run, in that ever-escalating prices test the endurance of less affluent citizens, especially given that they will be making increased campaign contributions.

To summarize, these 5 scenarios were selected to reflect changes in the attitudes of Agent (Y) towards political spending, increased government redistribution, and higher voter participation rates. Given that in the base-run analysis the conclusion was that differences in attitudes played a major role in exacerbating inequality, the purpose of this chapter was to test the prospects for changes in such attitudes in reversing inequality trends, primarily through progressive taxation (as tax rate is the policy being studied). The next chapter provides the results of these thought experiments, followed by a discussion on their causes and implications. Note that in the analysis of the scenarios there will be references to feedback loops of the model. *(please refer to the beginning of Chapter 5.2.2 for a CLD of the model)*

5.3.2. Results of Scenarios

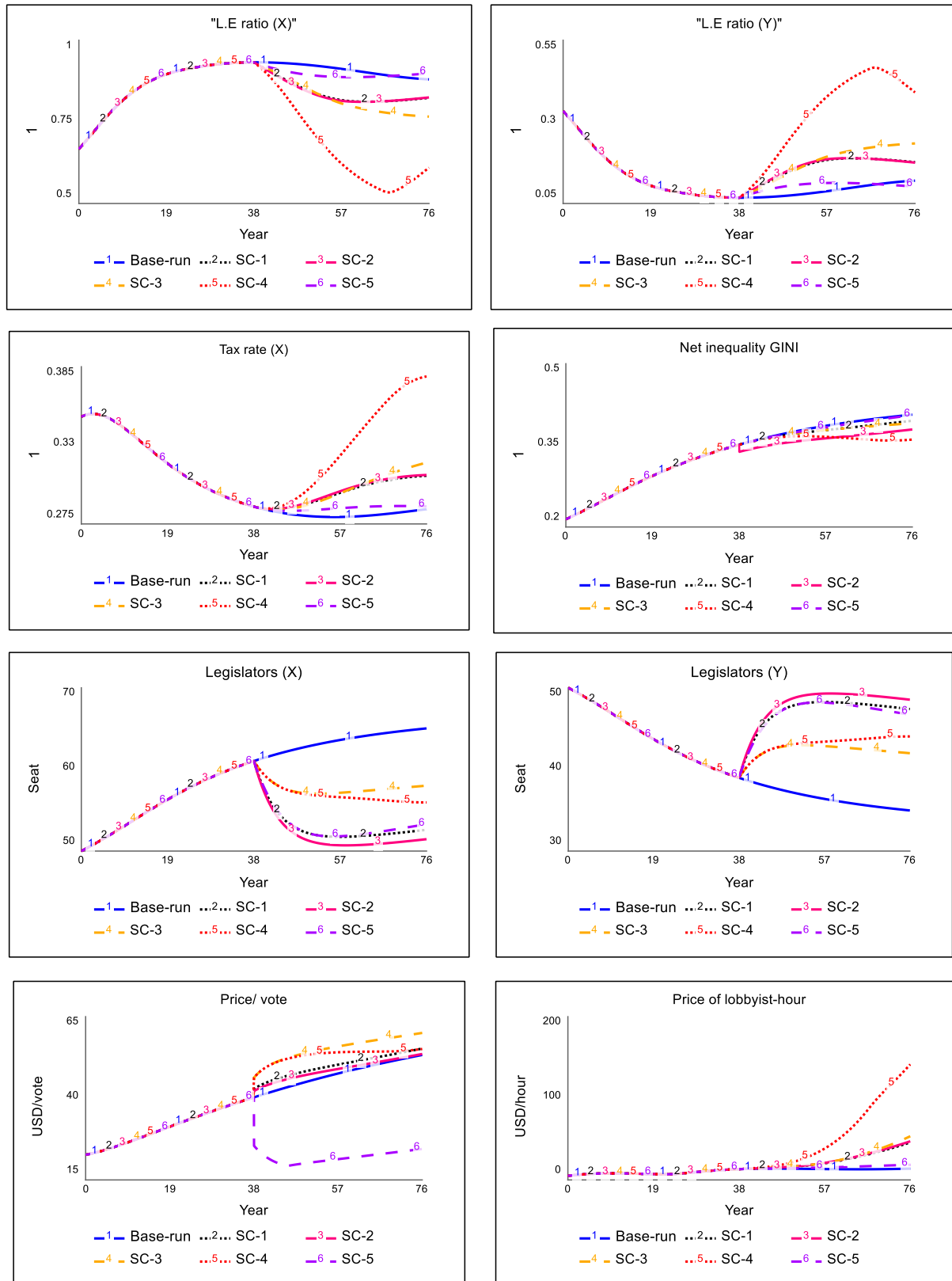


Figure 39 Results of scenarios (SC-1 through SC-5)

5.3.3. Discussion of scenario results

The broad measure of improvement of legislative power in this model is the ratio of legislative enterprises of agents, ‘L.E ratio (X)’ and ‘L.E ratio (Y)’. It captures both the shares of seats each agent has in the legislature, and how much information their respective legislators are equipped (or subsidized) with in order to advance legislation. It is apparent from all scenarios that any behavioural change on behalf of agent (Y) yields an improvement in legislative enterprise, therefore any attitude changes by Agent (Y) are desirable because they do have an observable effect. It was observed that mass mobilization of voters (SC-5) yielded L.E ratios, as well as Net inequality, very close to the base-run despite the considerable increase in legislator seats for Agent (Y), the discussion starts with that observation as it seems the most counterintuitive.

5.3.3.1. Mobilizing voters

In SC-5, increased voter mobilization increased legislator seats through loop (R3.4). Thus if Agent (Y)’s share in the legislator increased, this was because (R3.4) dominated (R3.3). This dominance shift occurred because mass mobilization caused a sharp decline in price per vote, while Agent (Y) had a higher price elasticity of campaign spending, which caused Agent (Y)’s campaign contributions to increase significantly as price dropped. In order to enact legislation, however, legislative enterprises compete rather than legislators. Such enterprises involve the action of (B3.3) versus (B5.7).

Any gains of Agent (Y) in the legislature were countered by the expensive services of lobbyists, comprising political intelligence, data, analyses, access to lawyers, and to consultants, as listed by Gerken & Tausanovitch (2014) who argued, in agreement with Hall & Deardorff (2006), that legislators cannot do their jobs without information. When legislative enterprises competed, (B3.3)

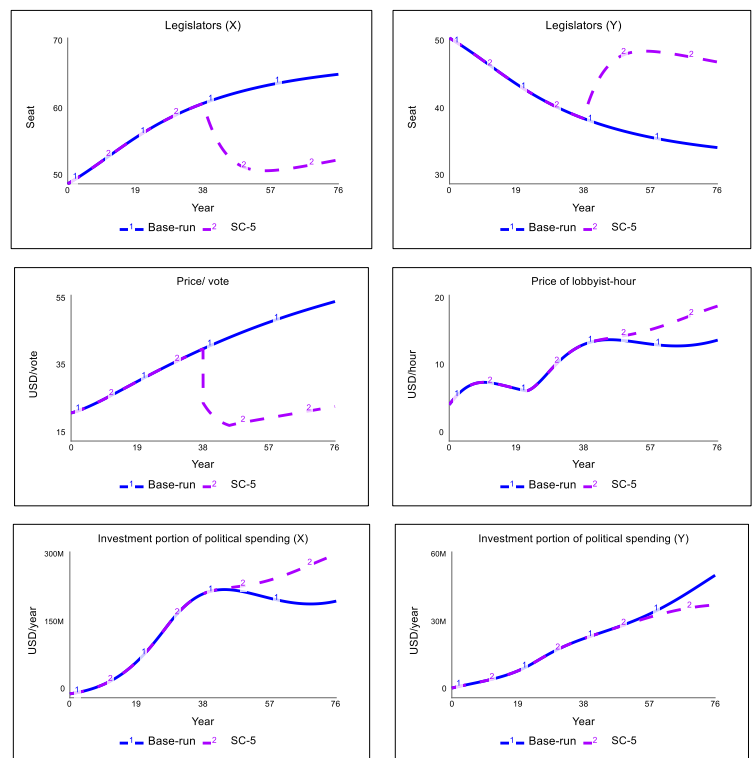


Figure 40 Comparison between base-run and SC-5

dominated because of the attributes of Agent (X) enabling higher investment political spending than those of Agent (Y), in addition to Agent (X) having higher initial political investment (at $t=38$ when the changes are introduced), almost eight times those of Agent (Y). The results of increased voter mobilization compared to the base-run are shown in Figure 40.

Agent (Y) gained seats in the legislator, which reduced 'L.E ratio (X)'. This causes (B3.3) to counter the gains of Agent (Y) by increasing lobbying spending. Such flooding of the system with money caused price inflation through loop (B2.2), which fed back to temper investment in lobbying spending through loops (B4.8) for Agent (X), and loop (B5.6) for Agent (Y) (*please refer to Chapter 4.3.2 for details on the action of loops (B4.8) and (B5.6)*).

The effect of loop (B5.6) was stronger than that of (B4.8) because of Agent (Y)'s higher price elasticity of lobbying spending, which explains why Investment spending of Agent (X) increased while that of Agent (Y) considerably declined as a response to price inflation.

Without lobbying to complement the won seats, Agent (Y)'s prospects for reducing inequality through mass mobilization have proven to be slim, as shown in Figure 41. The pattern of inequality was virtually unchanged as a result of mass-mobilization.

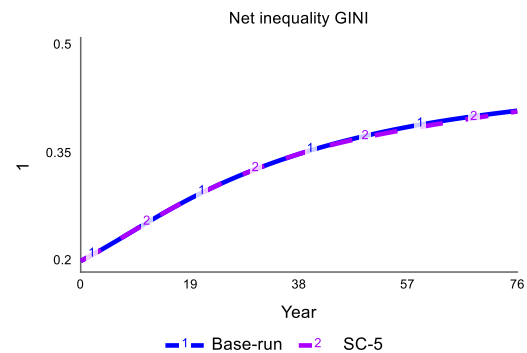


Figure 41 Comparing SC-5 with base-run inequality (GINI Index)

5.3.3.2. Aggressive increase in lobbying by Agent (Y)

Observing the scenarios where campaign contribution and lobbying attitudes were more balanced between the agents, SC-3 and SC-4, agent (Y)'s increased willingness to spend on politics strengthened both loops (R3.4) and (B5.7). It is apparent that in these two scenarios consumption political spending by Agent (Y) caused loop (R3.4) to dominate loop (R3.3), as is seen in Figure 42. This may be attributed to the attitude change in Agent (Y)'s 'Marginal propensity to spend on political campaigns' to be double that of Agent (X). Consumption spending by Agent (X) decreased after $t=38$, compared to the base-run due to the effect of price, but mainly because the higher 'Tax rate (X)' enforced by 'Legislative enterprise (Y)' reduced Agent (X)'s disposable income, rendering 'Consumption portion of political spending (X)' to be lower than the base-run.

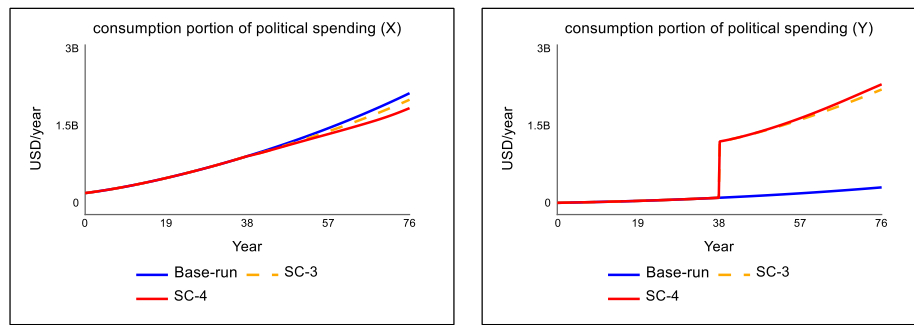


Figure 42 Consumption political spending by both agents (SC-3 & SC-4 compared to base-run)

Furthermore, the legislative enterprises came very close (almost equal) in SC-4. This is because ‘Investment AT (Y)’ was half that of Agent (X), rendering (B5.7) dominant. Investment AT reflects one of two model features that represent the vigour of an agent’s lobbying efforts, the second being the non-linear functions translating tax gaps (difference between desired tax rate and actual tax rate to investment goals). A lower ‘Investment AT (Y)’ expanded Agent (Y)’s lobbying spending to completely overtake Agent (X)’s lobbying efforts at $t=62.6$, shown in Figure 43. The same cannot be said about SC-3, even though in both scenarios ‘Price elasticity of lobbying spending (Y)’ was half that of Agent (X). But that elasticity only affects the loop (B5.6) of Agent (Y) reducing the price effect, meaning that the vigour of lobbying was the main driver behind the increased ‘Legislative enterprise (Y)’ causing ‘L.E ratio (X)’ to drop to its lowest levels in all 5 scenarios.

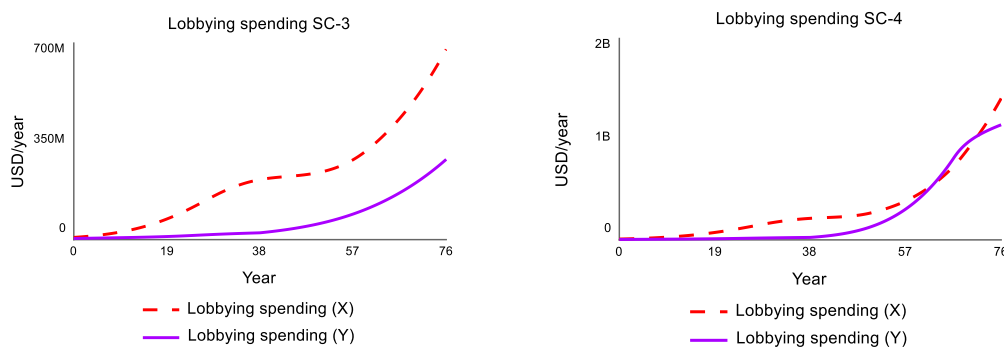


Figure 43 Contrasting investment spending of agents in SC-3 & SC-4

This informs on the conservativeness of the base-run calibration, where the investment AT for both agents was equal. If ‘Investment AT (X)’ was calibrated as being lower than that of ‘Investment AT (Y)’, the resulting inequality would’ve been higher than the one observed in the base-run. In SC-4, as Agent (Y)’s ‘Indicated investment portion (Y)’ slightly declined at $t=67$ due to the convergence of tax rate such that the non-linear ‘Effect of (X)’s tax gap on investment spending’ reduced investment, (B3.3) immediately dominated increasing Agent

(X)'s legislative enterprise reflecting in the sudden increase in 'L.E ratio (X)' at $t=67$ years (Figure 44).

Extending the simulation run time of SC-4, it was observed that damped oscillations emerged as there are two balancing loops (B3.3) and (B5.7), one of which had a shorter delay time (B5.7), $AT=3$, reaching an equilibrium where both agents escalated their spending. Agent (Y) could not impose their goals to reach an equilibrium (Figure 45). There are two reasons behind this, explained below.

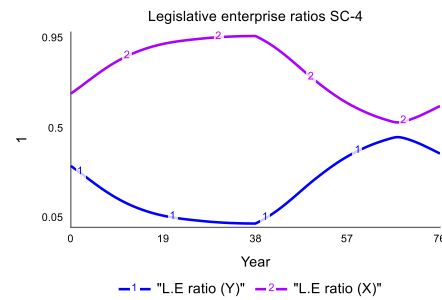


Figure 44 Legislative enterprise ratios of agents SC-4

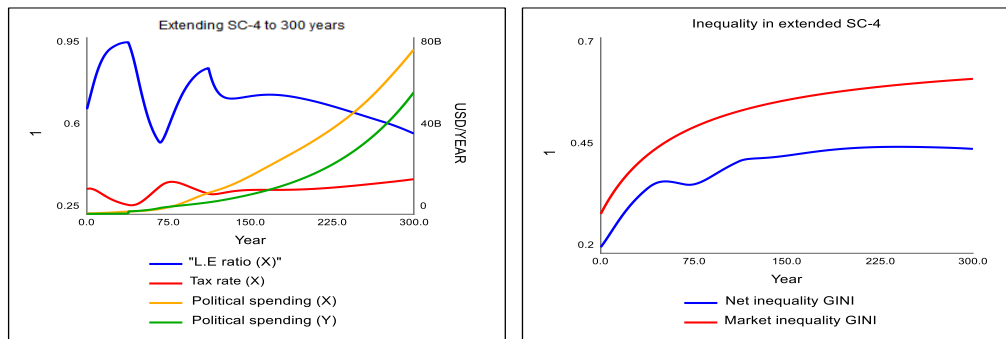


Figure 45 Extending SC-4 to $t=300$

Firstly, Agent (X) has a higher limit on total political investment, and this is assumed because when Agent (X)'s income and wealth are at risk, they will be willing, more willing than Agent (Y), to spend more on investment. This is partly because Agent (X) were preserving their advantage while Agent (Y) are running a risk of spending vast amounts of money on lobbying without guaranteed results. It is also because of cumbersome collective action problems faced by Agent (Y) due to their large population numbers compared to Agent (X) (by their definition they are nine times larger).

The second reason why Agent (Y) could not outspend the lobbying of Agent (X) is that Agent (X) had a higher discretionary income by virtue of their lower consumption patterns (of goods and services, not to be confused with political consumption) and therefore could afford to spend more on investment in politics. This is why even in SC-4, which seemed promising in the beginning, Agent (Y)'s goals were not met.

Inequality was slowed down, reaching a pattern that is close to equilibrium, at a level higher than the base-run inequality, with both agents spending billions of USD in lobbying and campaigns (indicated in the prices of votes and lobbying in Figure 46), in an escalation

behaviour due to the action of (R4.1) and (R5.1) (that anchor the investment goal in the investment stock).

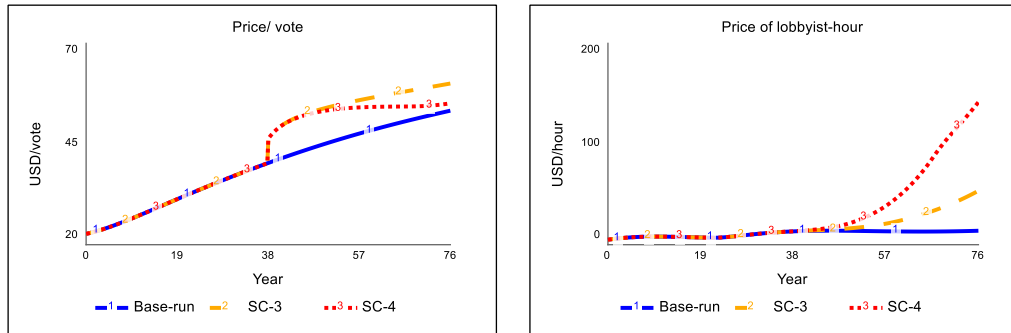


Figure 46 Prices of votes in campaigns and lobbying SC-3 & SC-4 vs. base-run

Taking the results of SC-3 & SC-4, with SC-5, it is clear that winning more seats in the legislature do not guarantee Agent (Y)'s policy outcomes. In fact, it had triggered a far more powerful loop (B3.3), the latent strength of which was somewhat unapparent in the base run (it did not exceed a few hundred million USD in the base-run). (B3.3) can escalate spending to levels much higher than loops (R3.3) and (R3.4). One important point to note is that reinforcing loops are sensitive to initial conditions, thus because of the calibration of the base-run, it is unlikely that (B5.7) can dominate (B3.3) in the long-run, as was demonstrated in Figure 45. To overcome (B3.3), (B5.7) would require a considerably stronger fractional increase rate compared to that of (B3.3), whether due to a lower 'Investment AT (Y)', or a sharper 'Effect of (X)'s tax gap on investment spending' such that small tax gaps trigger large output of the non-linear function. Also as demonstrated above, the cap for loop (B5.7) is lower in terms of the fraction of discretionary income compared to Agent (X)'s (B3.3), which further complicates the prospects of (B5.7) dominating (B3.3).

5.3.3.3. Government redistribution

Given the government's legitimate role of redistributing income and wealth, it is only logical to expect a governmental intervention could reduce inequality. Such intervention need not be in raising taxes (as this model explicitly demonstrates why such an option may be difficult to pursue) but in reshuffling the government's priorities in favour of more redistribution. SC-2 explored such concept, building on SC-1 whereby Agent (Y)'s attitudes are changed to match those of Agent (X), and government redistribution was increased from 0.5 to 0.625 (at a rate of 25% from base-run redistribution). Funding for such redistribution comes from the tax

revenues collected. Contrasting SC-1 and SC-2 gives an indication on the scope of government redistribution in reducing inequality, given the system modelled.

SC-2 calibration intended to demonstrate that as soon as redistribution increases, Agent (Y)'s attitudes would change. SC-2 is contrasted with SC-1, to test the net effect of increasing redistribution on inequality of representation and income.

As shown in Figure 47, the increase in government redistribution had little additional effect compared to SC-1, on legislator seat composition, political investment, and prices (representation inequality was not changed much by redistribution).

This is because 'Redistribution income (Y)' represents a relatively small portion of the income of Agent (Y), thus a 25% increase in redistribution will not represent a 25% increase in total income. Furthermore, as redistribution rose, so did 'Consumption (Y)' (again not to be confused with political consumption

spending; this is consumption of goods and services) which is a function of disposable income (income after taxes and transfers).

Given that Agent (Y) consumption, as explained in Chapter 5.1, is 92% of their disposable income, the larger share of the government redistribution effort was depleted through consumption. Moreover, only a part of discretionary income (disposable income minus consumption) is converted to 'Consumption political spending (Y)', which is why the difference between graphs of SC-1 and SC-2 is not substantial (for example, only a 2% increase in 'Legislators (Y)' despite the fact the redistribution increased by 25%).

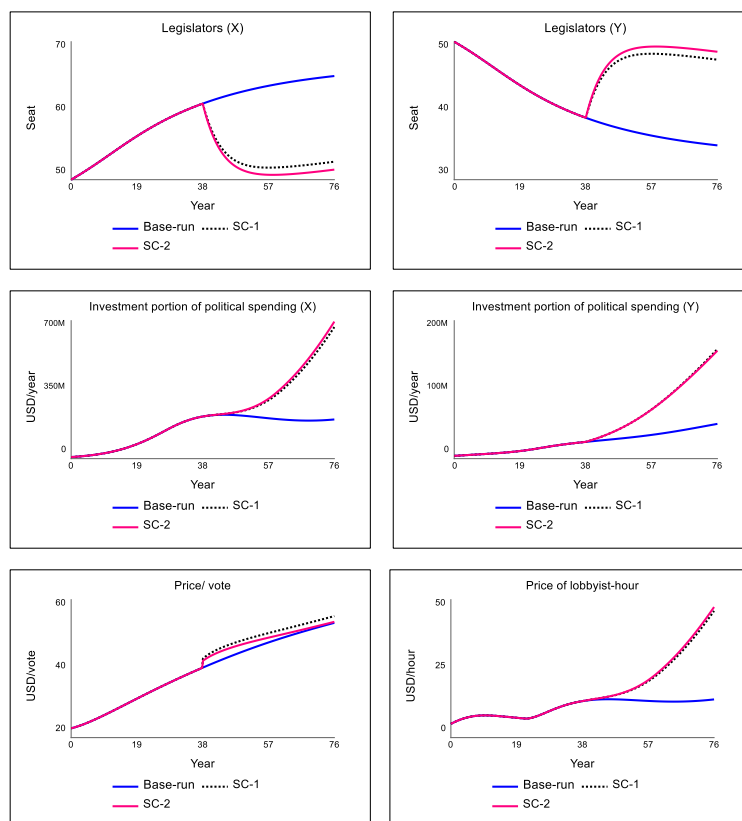


Figure 47 Results of SC-1, SC-2 versus base-run

Government redistribution did, however, immediately reduce inequality (step down) when the increase in ‘Fraction redistribution’ was applied. This is because the increased redistribution influenced directly the GINI Index calculation, yet the net changes in political attitudes of Agent (Y) as a result of higher redistribution seem to not have been substantial. The results in Figure 48 imply that government redistribution initiatives will have some effect on reducing income inequality, but will have a minute effect on representational inequality (legislator seats and legislative enterprises) unless an attitude change by Agent (Y) occurred concurrently.

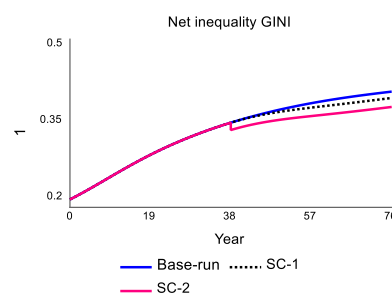


Figure 48 SC-1, SC-2 effect of inequality

An extension of SC-2 over 160 years, Figure 49 shows that an increased redistribution fraction to 0.75 (50% increase from base-run), coupled with attitude change by Agent (Y), did not reverse the trend of increasing inequality.

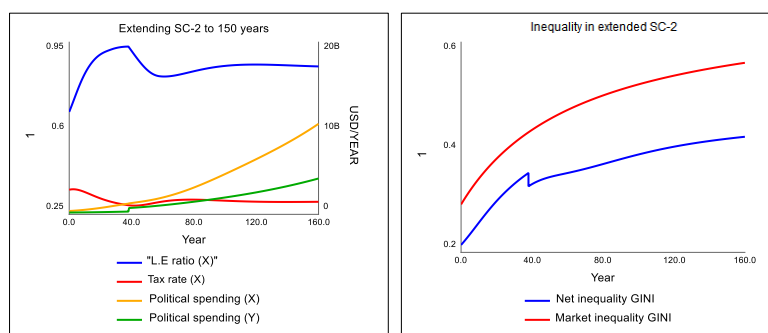


Figure 49 Extending SC-2 to $t=160$ and increasing redistribution by 50% compared to base-run

Winning additional legislator seats

as a result of attitude change, without countering (B3.3), does little to reverse inequality trends. ‘L.E. ratio (X)’ was 0.85 at $t=160$, ‘Legislators (X)’ were higher (10% higher) than ‘Legislators (Y)’, while ‘Lobbying spending (X)’ was almost five times that of Agent (Y). This is demonstrated in Figure 49 in a similar escalation behaviour observed in Figure 45 when comparing extending SC-4 (in chapter 5.5.3.2).

5.4. Conclusions of chapter 5

This Chapter aimed at answering (RQ2), analysing the implications of a free-market approach to campaign finance and lobbying. It demonstrated that a free-market of private money in the US political system causes wealth bias of US legislators, providing an explanation to the observations of Gilens & Page (2014), Bartels (2008), Gilens (2012), and Flavin (2015). Such wealth-bias was generated as a result of the heterogeneity in attitudes of the two agents, without

a regulatory framework seeking to equalize the influence of citizens across the income distribution.

It has also shown that the persistent trend of increasing inequality reinforces what Gerken & Tausanovitch (2014) stress on: that campaigns and lobbying lie on a continuum by which money is converted to influence. It seems that disparity in attitudes of the two agents explain only part of the story; they have contributed and still do contribute to the problem of rising income inequality, yet reversing the attitudes of the majority of US voters (Agent (Y)) has been demonstrated in this chapter to result in a larger share of the legislature, and increased lobbying yields more influence over tax policy, but both have been insufficient to substantively reverse net inequality trends. Furthermore, it has been demonstrated that voter mobilization and government redistribution (without increasing tax progressivity) are insufficient in reversing income (and political) inequality in the current system structure.

In the next chapter, more experiments are run to test proposals for campaign finance reform. Chapter 6 may be considered to build on the findings of this chapter. Given that attitude changes alone are insufficient to reverse inequality, can government interventions do? It aims to address (RQ3), testing if a reorganization in the system structure may overcome the limitations of attitude changes observed in Chapter 5. It starts with a proposal for limiting contributions received by political candidates, assessing its efficacy, and moves to test Lessig's 'Grant & Franklin' project (Lessig, 2011).

6. Policy

Given the results of Chapter 5.5, more voter mobilization to the ballots, change in voter attitudes towards political spending and redistribution seem to be insufficient for reversing inequality trends. This chapter tests two policies from literature, to assess if they can succeed in resolving the increasing trend of income inequality in the US. *(please refer to Chapter 14 (Appendix 5) for details on the model structure of Policies (A) and (B)).*

6.1. Policy A: Contribution limits per candidate (Level-down approach)

The rationale of this policy is that a candidate should not accept contributions exceeding a certain limit. This will temper price inflation of the cost of winning votes, as explained in Chapters 4.3.1, and 5.2.3.1. The policy structure is explained first, followed by results of applying the policy in the model, concluding with an analysis and discussion of the policy implications.

In previous US cases where campaign contribution limits were enacted, the law distinguished between campaign contributions and campaign expenditures, concluding that limiting contributions is constitutional because it prevents corruption or the appearance of corruption thus maintains the confidence of the voters in the political system (Lessig, 2011; Issacharoff, 2010). Limiting expenditures, on the other hand, is unconstitutional in the view of the current US Supreme court as it infringes on the free speech of individuals and organizations (Issacharoff, 2010). In states with contribution limits, independent expenditure is carried out by organizations independent of the campaign of the political candidate, yet in support of that candidate's party, policy-agenda, or against their opponent.

If a candidate of Agent (X) was running against increasing taxes, independent organizations who would not be able to contribute to such candidate's campaign due to the restrictions placed by Policy (A), may still run ads convincing voters that increased progressive taxation is harmful to the economy. This would increase that candidate's chances of winning the race by mobilizing voters who share the worldview, or who are convinced by the arguments of the ads, granting such candidate their votes. thus independent expenditures may be conceptualized as a secondary market to the campaigns marketplace. Independently purchasing political ads to support or oppose political candidates is a norm in US politics (Dawood, 2015). Regulating the primary market only shifts the economic activity to the secondary market of independent expenditures.

It is assumed that the effectiveness of a single USD of independent expenditure will not be as effective as a USD spent by the candidate herself on running her own campaign, thus where independent expenditure is unrestricted (in P(A)-1), a measure of effectiveness is used to reflect that.

P(A)-2 tests the implications of limiting campaign contributions as well as independent expenditures, because as Issacharoff (2010) affirmed in the below direct quote, limiting contributions only while leaving independent expenditures unchecked will not produce the intended consequences of increased equality in the political process,

“No rational regulatory system would seek to limit the manner by which money is supplied to political campaigns, then leave unchecked the demand for that same money by leaving spending uncapped.” (Issacharoff, 2010, p119-120).

Taking an extreme situation where all independent expenditures are prevented from influencing political campaigns, ‘Independent expenditure’ is made to equal zero in P(A)-2. The contrast between the 3 runs shown in chapter 6.1.3 are contrasted in the below table:

	Base-run	P(A)-1	P(A)-2
Campaign contributions	Unlimited	Limited	Limited
Independent expenditure	Unlimited	Unlimited	Limited

Table 5 Contrast between P(A)-1, P(A)-2, and base-run

The next chapter describes the effect of this policy on the system structure in the form of a CLD, emphasizing on the channels by which money moves through the political system in light of Policy (A).

6.1.1. Dynamic Structure of Policy-A

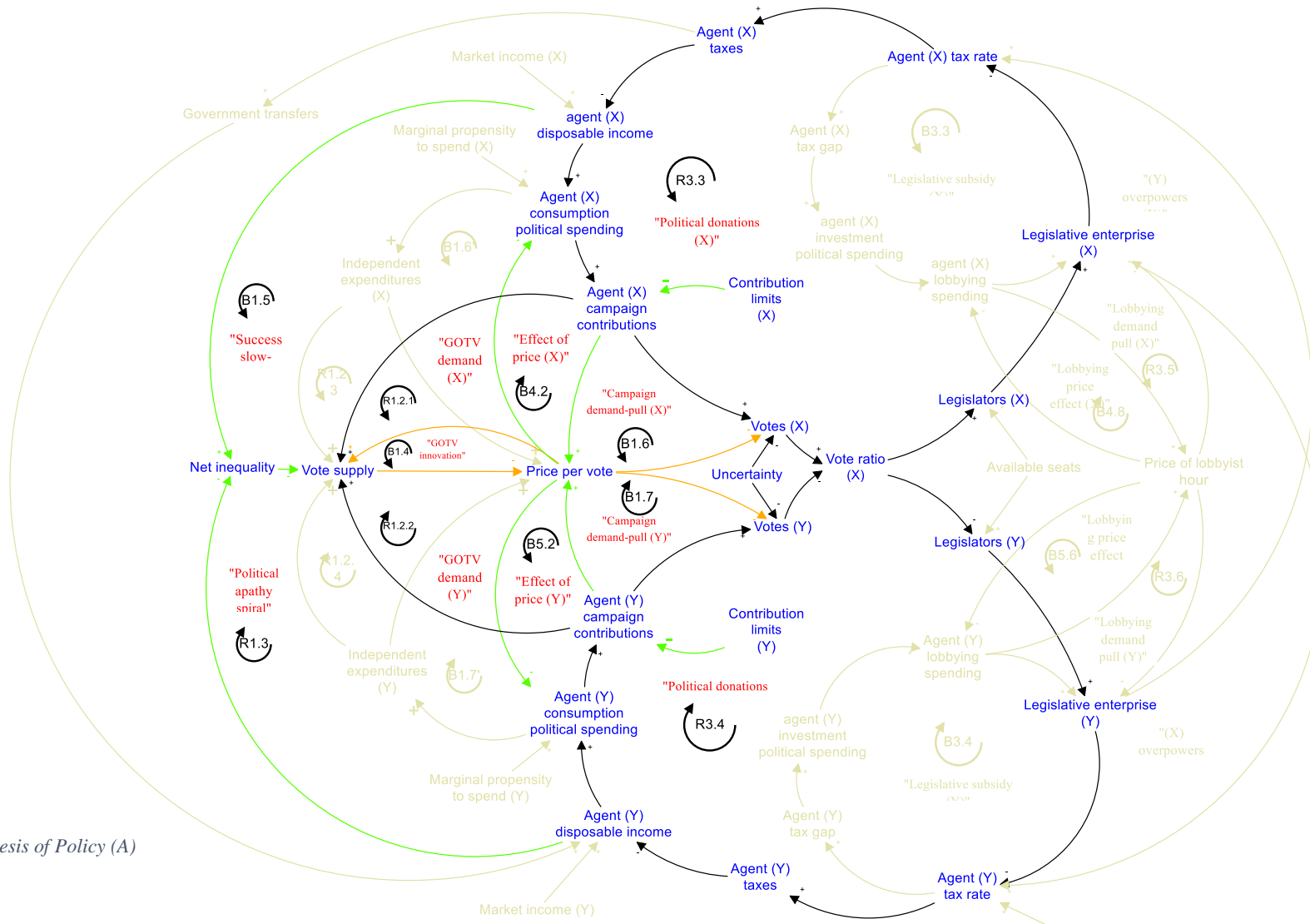


Figure 50 dynamic hypothesis of Policy (A)

Figure 50 shows the political campaigns system structure. The main loops, representing the ‘Success to the successful’ generating structure are loops (R3.3) and (R3.4). The purpose of Policy A, is to apply contribution limits to be received per candidate, thus levelling the effectiveness of a single dollar donated by any given voter in contribution to a legislator’s campaign. By limiting the total amount of money in the system, a small donation’s relative effectiveness increases. This gives Agent (Y) more voice in the marketplace of elections. Highlighted in green is the application of Policy A, “Contribution limits (X)” and “Contribution limits (Y)”.

The intended outcomes of such policy are also demonstrated in light-green connectors in Figure 50. When contributions are limited, the inflationary effect of massive campaign spending is theorized to be reduced. This works through loops (B4.2) and (B5.2), capitalizing on the heterogeneity between the agents. Since Agent (Y) displays a higher ‘Price elasticity of political spending (Campaigns)’, the reduction in price would activate (B5.2) to dominate (B4.2), giving Agent (Y) an equal opportunity to contribute to campaigns via consumption political spending. The higher contributions of Agent (Y) should result in votes and thus more ‘Legislators (Y)’. This would, first of all, weaken loop (R3.3) relative to loop (R3.4), and strengthen loop (R3.7) allowing Agent (Y) to impose higher taxes on Agent (X). This would also reduce inequality through loops (B1.5) and (R1.3), increasing vote supply. That increase would counter the effects of loops (R1.2.1), (R1.2.2) and (B1.4). Loops (R1.2.1) and (R1.2.2) translate demand for votes (campaign contributions over price per vote) into supply through GOTV (*please refer to Chapter 12.1 and 12.6 for details on GOTV dynamics*) thus it is expected that when campaign contributions decrease, supply of votes will also decrease. Furthermore, (B1.4) represents the innovations in GOTV which increase supply as the ‘Price/vote’ increases.

Lower price would lead to a reduction in the supply of votes. But loops (B1.5) and (R1.3) would counter that reduction in supply by reducing inequality. Lower inequality would increase GOTV through these two loops. But as mentioned in Chapter 6.1.1, campaign finance reforms focus on campaign contributions and leave out campaign spending. The consequences of that approach, due to constitutional hurdles, gives way to the activity of the loops outlined (in dark green) in Figure 51. Loops (B1.6’) and (B1.7’) are the equivalents of loop (B1.6) and (B1.7). When campaign contribution limits are applied, independent expenditures (independent to the political candidate as in not coordinated by her/ him) cause similar inflationary effects on the

political system because they flow into advertising media with the purpose of Getting Out The Vote through loops (R1.2.1') and (R1.2.2'), thus keeping (B1.4) dominant by raising price. Money flows through the path of least resistance (Issacharoff, 2010). The first run testing Policy A includes the introduction of Contribution limit without banning independent expenditure, while the second run assumes the extreme case of banning independent expenditure altogether. The results are shown in the next chapter.

6.1.2. Results of Policy-A

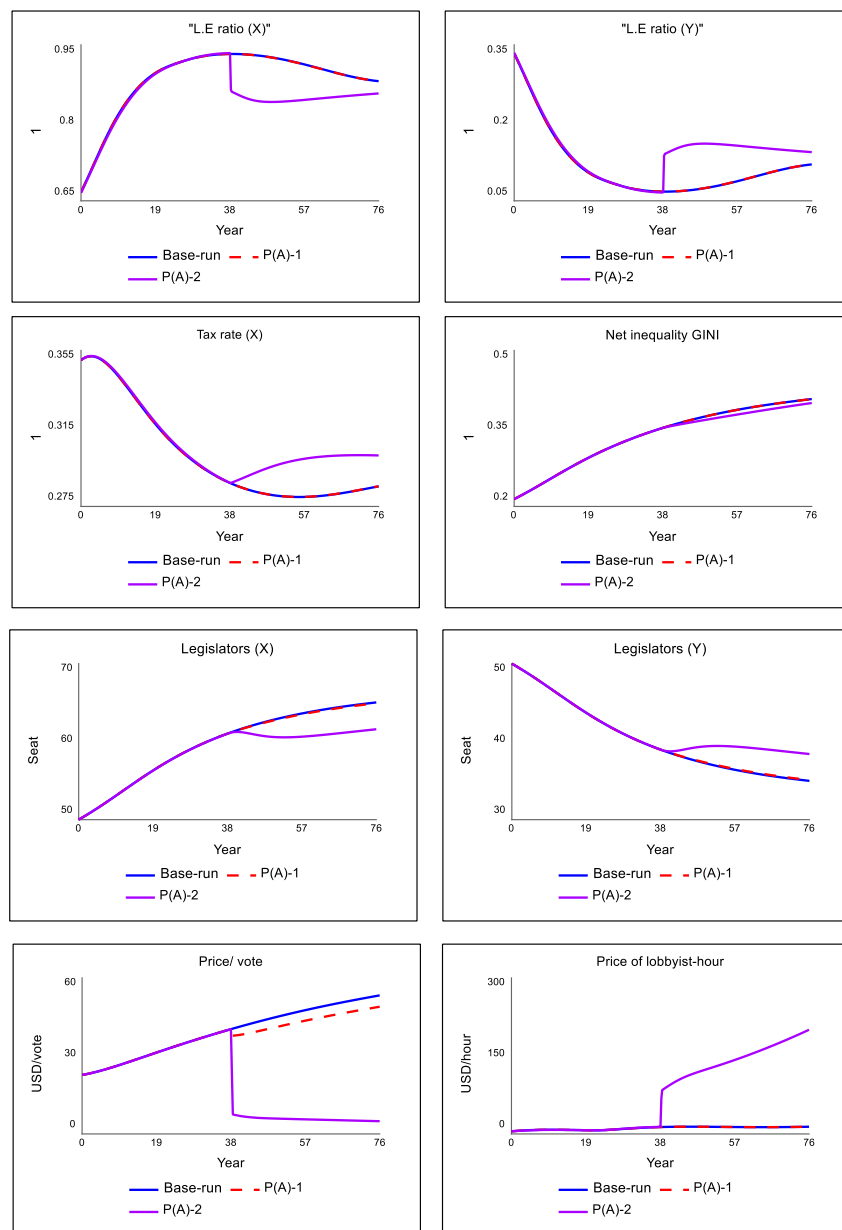


Figure 52 Overall results of P(A)-1, P(A)-2, compared to base-run

6.1.3. Discussion of Policy-A results

As elaborated in Chapter 6.1.1, the results of P(A)-1 showed virtually no difference to the base-run despite price slightly decreasing. This price decrease as shown in Figure 52 as a result of ‘Effectiveness of independent expenditure’ being 80% of money expended by the candidates themselves. Since the money prevented from going to candidates flowed into the campaign system indirectly, its inflationary effects were less pronounced, but lead to the same ends. The effects of lower price are minimal reflecting in slightly higher consumption political spending by the two agents, especially by Agent (Y), and a minimal increase in Agent (Y)’s vote share compared to the base run. In P(A)-2, however, the results are substantially different even though they fall short of the intended purpose of the policy.

‘L.E ratio (X)’ declined immediately when the policy was initiated, and ‘L.E (Y)’ increased at $t=38$. Agent (Y) won seats in the legislature and managed to raise tax rates on agent (X), yet inequality did not change sufficiently which may be explained by studying the graphs of prices in Figure 52. Price per vote dropped at $t=38$, and continued to fall slowly over the run time. This is because loop (B1.4), instead of increasing supply, worked in the opposite direction and reduced supply in fact working in synergy with loops (B1.5) and (R1.3), the effect of which suppressed voter participation as a result of persistent inequality. This inequality continued because no tax increases were enacted by the legislator. With the limitations placed on independent expenditure, the remaining consumption portion of political spending of the two agents flowed to lobbying, strengthening (B3.3) and (B5.7). This can be first seen in the graphs of consumption political spending in Figure 53.

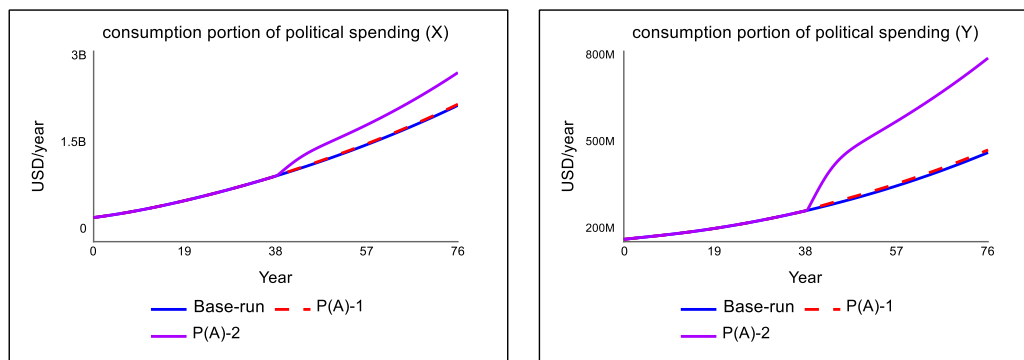


Figure 53 Consumption political spending for Agent (X) and Agent (Y) in P(A)-1, P(A)-2, and base-run

Due to Agent (Y)’s higher price elasticity, the lower price caused a percentage increase in Agent (Y)’s consumption political spending higher than that of Agent (X). Yet in absolute terms, the consumption of Agent (Y) was much less than that of Agent (X).

When the consumption political spending diverted to lobbying in P(A)-2, the surges in lobbying spending, observed in Figure 54, occurred. These graphs surge at $t=38$, because of the application of expenditure limits, that surge in lobbying expenditure is what caused the surge in the price of lobbyist hour in Figure 52 (Price of lobbyist-hour).

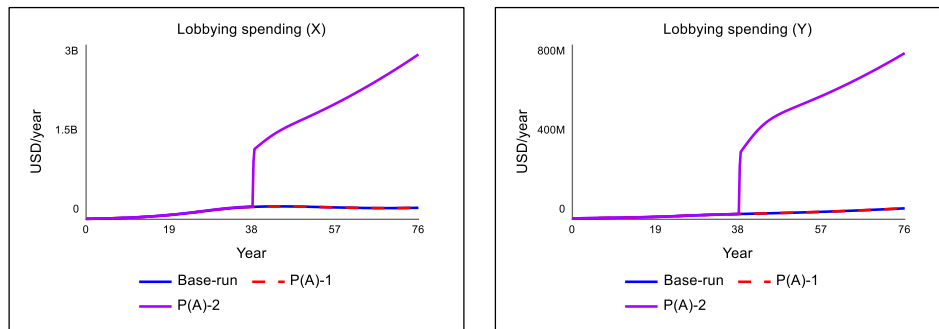


Figure 54 Lobbying spending in P(A)-1, P(A)-2, versus base-run

The diverting of money from campaigns into lobbying as a consequence of policy P(A)-2, had effects of investment political spending of both agents, both of whom reduced investment political spending due to price increase. Agent (X), although experiencing an increase in taxes starting $t=38$, lowered investment political spending because the ‘Effect of tax gap on investment spending’ indicated higher investment, while the ‘Effect of price (lobbying) (X)’ was decreased investment. The combined effect of both was to lower investment. This continued until $t=42$, at which ‘Tax gap ratio (X)’ was sufficiently high to overcome effect of price. For Agent (Y), however, ‘Effect of (X)’s tax gap on investment spending’ was not sufficient at any time after $t=38$ to overcome the effect of inflation in ‘Price of lobbyist-hour’ to justify any increased investment. The two agents relied on their consumption spending to fund most of their lobbying (notice that lobbying spending is at least 5 times investment

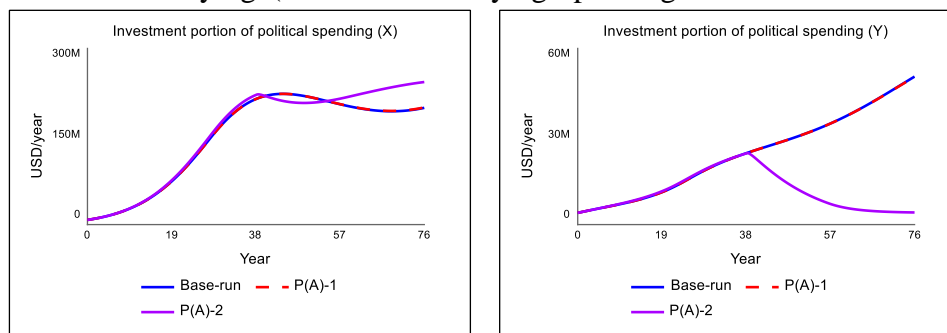


Figure 55 Investment political spending of P(A)-1, P(A)-2, versus base-run

political spending). This behaviour implies that limiting the role of money in political campaigns will only shift the burden to the lobbying industry. This is shown in Figure 56, where the flow of money from consumption political spending activates reinforcing loops (R3.3.P) and (R3.4.P).

This suggests that levelling-down policies for campaign finance reform have limited effectiveness, in agreement with Gerken & Tausanovitch (2014). The next policy tests if restructuring the campaign system through levelling-up approaches could yield better results in reducing representational, and income inequality.

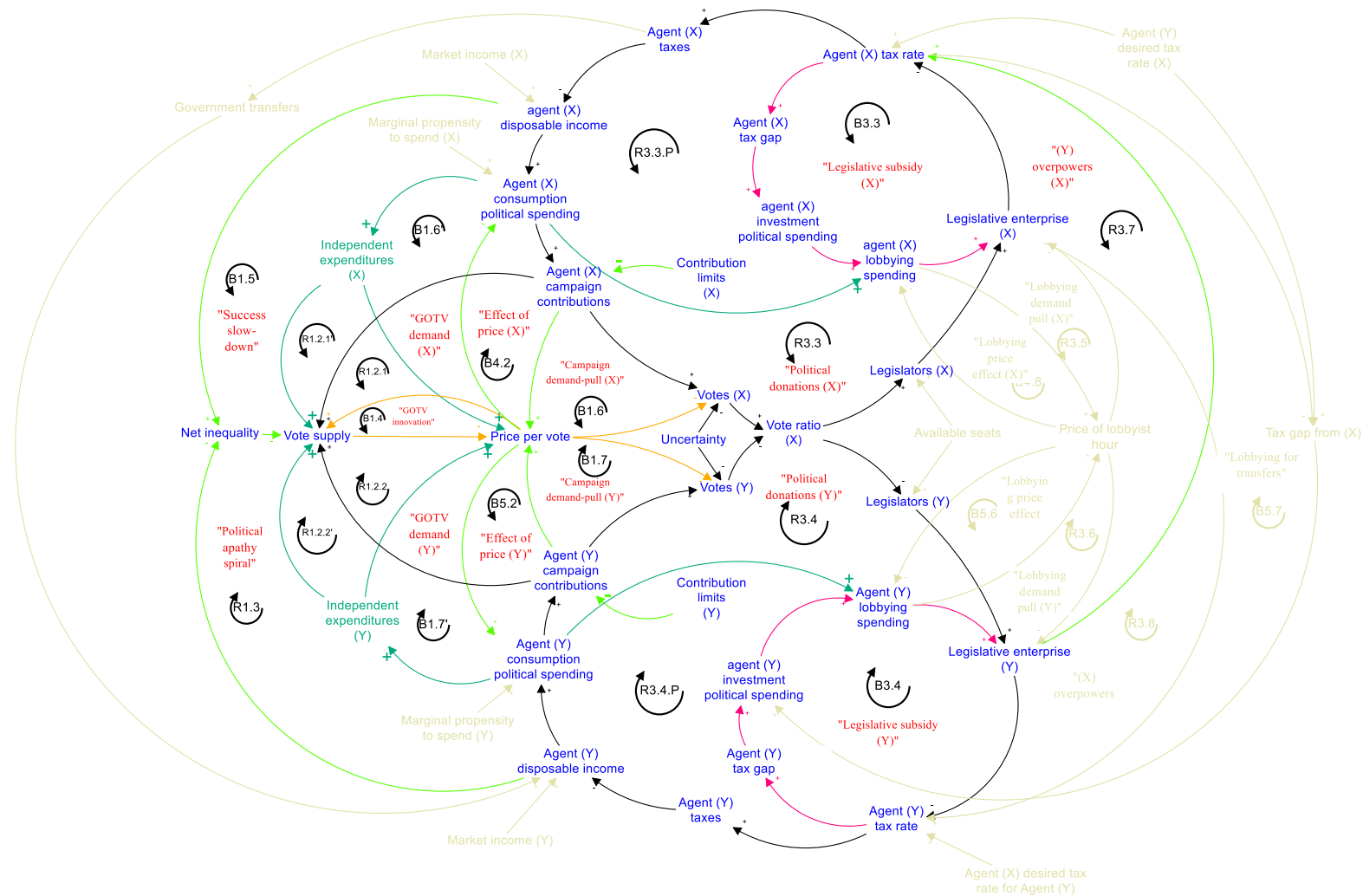


Figure 56 Full range of unintended consequences of P(A)

6.2. Policy B: the Grant & Franklin project (Level-up approach)

This policy is adapted from Lessig (2011). Its approach may be framed as a combination between making publicly-funded the now private marketplace of US elections, yet maintaining a certain private aspect to it. By using Tax-payer money as the basis for funding campaigns, the project aims to increase the role of small donors in fund-raising for political campaigns. The ‘Grant’ in the project’s name represents Former US President (number 18) Ulysses S. Grant, whose image is printed on the 50 USD bill. He proposed that the state reserves 50 USD of taxes paid by each eligible voter (tax-payer) issuing a voucher for the amount of 50 USD. Each voter then gets to allocate her voucher to one or more politicians for a given election. Furthermore, each voter may top-up their voucher with a maximum of 100 USD per candidate. This explains the ‘Franklin’ in the name of the project, as the image of Benjamin Franklin is printed on the 100 USD bill.

6.2.1. Dynamic structure of Policy B

Figure 57 shows the hypothesis of Policy (B), by adopting a new source of funding for campaign contributions, loops (R3.3) and (R3.4) are broken. Given the sheer numbers of Agent (Y)’s tax-payers/ voters (and hence donors), and the small values of each Grant and Franklin allocated per voter, it is expected that more ‘Legislators (Y)’ will get to office, balancing the inequality of representation in the legislature thus strengthening (R3.7), and enabling Agent (Y) to enact tax increases on Agent (X), reducing net income inequality and increasing participation.

Given that nothing was done about loops (R3.3.P) and (R3.4.P), it is expected that the effectiveness of this policy in reducing income inequality will be low, yet in terms of representational inequality, it theoretically should be the most effective of all scenarios and policy tests. This is because a huge ‘levelling-up’ effort would be put in place that maintains an advantage for the majority agent, Agent (Y), in terms of the sheer amounts of ‘Grants’ by Agent (Y). The results of Policy (B) are shown after the dynamic hypothesis, in Chapter 6.2.2.

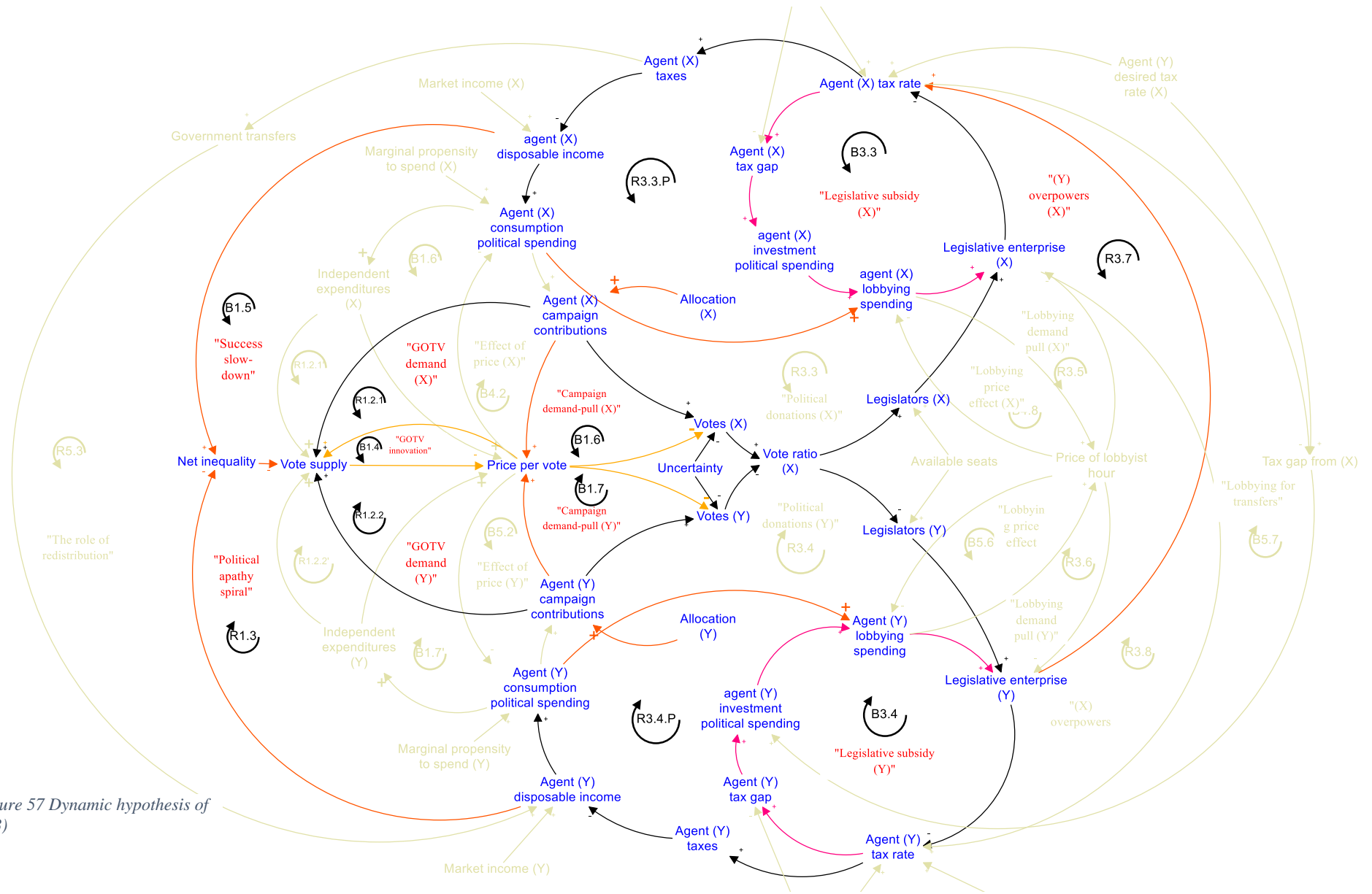


Figure 57 Dynamic hypothesis of P(B)

6.2.2. Results of Policy B

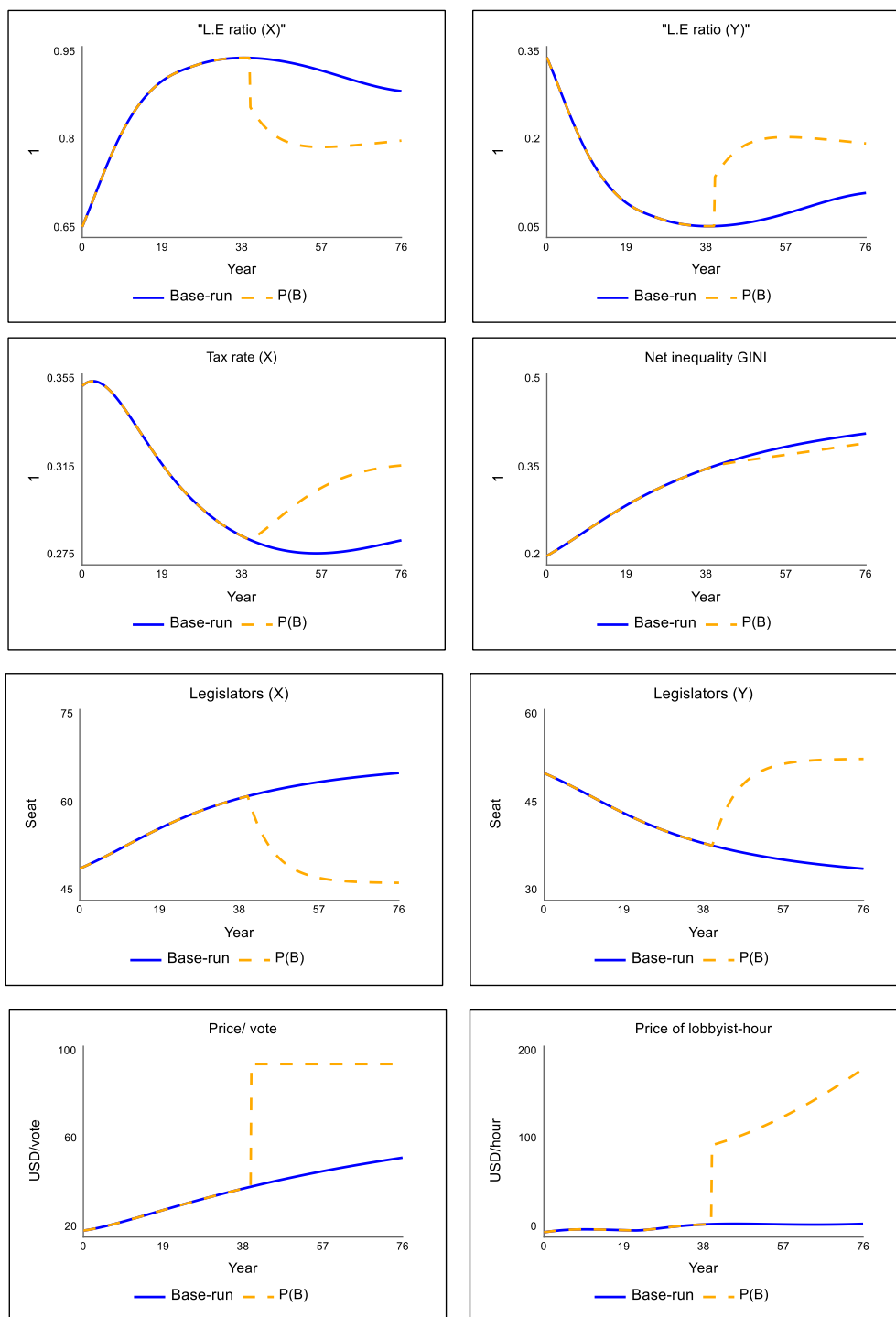


Figure 58 Results of P(B) versus base-run

6.2.3. Discussion of policy B results

As anticipated, the ‘Grant & Franklin project’ yielded substantial reduction in representational inequality in terms of legislators in office. For the first time in all the runs simulated through Chapter 5 & 6, Agent (Y) had more legislators in office than Agent (X). This informs on the importance of drastic system change, rather than attitude change, to yield lower political inequality. It also informs on the potential for synergy between both system change and attitude change by Agent (Y) in order to increase their representation in office.

Price per vote actually increased because of the influx of massive amounts of small donations, the ‘Grants’ and the ‘Franklins’ into campaigns and activating (B1.4) to increase vote supply, reaching full participation which is why price stabilized immediately at $t=38$ (‘Perceived price/ vote’ took some time to follow, reaching equilibrium at around $t=52$ as shown in Figure 59.

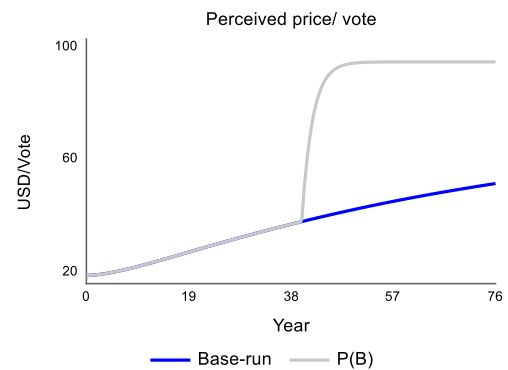


Figure 59 Perceived price per vote changes in $P(B)$ versus base-run

The issue of income inequality, however, did not show much improvement because of the loop (R3.3.P). All consumption money continued to flow through (R3.3.P) and (R3.4.P) as no regulation on lobbying was enacted to complement Policy (B) which is why all consumption and investment money continued to flow into lobbying.

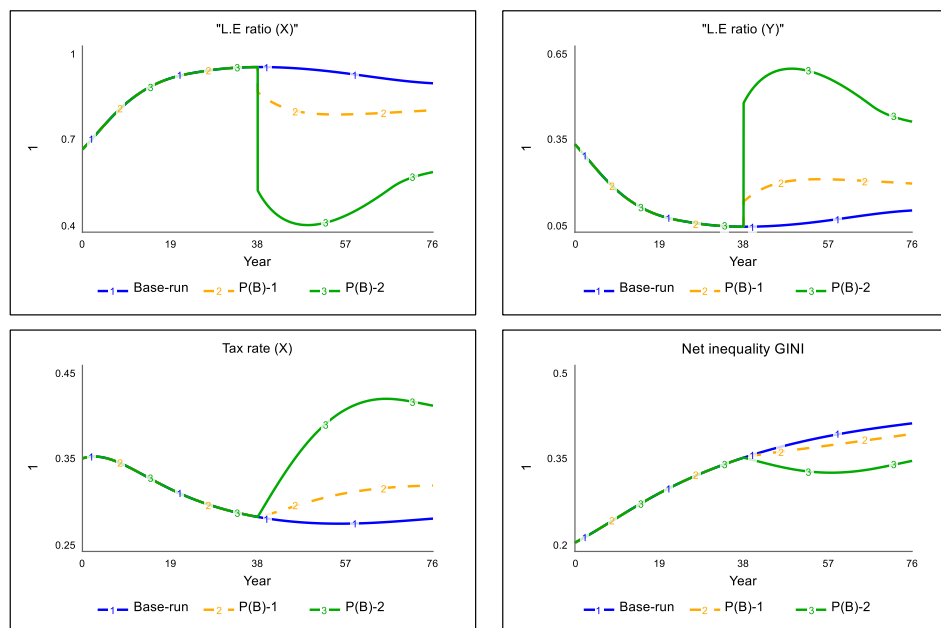


Figure 60 $P(B)$, $P(B)-2$, versus base-run. $P(B)-2$ is a variant of $P(B)-1$ with a restriction placed on ‘Lobbying spending (X)’

This is reflected in the escalation of ‘Price of lobbyist hour’ in Figure 58. To test whether disabling loop (R3.3.P) would improve outcomes, a sudden shock is introduced at $t=38$, in a variant of Policy (B), whereby ‘Lobbying spending (X)’ is reduced by 80%. The results of this experiment are shown in Figure 60, which demonstrate that limiting the action of loop (R3.3.P) yields much better results in terms of income inequality (because there is no change in the number of legislators from P(B)-1 to P(B)-2). The changes observed in legislative enterprises comes solely from the lower lobbying spending by Agent (X).

This implies that there must be coordinated reform actions on both campaigns and lobbying to prevent money from simply flowing from one channel to the other whenever limits are placed on one channel, what Issacharoff & Karlan (1998) referred to as the ‘hydraulics of campaign finance reform’. The next chapter gives a brief contrast of all the scenarios run in Chapters 5 and 6 to summarize the findings of model analysis and policy tests.

6.3. Overall results and discussion on policies

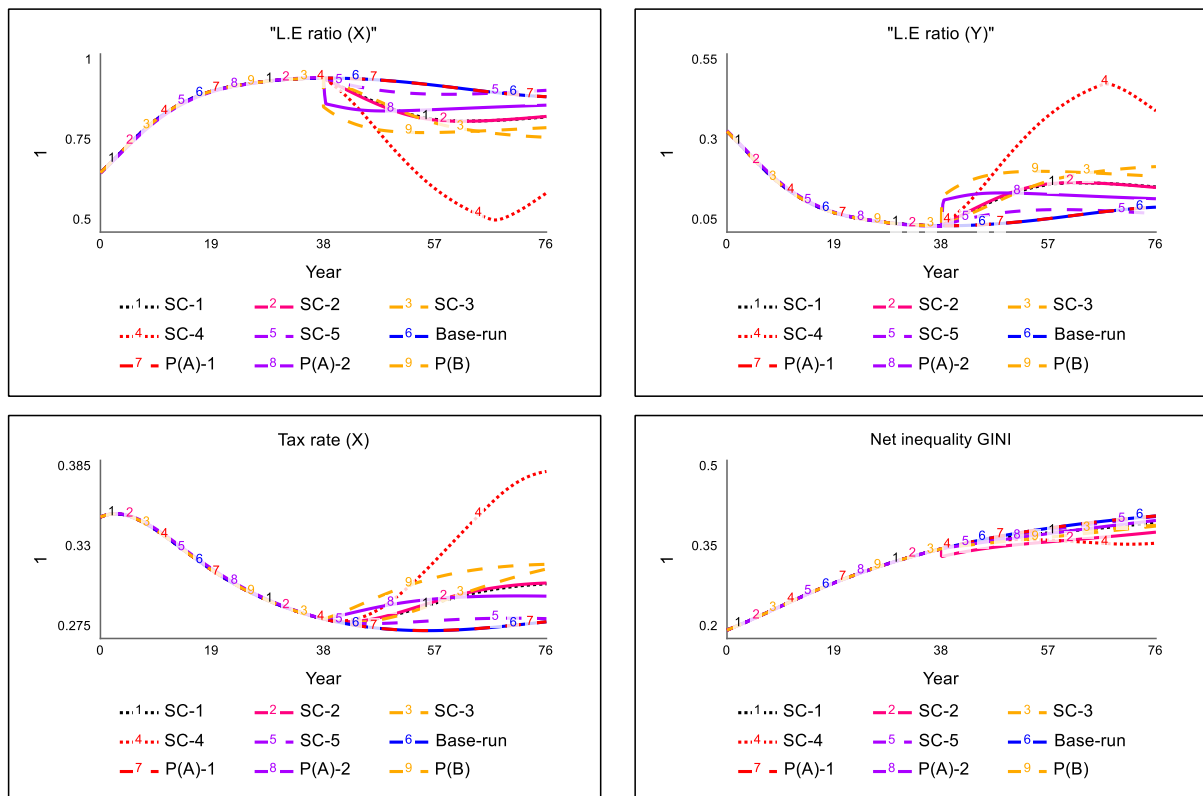


Figure 61 Comparison of scenarios and policies (L.E ratios, tax rate (X), and inequality)

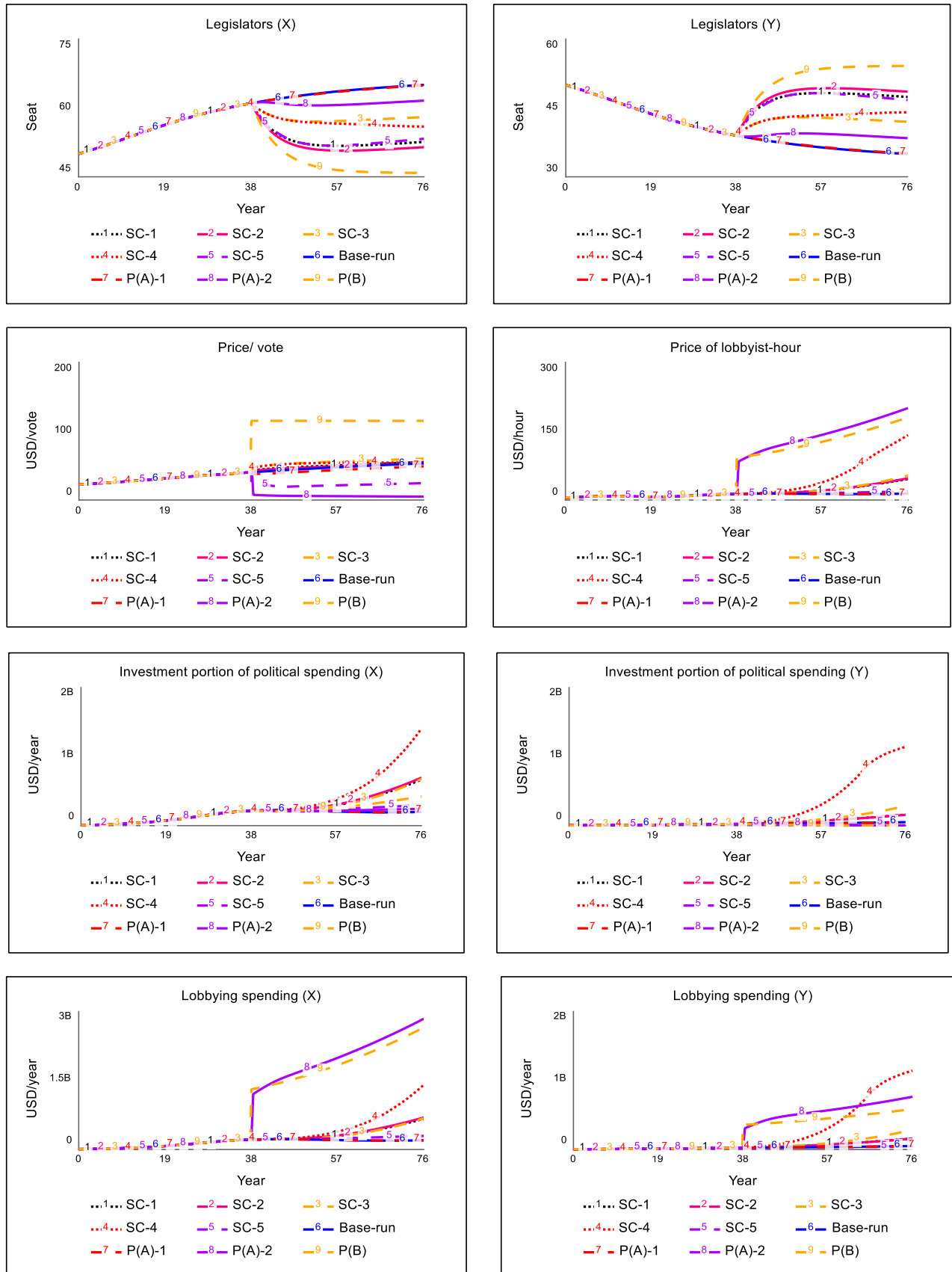


Figure 62 Comparison of scenarios and policies (Legislator seats, prices of campaigns and lobbying, investments in politics, and lobbying spending)

Contrasting the five scenarios from Chapter 5.3 with the two policies from Chapter 6, it is clear that attitude change in terms of political spending, mass-voter mobilization, and higher government redistribution have a non-zero effect on both representational inequality and income inequality. In Chapter 5.3, it was demonstrated that increased ‘Legislators (Y)’ in the US Senate will not guarantee a considerable change in tax progressivity, as competition for influence between the two agents occurs at the level of ‘Legislative enterprise’ rather than on the ‘Legislator’ level. ‘Legislative enterprise’, being composed of both the number of legislators of an agent multiplied by their lobbying spending, complicates the dynamics of representational inequality such that attempts of reforming campaign finance may have unintended consequences. Money follows the path of least resistance (Issacharoff, 2010), thus constraining money’s entry into campaigns simply shifts the flow of money to other lightly regulated channels as was observed in Chapter 6. When contribution limits were applied, money flowed to independent expenditures. When independent expenditures were constrained, money flowed to lobbying spending. Finally, when the campaign finance system was redesigned, giving Agent (Y) a considerable advantage, consumption political spending flowed to lobbying spending (lobbying is virtually unregulated in terms of monetary limits (Gerken & Tausanovitch, 2014)).

Whether a specific policy is effective or not has to be decided based on the intended purpose of the policy. The assessment of Policy (A) in terms of income inequality suggests that Policy (A) is not going to be effective, even if independent expenditures were restricted. This is because contribution limits do little to change the composition of campaign contributions, in that the main advantage given to Agent (Y) is in the reduced price, and thus increased ‘Consumption portion of political spending (Y)’ as a result of the price reduction (B5.2). Attitudes of Agent (X), modelled as ‘Marginal propensity to spend on political campaigns (X)’, remains superior to that of Agent (Y), and the tax increases enacted in P(A) remained insufficient to give Agent (Y) a disposable income advantageous to that of Agent (X), in order to overcome Agent (X)’s consumption political spending. Furthermore, even if ‘Tax rate (X)’ was considerably increased, giving Agent (Y) a larger disposable income, a further hurdle to Agent (Y) gaining an advantage is their consumption attitudes of goods and services. Since consumption political spending is a function of discretionary income, and discretionary income is equal to disposable income minus consumption (of goods and services), and given that Agent (X) consume less of their disposable income than Agent (Y), it is very hard for Agent (Y) to

overtake the discretionary income of Agent (X), even if their ‘marginal propensity to spend on political campaigns’ were equal.

Of all the scenarios and policies discussed in chapters 5 & 6, Policy (B) yielded the best results in terms of ‘Legislators (Y)’ (Figure 62). This occurred despite conservative estimates of donor behaviour for Agent (Y) (*Please refer to Chapter 14.2 for details on the calibration of Policy (B)*) it did have an inflationary effect on price (Figure 62), yet loops (B4.2) and (B5.2) were disabled in P(B), because they were replaced by an alternate mechanism of making political consumption spending (through the Grant & Franklin project). The effects portrayed in loops (B4.2) and (B5.2) indicate the insignificance of any additional contribution given the escalating costs of campaigns. However, because P(B) is designed to collect vast amounts of money for the public funding of political campaigns through small donations (50 USD and 100USD), it overrides loops (B4.2) and (B5.2).

Taking the results of P(A), P(B), and SC-4, the conclusion that may be drawn is that representational equality measured only by legislator seats representing the agents hides that fact that the ability of legislators to influence policy is proportional to an agent’s ‘legislative subsidy’ (Hall & Deardorff, 2006). In order for the agents to have equal influence represented by the ‘L.E ratios’ in Figure 61, the ratio of legislator seats has to be equal to the reciprocal of the ratio of lobbying spending. The implications of this idea point out to the need to consider the influence of money over the political system as a continuum of feedback loops, rather than discrete stages of a political process.

Thus, the answer to (RQ3) is that campaign finance reform, taken separately from lobbying yields better representational equality in terms of the number of legislator seats from Agent (Y), who come from a more modest background compared to Agent (X). In terms of campaign finance reform on US legislation, however, it seems to be insufficient to eliminate the role of money, and thus concentration of influence with Agent (X), in lobbying legislators; a practice that enables legislators to do their job. Reform of the political system has to adopt a holistic view, in order to design effective policies that do not only fix intermediate measures (such as number of ‘Legislators (Y)’ in the Senate) but fix political outcomes as well. Such policies, however, face tremendous legal and constitutional challenges as will be outlined in the next chapter.

7. Implementation

Taking the results of chapter 6, this chapter discusses the implementation challenges in adopting policies (A) & (B). Generally, there are two camps on the spectrum of opinions on campaign finance regulation, the libertarian, and the egalitarian camp (Dawood, 2015). The first considers restrictions on campaign donations as an infringement on free speech equating ‘money’ to ‘speech’ while the second camp voice concerns over concentration of income and wealth to translate to concentration of power and influence, hence corrupting the system, and use that argument to justify regulation over campaign finance (Dawood, 2015). The two isles of the debate are parallel, and it does not seem they will intersect in the near future. On one hand, there is a narrow definition of corruption that gives way to regulatory loopholes, and a broad emphasis on the right to free speech guaranteed by the First Amendment of the Constitution. On the other hand, the emphasis by dissidents is that potential of political capture is in and of itself damaging to public’s faith in the system and thus falls under the definition of corruption.

There have been several cases addressed by the US Supreme Court over the years, on the constitutionality of campaign finance regulation, a common feature of all such cases since *Buckley v Valeo* in 1976 has been the distinction made between campaign contributions and campaign finance (Issacharoff, 2010). Lessig (2011) echoed Issacharoff (2010) in criticizing this distinction which in his opinion gives way to loopholes which are being exploited today in funnelling money through the campaigns marketplace (Gerken & Tausanovitch, 2014). The most recent of US Supreme Court rulings impacting the influence of money on politics were *Citizens United v FEC* in 2010, and *McCutcheon v FEC* in 2014. The votes for both were 5 to 4, indicating the intensity of the debate amongst the court judges on the constitutionality of limiting the role of money in politics which adds to the salience of the issue since supreme court justices change over time, thus a shift in the vote in favour of tighter regulation of money in politics, may come within the next few decades.

Implementation of both policies (A) and (B), hinge on the acceptance by the divided US Supreme Court, which has a majority of conservatives (5 judges) to liberals (4 judges), and decisions are passed with a 50%+1 vote. Future research could investigate cases where mass-mobilization put pressure not only on the executive (President) and legislative (Congress) branches, but also on the judicial. Chapters 5 & 6 indicate that campaign finance reform alone will not be sufficient to prevent income inequality from translating to representational

inequality and vice versa. They suggested that comprehensive reform is needed to equalize political voices, in order to reach a more egalitarian distribution of income and wealth through the adoption of government policies that curb, if not limit, income inequality. Regulating the lobbying industry is a relatively scarcely-discussed idea and poses its own constitutional challenges as it collides with the right to petition (Gerken & Tausanovitch, 2014). This brings the debate back to whether the current system may be categorized as generating ‘corrupting consequences’ as Issacharoff (2010) argued. The findings of this research argue that money’s influence in politics has several corrupting consequences, whether in inequality of representation, inequality of influence over policy, or in its distorting effects on voter participation (rising income inequality leading to low voter participation). A change in the US Supreme Court’s definition of corruption would be the starting point for any realistic political reform, leading to policy reform that better reflects the majority’s policy preferences.

8. Conclusions

8.1. Concluding remarks

Post-tax (net) income inequality in the US has been rising since the mid-1970s at a rate higher than most industrial democracies. Government policy has contributed to, and failed to restrict this trend despite popular concern for the issue of increasing inequality, and against public preferences for progressive taxation. Recent empirical findings have detected a wealth-bias in US policy-making as a result of several factors including low voter participation by low-income earners, political party structure and practices, the role of money in elections, and in lobbying. This research aimed to structure the knowledge on how income inequality translates to political inequality, and vice versa, through a closed-boundary, white-box theory using System Dynamics. It aimed to contribute to the debate on US income inequality by answering three research questions:

- RQ1: What are the feedback mechanisms by which net income inequality and the political system influence one another?
- RQ2: What are the implications of a free-market approach to the US political system, through elections and lobbying, on net income inequality?
- RQ3: What are the effects of campaign finance reform on reducing net inequality?

Chapter 4 aimed to answer (RQ1) by providing a dynamic hypothesis on the relationship between net inequality and the US legislative process taking the US Senate as the enactor of tax policy. Chapter 5 aimed to answer (RQ2) by providing a base-run, and five scenarios exploring the implications of a free-market approach to US Senate campaigns and lobbying. Chapter 6 aimed to answer (RQ3) by testing the efficacy of two approaches to campaign finance reform in reducing income inequality in the US.

In answering (RQ1), the four factors listed by the Task Force on Inequality and American Democracy (TFIAD, 2004) were synthesized in the dynamic hypothesis that mapped the feedback relationships between income inequality and political inequality, combining Sterman's theory of commodity markets (Sterman, 2000) with the theory of 'lobbying as a legislative subsidy' by Hall & Deardorff (2006). This synthesis provided a free-market theory of campaign finance and lobbying by which income inequality resulted in political inequality, which created more income inequality. This occurred through loops (R3.3) versus (R3.4) that bifurcated legislator seats representing the two agents, and loops (B3.3) versus (B3.4) and (B5.7) which represented the ability to 'subsidize' an agent's legislators to enact their tax policy preferences. The implications of this free-market approach to the US political system (RQ2) were an increasing trend of income inequality, escalation of campaign and lobbying costs, as well as a decreased political representation and influence for the US middle-class and low-income earners. This was a consequence of heterogeneity of political spending patterns through consumption and investment political spending across income groups; concentration of income and wealth lead to concentration of political power and influence which leads to government policies that generated higher concentration of income and wealth. It was concluded that the question whether individuals and groups donate to legislators' campaigns with an 'ideological consumption' motive or an 'investment' motive has little significance in terms of political representation, given the system structure. Despite the model assuming all campaign contributions are made with an ideological consumption' motive, political inequality was the outcome, given a free-market of campaign funding. From scenarios run in Chapter 5, it was concluded that given the continuity between the market of legislature elections and the lobbying market, changing voter participation would yield higher representation for the middle and bottom income earners in the US legislature, but would not yield higher influence to enact progressive taxation on the top US income earners. It was also concluded that changes in attitudes by the bottom 90% of US income earners through increased campaign contributions or lobbying would yield higher representational (political equality), but would do little to reverse income inequality trends. Furthermore, increased redistribution through reshuffling of

government priorities (without making taxes more progressive) yielded significant improvement in terms of income inequality through the sheer increase of after-tax and transfer incomes for the majority of the US population, but did little to increase political equality.

Testing two policies for campaign finance reform (RQ3), applying Issacharoff & Karlan's 'hydraulics of campaign finance reform' concept (Issacharoff & Karlan, 1998), the consequences of attempts to regulate the free-market of political campaigns were explored. Regulation attempts resulted in money shifting from the regulated channels to those that were less regulated. When campaign contributions were capped, money flowed to independent campaign expenditures. When both contributions and expenditures were capped, money flowed to lobbying. When the campaign finance system was revamped completely, shifting the balance of power to the middle and low-income American voters/ donors, lobbying played a significant role in keeping the top US income earners' influence over the legislature, and consequently over tax policy. This resulted in a persistent trend of increasing inequality. This affirmed the argument of Gerken & Tausanovitch (2014), that campaign finance and lobbying finance are two faces of the same coin, calling for a holistic approach to private funding of public functions (electing legislators and carrying out legislation), and pointing to, in agreement with the findings of this research, the need to regulate both campaign finance as well as the lobbying industry. Proposals for regulating campaign finance and the lobbying industry clash with US constitutional rights expressed in the 'right to free speech' through political donations, and the 'right to petition' one's elected official through lobbying. Such clashes hinge on the US Supreme Court's definition of 'corruption', the central concept used to justify such calls for reform. The US Supreme Court currently defines political corruption in narrow 'quid-pro-quo' terms whereby politicians exchange money for political/ policy favours. Considering the distorting effects, on democracy and equal representation, of a free-market of political spending several law scholars (Gerken & Tausanovitch, 2014; Lessig, 2011; Issacharoff, 2010) have called for a broader definition of 'corruption' to encompass not only 'quid-pro-quo', but also the 'appearance of corruption' which threatens American citizens' faith in the political system. There have also been calls for the US Supreme Court's definition of corruption to encompass not only corrupt 'process', as in quid-pro-quo dealings with members of the constituency, but also corruption of 'outcomes' (Issacharoff, 2010) which this research has demonstrated. The free-market of political influence corrupts the democratic representation of American voters who cannot afford the costly commodities of the US political system.

This research showed that rational agents, acting in congruence with the law, and merely through the heterogeneity of their political spending patterns can create a ‘success to the successful’ behaviour in the context of a free market of political commodities, whereby the democratic representation of American citizen is distorted and made increasingly unequal. It is worth noting that most of the deregulatory consequences of US Supreme Court decisions concerning campaign finance laws have been enacted through a 5 to 4 majority vote, meaning that the US Supreme Court is divided on the matter, and since its composition changes over the years between liberal and conservative the legal framework within which such regulations operate may change over the next few years.

8.2. Contributions to research

This research provided a novel synthesis of theories on markets with the ground-breaking work of Hall & Deardorff (2006) to explain the mechanisms by which money influences the US political system, providing an answer to why net income inequality has been increasing over the past four decades. It provides the first step of using simulation models to synthesize multi-disciplinary knowledge into a single coherent theory on US income and political inequality. To the knowledge of the author, this is the first simulation modelling study to combine both campaign finance and the lobbying industry in one model, contesting the median-voter theory set forth by Downs (1957) in his ‘economic theory of democracy’. The research was approached with a ‘conceptual virtual lab’ strategy as coined by De Gooyert (2019), enabling the reader to run thought experiments with the aid of a white-box simulation model. The assumptions of the model used in this study were made conservatively, emphasizing on the heterogeneity between the two competing agents incorporated in the model, and aim to encourage debate such that the theory of income and political inequality in the US can be expanded and refined. The next chapter gives recommendations on possible alleys for improvement in future works.

Finally, this research focused on net inequality by adopting the US tax policy as the government policy through which legislative enterprises representing different income groups compete. The conclusions of this research, however, inform on market inequality as well. As stated in Chapters 1 & 2, government policies have contributed to the exacerbation of market inequality as well as net inequality. Given that this model provides a theory on government policy-

making, it is rather straightforward how other policies, such as deregulation of certain industries, may exacerbate market inequality, since the policy-making process is governed by the same campaign and lobbying market mechanisms.

8.3. Critique & Future work

Given the novelty of this study in synthesizing theories across disciplines and adapting Sterman's well-studied commodity market model (Sterman, 2000) to the field of political science, various challenges, as well as constraints, were faced during the research process. Several assumptions needed to be made in order for the research to progress within the time and resource limitations. This chapter outlines some of the aspects the author had wished to explore and incorporate into the model yet was compelled to make trade-offs. The critique is categorized as conceptual and methodological, to help guide future works on this topic.

8.3.1. Conceptual critiques

The author assumed made no distinction between individual campaign contributions/ lobbying and business contributions/ lobbying, thus both individuals and Political Action Committees (PAC) were incorporated implicitly into the agents' structure. This followed Gilens & Page's conclusions that US policy-making is best described using a synthesis of economic-elite domination theories, and biased pluralism theories (Gilens & Page, 2014). Thus an aggregation decision was made in this research to combine mass-based interest groups within Agent (Y) and combine business-oriented interest groups into Agent (X). It was assumed that the top 10% income earners are the same individuals who make the decisions at the top of large corporations to simplify the modelling effort, but future works can explore a distinction between individuals and organizations for both agents, separating PAC, from individual contributions.

Secondly, partisan competition was eliminated, given the view of several scholars that since the mid-1970s the Democratic party became as pro-business as the Republican party and biased towards affluent donors and political activists (Bonica et al, 2013; Hacker & Pierson, 2010; Soss & Jacobs, 2009). However, the author believes party competition may have an additional inflationary effect on campaigns and lobbying adding an extra layer of competition within Agent (X), thus can be investigated in future works.

The third critique lies in voting patterns. A key oversimplification in this model is that there is no distinction in voting patterns between agents, and voters are considered to be a homogenous pool. This was compensated for by including a ‘self-motivated voters’ fraction of the electorate to cover for the high-income earners higher participation rate, yet future works can explore making the distinction between Agent (X) self-motivated voters and those of Agent (Y).

Another point to note is that only the Senate has been modelled as the policy-maker (through issuing legislation) for this study although the legislative cycle has been outlined in detail in Chapter 2 to include a cycle from the executive branch, passing through the lower chamber of the House of representatives, to the Senate, and back to the President to either approve or veto. This means that if one of these three branches escaped reform, the reform of the US Senate would be less effective, as the other actors in the legislative cycle would stall, or thwart the legislative endeavour to, for example, increase tax progressivity. Future research could incorporate the legislative cycle in detail to assess if there are thresholds of representation that would increase the likelihood of such policies passing (via majority votes) in both chambers of the House. This, again, still does not deal with the fact that the President could veto the tax bill once approved by the Senate.

Finally, the author concluded this research by emphasizing on the importance of loops (B3.3), (B3.4), and (B5.7), namely the lobbying loops. Future works should experiment with policies for revamping the lobbying industry concurrently with the campaign finance reforms. The author recommends Gerken & Tausanovitch (2014) as a starting point.

8.3.2. Methodological critique

Forrester (1992) emphasized on the need for modellers to work closely with experts in the field due to the funnel hypothesis of information. This research was a theoretical effort using academic, peer-reviewed, journals as the sole source of data to build and test the model. It should be complemented with qualitative tests as set forth in Barlas (1996) such as the Turing test, and Walkthroughs. Furthermore, the author recommends disconfirmatory interviews based on Andersen et al (2012) to build confidence in the model structure.

Group Model Building could also be used in future work to incorporate the cross-disciplinary aspects that this research may have missed out due to the disciplinary nature of the literature used to build the model, as well as the disciplinary nature of the experts that would be

interviewed if the first methodological critique was overcome. It will allow the participants to co-create the system structure together, filling in such gaps. For this research, however, being a stepping stone for System Dynamics in the issue of inequality dynamics, and the fact that the author was based in Switzerland-The Netherlands for the duration of the thesis semester, it was exceptionally difficult to arrange for a GMB session with US experts in the respective fields, and simultaneously interested in inequality dynamics.

Following the formal validation of the structure built in this study with experts in economics, political science, and tax law, as it is certainly expected enrich the model with additional, as well as alternative structure, the author recommends formal calibration of the model to fit with historical data for the US. After calibration, behaviour pattern tests in Barlas (1996), Senge & Forrester (1980) and Sterman (1984) may be conducted to complete the tests of formal model validation.

8.4. Final words

Research on the issue is useful to inform the heated debate on the implications of having an unfettered influence of money in politics, versus limiting such influence and risking infringement on constitutional rights. It is not merely an ethical, legal, economic, or a political issue. It is all at the same time, in both its causes and consequences. Despite the rather disturbing findings of this research, it merely echoes equally disturbing findings that have accumulated over the past few decades on income and political inequality. The author is hopeful that change is coming, and believes that it will be ushered in by the idealists-turned-interventionists of the world they seek to shape.

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9. References

1. Agnone, J. (2007). Amplifying public opinion: The policy impact of the US environmental movement. *Social Forces*, 85(4), 1593-1620.
2. Alvaredo, F., Chancel, L., Piketty, T., Saez, E., & Zucman, G. (Eds.). (2018). *World inequality report 2018*. Belknap Press.
3. American Political Science Association Task Force on Inequality and American Democracy . (2004). *American democracy in an age of rising inequality* . Washington , DC : American Political Science Association .
4. Ansolabehere, S., De Figueiredo, J. M., & Snyder Jr, J. M. (2003). Why is there so little money in US politics?. *Journal of Economic perspectives*, 17(1), 105-130.
5. Ansolabehere, S., De Figueiredo, J. M., & Snyder Jr, J. M. (2003). Why is there so little money in US politics?. *Journal of Economic perspectives*, 17(1), 105-130.
6. Axelrod, R. (1997). Advancing the art of simulation in the social sciences. In *Simulating social phenomena* (pp. 21-40). Springer, Berlin, Heidelberg.
7. Barlas, Y. (1996). Formal aspects of model validity and validation in system dynamics. *System Dynamics Review: The Journal of the System Dynamics Society*, 12(3), 183-210.
8. Campbell, A. L. (2010). The Public's Role in Winner-Take-All Politics. *Politics & Society*, 38(2), 227-232.
9. Carnes, N., & Lupu, N. (2016). Do voters dislike working-class candidates? Voter biases and the descriptive underrepresentation of the working class. *American Political Science Review*, 110(4), 832-844.
10. Center for Responsive Politics. (2018). Did Money Win? [Web page]. Retrieved August 2, 2019, from <https://www.opensecrets.org/elections-overview/did-money-win>
11. Center for Responsive Politics. (2019a). Lobbying Database [Webpage]. Retrieved August 2, 2019, from <https://www.opensecrets.org/lobby/>
12. Center for Responsive Politics. (2019b). Lobbying: Ranked Sectors [Webpage]. Retrieved August 2, 2019, from <https://www.opensecrets.org/lobby/top.php?showYear=2018&indexType=c>
13. Center for Responsive Politics. (2019c). New York District 14 2018 Race. [Web page]. Retrieved August 3, from <https://www.opensecrets.org/races/candidates?cycle=2018&id=NY14&spec=N>
14. CFI: Campaign Finance institute. (2018). Historical stats [Webpage]. Retrieved August 5, 2019, from <http://www.cfinst.org/data/historicalStats.aspx>
15. Coyle, G. (2000). Qualitative and quantitative modelling in system dynamics: some research questions. *System Dynamics Review: The Journal of the System Dynamics Society*, 16(3), 225-244.
16. De Figueiredo, J. M., & Richter, B. K. (2014). Advancing the empirical research on lobbying. *Annual review of political science*, 17, 163-185.
17. de Gooyert, V. (2019). Developing dynamic organizational theories; three system dynamics based research strategies. *Quality & Quantity*, 53(2), 653-666.
18. de Gooyert, V., & Größler, A. (2018). On the differences between theoretical and applied system dynamics modeling. *System Dynamics Review*, 34(4), 575-583.
19. Denscombe, M. (2007). *The good research guide for small-scale social projects*. Maidenhead, England: McGraw Hill.
20. Denscombe, M. (2012). *Research proposals: A practical guide: A practical guide*. McGraw-Hill Education (UK).
21. Ferejohn, John (2009). Is inequality a threat to democracy? In Jacobs, L., King, D., & King, D. S. (Eds.), *The Unsustainable American State* (pp. 34 – 60). Oxford University Press.
22. Ferguson, Thomas and Jorgensen, Paul and Chen, Jie, *How Money Drives US Congressional Elections* (August 1, 2016). Institute for New Economic Thinking Working Paper Series No. 48. Available at SSRN: <https://ssrn.com/abstract=2817705> or <http://dx.doi.org/10.2139/ssrn.2817705>

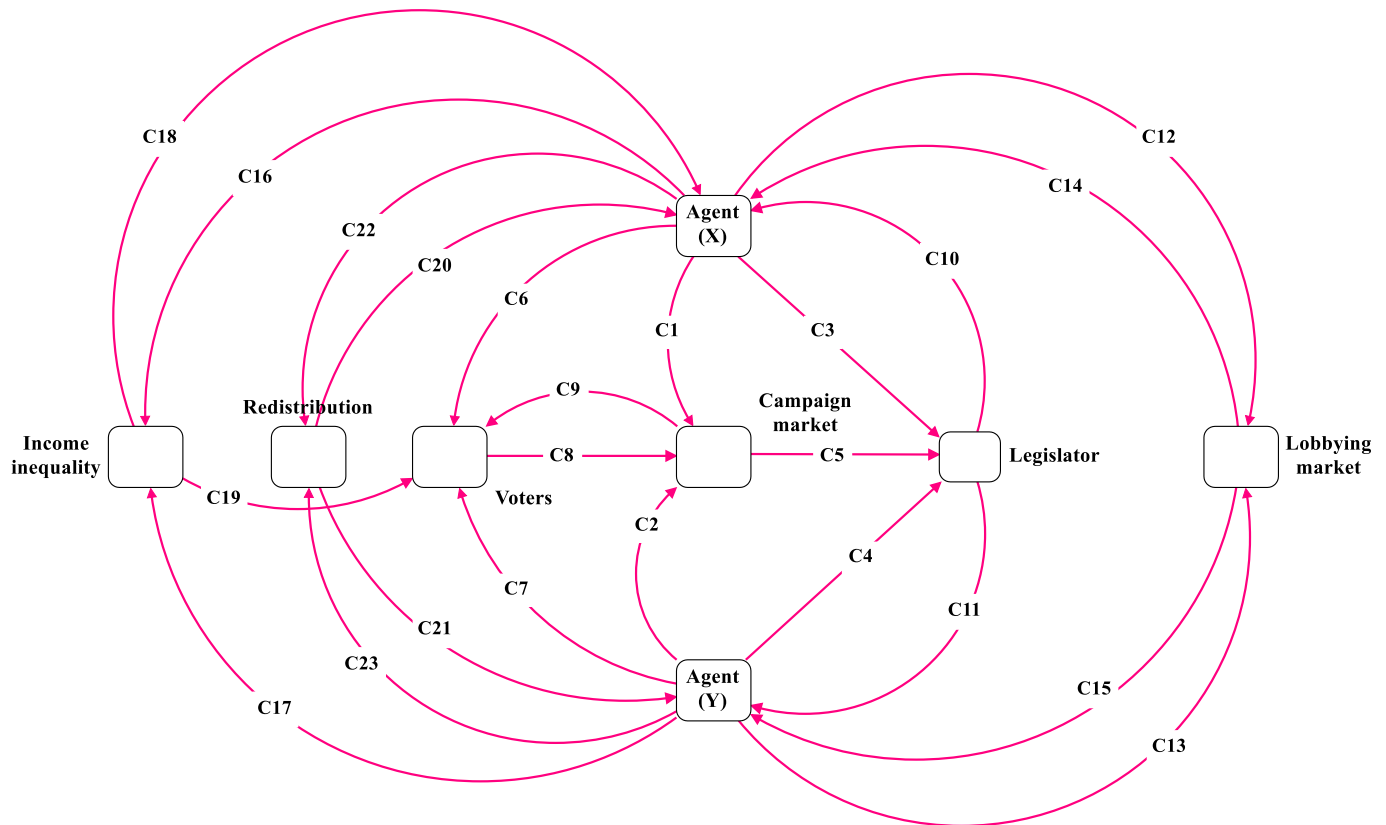
23. Flavin, P. (2015). *Lobbying Regulations and Political Equality in the American States*. *American Politics Research*, 43(2), 304–326. <https://doi.org/10.1177/1532673X14545210>
24. Forrester, J. (1958) *Industrial Dynamics – a Major Break Through for Decision-Makers*. *Harvard Business Review* 36 (4) 37-66.
25. Forrester, J. W. (1992). *Policies, decisions and information sources for modeling*. *European Journal of Operational Research*, 59(1), 42-63.
26. Forster, M., Levy, H. (2014) *United States: tackling high inequalities creating opportunities for all*. Organisation for Economic Co-operation and Development (OECD). Division SP. Paris. France.
27. Freeman, R. B. (2003). *What, me vote?* (No. w9896). National Bureau of Economic Research.
28. Fuentes-Nieva, R., & Galasso, N. (2014). *Working for the Few: Political capture and economic inequality*. Oxfam. Oxford. UK.
29. Fuentes-Nieva, R., & Galasso, V. N. (2014). *Working For the Few: Political Capture and Economic Inequality* (No. 54984). University Library of Munich, Germany.
30. Gallup. (2016). *Taxes* [Web page]. Retrieved June 20, 2019, from <https://news.gallup.com/poll/1714/taxes.aspx>
31. Gerken, H. K., & Tausanovitch, A. (2014). *A public finance model for lobbying: Lobbying, campaign finance, and the privatization of democracy*. *Election Law Journal*, 13(1), 75-90.
32. Gilens, M. (2005). *Inequality and democratic responsiveness*. *Public Opinion Quarterly*, 69(5), 778-796.
33. Gilens, M., & Page, B. I. (2014). *Testing theories of American politics: Elites, interest groups, and average citizens*. *Perspectives on politics*, 12(3), 564-581.
34. Giugni, M. (2007). *Useless protest? A time-series analysis of the policy outcomes of ecology, antinuclear, and peace movements in the United States, 1977-1995*. *Mobilization: An International Quarterly*, 12(1), 53-77.
35. Gooyert, V. D. (2016). *Nothing so practical as a good theory; Five ways to use system dynamics for theoretical contributions*. In *Proceedings of the 34th International Conference of the System Dynamics Society*. Delft:[Sn].
36. Gordon, S. C., Hafer, C., & Landa, D. (2007). *Consumption or investment? On motivations for political giving*. *The Journal of Politics*, 69(4), 1057-1072.
37. Hacker, J. S., & Pierson, P. (2010). *Winner-take-all politics: Public policy, political organization, and the precipitous rise of top incomes in the United States*. *Politics & Society*, 38(2), 152-204.
38. Hall, A. B. (2016). *Systemic effects of campaign spending: evidence from corporate contribution bans in us state legislatures*. *Political Science Research and Methods*, 4(2), 343-359.
39. Hall, R. L., & Deardorff, A. V. (2006). *Lobbying as legislative subsidy*. *American Political Science Review*, 100(1), 69-84.
40. Hall, R. L., & Miler, K. C. (2008). *What happens after the alarm? Interest group subsidies to legislative overseers*. *The Journal of Politics*, 70(4), 990-1005.
41. Huddy, L., Sears, D., Levy, J., & Chong, D. (2013-09-04). *Degrees of Rationality in Politics*. In *The Oxford Handbook of Political Psychology*. : Oxford University Press. Retrieved 2 Aug. 2019, from <https://www.oxfordhandbooks.com/view/10.1093/oxfordhb/9780199760107.001.0001/oxfordhb-9780199760107-e-004>.
42. Issacharoff, S. (2010). *On political corruption*. *Harv. L. Rev.*, 124, 118.
43. Issacharoff, S., & Karlan, P. S. (1998). *Hydraulics of campaign finance reform*. *Tex. L. Rev.*, 77, 1705.
44. Kalla, J. L., & Broockman, D. E. (2016). *Campaign contributions facilitate access to congressional officials: A randomized field experiment*. *American Journal of Political Science*, 60(3), 545-558.
45. Lessig, L. (2011). *Republic, lost: How money corrupts Congress--and a plan to stop it*. Hachette UK.
46. Levy, F., & Temin, P. (2007). *"Inequality and Institutions in 20th Century America," NBER Working Papers 13106*, National Bureau of Economic Research, Inc. Cambridge, MA

47. Marble, William and Lee, Nathan, *Why Not Run? Assessing Disincentives to Office-Seeking* (April 4, 2018). Available at SSRN: <http://dx.doi.org/10.2139/ssrn.3165193>
48. Milberg, W., & Winkler, D. (2009). *Financialisation and the dynamics of offshoring in the USA*. *Cambridge Journal of Economics*, 34(2), 275-293.
49. Moxnes, E. (2009). *Presidential address Albuquerque 2009: Diffusion of System Dynamics*. Retrieved from System Dynamics Society Website: <https://www.systemdynamics.org/assets/conferences/2009/proceed/papers/P1449.pdf>
50. Munro, André. (2018). *Campaign finance*. Encyclopaedia Britannica. Encyclopaedia Britannica, inc. Retrieved on July 31, 2019, from <https://www.britannica.com/topic/campaign-finance>
51. New York City Campaign Finance Board. (2019). Alexandria Ocasio-Cortez. [Web page]. Retrieved August 3, from <https://www.nycfb.info/nyc-votes/vgwelcome/congressional-primary-2018/meet-the-candidates/congressional-district-14-democratic/alexandria-ocasio-cortez/>
52. Olzak, S., Soule, S. A., Coddou, M., & Muñoz, J. (2016). *Friends or foes? How social movement allies affect the passage of legislation in the US congress*. *Mobilization: An International Quarterly*, 21(2), 213-230.
53. Organisation for Economic Co-operation and Development (OECD). (2011). *Divided we stand: Why inequality keeps rising*. Paris: OECD publishing.
54. Orlitzky, Marc. (2018). *Free market*. Encyclopaedia Britannica. Encyclopaedia Britannica, inc. Retrieved August 3, from <https://www.britannica.com/topic/free-market>
55. Page, B. I., & Jacobs, L. *Economic inequality and the American public*. In Jacobs, L., King, D., & King, D. S. (Eds.). (2009). *The Unsustainable American State*. Oxford University Press.
56. Piketty, T., Saez, E., & Zucman, G. (2018). *Distributional National Accounts: Methods and Estimates for the United States*. *The Quarterly Journal of Economics*, 133(2), 553-609.
57. Rawls J. 1999. *A Theory of Justice*. Cambridge, MA: Belknap Press of Harvard Univ. Press. Rev. ed.
58. Richardson, G. P. (2011). *Reflections on the foundations of system dynamics*. *System Dynamics Review*, 27(3), 219-243.
59. Richter, B. K., Samphantharak, K., & Timmons, J. F. (2009). *Lobbying and taxes*. *American Journal of Political Science*, 53(4), 893-909.
60. Saez, E. and Zucman, G. (2016). *Wealth Inequality in the United States since 1913: Evidence from Capitalized Income Tax Data*. *The Quarterly Journal of Economics*, 131(2):519-578.
61. Saez, E., & Zucman, G. (2016). *Wealth inequality in the United States since 1913: Evidence from capitalized income tax data*. *The Quarterly Journal of Economics*, 131(2), 519-578.
62. Saunders, Mark & Lewis, Philip & Thornhill, Adrian & Bristow, Alex. (2019). *"Research Methods for Business Students"*. England: Pearson Education Limited.
63. Schwaninger M., Hamann T.K. (2005) *Theory-Building with System Dynamics: Principles and Practices*. In: Moreno Díaz R., Pichler F., Quesada Arencibia A. (eds) *Computer Aided Systems Theory – EUROCAST 2005*. EUROCAST 2005. *Lecture Notes in Computer Science*, vol 3643. Springer, Berlin, Heidelberg
64. Peter, S. (1990). *The fifth discipline. The Art & Practice of Learning Organization*. Doubleday Currence, New York.
65. Senge, P. M., & Forrester, J. W. (1980). *Tests for building confidence in system dynamics models*. *System dynamics, TIMS studies in management sciences*, 14, 209- 228.
66. Solt, F. (2008). *Economic inequality and democratic political engagement*. *American Journal of Political Science*, 52(1), 48-60.
67. Solt, F. (2010). *Does economic inequality depress electoral participation? Testing the Schattschneider hypothesis*. *Political Behavior*, 32(2), 285-301.
68. Soss, J., & Jacobs, L. R. (2009). *The place of inequality: Non-participation in the American polity*. *Political Science Quarterly*, 124(1), 95-125.
69. St. Louis Fed (2019). *Personal saving as a percentage of disposable personal income* [Webpage]. Accessed Aug 3, 2019, from <https://fred.stlouisfed.org/series/A072RC1Q156SBEA>

70. Sterman, J. D. (1984). *Appropriate summary statistics for evaluating the historical fit of system dynamics models*. *Dynamica*, 10(2), 51-66.
71. Sterman, J. D. (2000) *Business dynamics: systems thinking and modeling for a complex world*. Boston: Irwin/McGraw-Hill.
72. Sterman, J. D. (2002). *All models are wrong: reflections on becoming a systems scientist*. *System Dynamics Review: The Journal of the System Dynamics Society*, 18(4), 501-531.
73. Stratmann, T. (2005). *Some talk: Money in politics. A (partial) review of the literature*. In *Policy challenges and political responses* (pp. 135-156). Springer, Boston, MA.
74. The Brookings Institution. (2019). *Vital Statistics on Congress: Data on the U.S. Congress, Updated March 2019* [Webpage]. Retrieved August 1, 2019, from <https://www.brookings.edu/multi-chapter-report/vital-statistics-on-congress/>
75. U.S. Department of The Treasury. (2010). *Writing and Enacting Tax Legislation* [Web page]. Retrieved June 25, 2019, from <https://www.treasury.gov/resource-center/faqs/Taxes/Pages/writing.aspx>.
76. United States Department of Labor: Bureau of Labor Statistics. (n.d.). *Labor Force Statistics from the Current Population Survey: Access to Historical Data for the Tables of the Union Membership News Release* [Web Portal]. Retrieved July 10, 2019, from <https://www.bls.gov/cps/cpslutabs.htm>.
77. United States Senate. (n.d.). *Direct Election of Senators* [Web page]. Retrieved July 2, 2019, from https://www.senate.gov/artandhistory/history/common/briefing/Direct_Election_Senators.htm
78. United States Senate. (n.d.). *Lobbying Disclosure Act of 1995: Definitions* [Web page]. Retrieved July 2, 2019, from https://www.senate.gov/legislative/Lobbying/Lobby_Disclosure_Act/3_Definitions.htm
79. World Inequality Database. (n.d.) USA [Webpage]. Retrieved July 15, 2019, from <https://wid.world/country/usa/>
80. Yamaguchi, K. (2012). *On the Monetary and Financial Stability under A Public Money System*. In *30th International Conference of the System Dynamics Society*, St. Gallen.
81. Yamaguchi, K. (2019). *Money and Macroeconomic Dynamics - Accounting System Dynamics Approach -*. 4th ed. Awaji Island, Japan: Japan Future Research Center.

APPENDICES

10. Appendix 1: Overview of model sectors



The figure above represents the 8 sectors of the model representing two agents, ‘Agent (X)’ are the top 10% income earners of US population, while ‘Agent (Y)’ represents the bottom 90% of the income distribution. The first table (Chapter 10.1) below gives an overview of each sector. The second table (Chapter 10.2) explains the connections between sectors.

10.1. Overview of sectors

Model sector	Overview
Agent (X)	Represents the top 10% earners in the US. They receive a market income, exogenous in this model, and contribute to political campaigns as well as spend money on lobbying. They have a tax rate as a goal and pursue such goal. The actual tax rate that applies to them influences their disposable income.
Agent (Y)	Represents the bottom 90% earners in the US. They receive a market income, exogenous in this model, and contribute to political campaigns as well as spend money on lobbying. They have a tax rate as a goal and pursue such goal. The actual tax rate that applies to them influences their disposable income.

Campaign Market	Campaign contributions by both agents flow into the market mechanism of campaigns. The money flow into the market represents demand for votes which, according to a market price, yields each agent a number of votes. It is assumed that votes won by the candidates funded by an agent are proportional to the total campaign contributions spent by such agent.
Voters	A simple population model that constitutes the supply of votes to the campaign market. It is influenced by the demographic dynamics specific to the US, income inequality, and the campaign market, in that increases in the demand for votes, for a given supply, increases in efforts to 'Get Out The Vote' (GOTV).
Legislator	Legislator seats in the US Senate. Senate elections are held every 2 years, whereby a third of all senator positions are subject to elections. They are classified based on their affiliations, as either belonging to Agent (X) or Agent (Y), and thus are labelled as 'Legislator (X)' and 'Legislator (Y)'. The seats are won based on the campaign contributions donated by each agent, subject to the changing price per vote in the campaigns market. Furthermore there is uncertainty in the ability of higher campaign funds to automatically win an election, and votes per agent are subject to such uncertainty.
Lobbying Market	Money spent on lobbying constitutes demand for lobbyists services. Such demand is balanced by a supply of qualified lobbyists who recruit over a period of years to respond to changes in the demand. The higher the demand, compared to supply, the higher the price gets, which triggers an expansion in the lobbying industry through higher recruitment. Lobbying has an effect on tax policy, and thus the income of the two agents.
Income Inequality	This is a rough calculation of income inequality in the US, represented in the GINI coefficient, which compares the distribution of incomes between the two agents.
Redistribution	Tax revenue collected by the government can be spent on transfers, amongst other projects such as defence and infrastructure. The higher the transfers, the more income Agent (Y) would receive, and thus the lower income inequality is.

10.2. Overview of connections

Connection	Overview
C1	Campaign contributions by Agent (X)/ Agent (Y) feed into the ‘Campaign market’ as demand for votes via political campaigns. The supply – demand balance of votes has an effect on the price per vote, which is a measure of the total campaign contributions spent at any point in time, elections in continuous time rather than discrete, over the number of votes that participated in the election.
C2	
C3	Number of votes gained by the candidates funded by Agent (X)/ Agent (Y) is proportional to the campaign contributions spent by Agent (X)/ Agent (Y) divided by the market price per vote, subject to a measure of uncertainty (as outspending an opponent does not guarantee winning 100% of the time).
C4	
C5	Votes gained by an agent’s candidates for a given campaign contribution in a given year are inversely proportional to the price per vote. To clarify this concept: imagine if every year less and less people were willing to vote. This will shrink supply, resulting in an upward pressure on the price per vote for a given total amount of campaign contributions.
C6	Total campaign contributions divided by the perceived price per vote is the demand for votes. This demand is the number of votes an agent expects to gain as a consequence of their spending on campaigns. (note that perceived price is a smoothed price per vote). Some voters are intrinsically interested in politics and are referred to as ‘self-motivated voters’. The campaign effort may be to convince those intrinsically motivated voters, but mainly to Get Out The Vote (GOTV), which means mobilize the citizens to go out and vote. If C9 and C20, the effect of campaign innovation, and the effect of income inequality on getting-out-the-vote respectively, were non-existent the number of voters mobilized as a result of campaigning will equal demand for votes exactly.
C7	
C8	Vote supply feeds into the supply-demand balance named “aggregate campaign effectiveness”, which adjusts the price per vote in the ‘Campaign market’. If supply exceeded demand, there will be a downward pressure on price. If demand exceeded supply, there will be an upward pressure on price.

C9	<p>When price increases due to scarcity (demand exceeds supply), new innovative means would emerge to attract more voters, such as social media campaigns, expensive media consultants and companies.</p> <p>“[...] Money is the oxygen of today’s elections, given the reliance of candidates on high-priced consultants and expensive media advertisements.” (TFAID, 2004, p12).</p> <p>Thus, increasing price has a positive effect on GOTV supply.</p>
C10	<p>The candidates who share the worldview of Agent (X)/ Agent (Y) are part of what Hall and Deardorff (2006) coined as a “Legislative enterprise”. An agent’s legislative enterprise is the product of both number of seats of sympathetic legislators who share the agent’s worldview, and the lobbying carried out by the agent who funded the legislator’s campaigns (<i>please refer to C12 & C13</i>). This is what Hall & Deardorff (2006) referred to as ‘Legislative subsidy’. If there were no legislators funded into office by an agent, then they would have no legislative enterprise.</p>
C11	
C12	<p>Agents lobby the legislators who share their worldview, expending money to provide research, analyses, political intelligence that would reinforce a legislator’s ability to influence the agenda and votes to achieve her goals (Hall & Deardorff, 2006). All the aforementioned services may be conducted by professionals. Since many lobbyists are lawyers who are charged by the hour, the unit chosen for lobbying price is lobbyist-hour. If agents spent more on lobbying, the price of a lobbyist hour would increase, as demand for lobbying would increase. Demand for votes is equal to total lobbying spending divided by perceived price per lobbyist hour. Furthermore, if price of lobbyist hour increased this would lead to an increase in recruitment of lobbyists and an expansion in the industry (supply response to increase in demand).</p>
C13	
C14	<p>Besides number of legislators an agent has in office, the second aspect of an agent’s ‘legislative enterprise’ is the ‘legislative subsidy’ mentioned in C12 & C13. The two legislative enterprises compete to determine the tax rate for each agent. The agent with a higher legislative enterprise gets to dictate their desired tax rate in the form of a weighted average (<i>Please refer to Chapters 4.3.4 & Chapter 12.3 for more details on Agent competition</i>). The value of an agent’s legislative enterprise is equal to the number of seats representing an agent, multiplied by the agent’s lobbying spending divided by the lobbyist price per</p>
C15	

	hour. A higher price of lobbyist hour decreases an agent's legislative enterprise for a fixed amount of lobbyist spending.
C16	The incomes of the two agents feed into the calculation of GINI coefficient, the measure of income inequality. In the sector "income inequality" there are two GINI indices, the first being market inequality which is the distribution of incomes in a population before taxes and transfers. The second GINI index captures net inequality after taxes and transfers. The higher tax revenue the government collects, and the higher the government decides to allocated for transfers, or social spending, the lower new inequality is.
C17	
C18	Income inequality has an effect on the ability of Agent (X) to reduce taxes. Inequality causes public outcry, and the public exerts pressure on the legislators, who are accountable to their voters, to delay or to dilute their intended efforts to reduce taxes. Thus the legislator acts more slowly under conditions of high public outcry.
C19	Income inequality has a negative impact on voting. A more unequal population is less involved in politics and the political process. When income inequality increases, the supply of voters is reduced despite efforts by legislator candidates running for office to GOTV.
C20	Based on the tax rates and the incomes of the full population, the government tax revenue is collected. The higher the revenues, the more will be spending on redistribution through transfers for example, for a given redistribution fraction of total revenue. Increased transfers result in higher disposable income for Agents (X) and (Y).
C21	
C22	Tax rates of the two agents feed into government tax revenues. When received, the government allocates money for redistribution.
C23	

11. Appendix 2: Model assumptions

Assumption	Notes
1. Agents are rational	<p>Applying the rules of the marketplace in the arena of politics is the realm of public choice economics or public choice theory. It began mid-twentieth century with the aim of conceptualizing positive theories of government rather than idealizing behaviour, in the marketplace, as is with traditional economics.</p> <p>Rational agents pursue the goals that would increase their utility, assumed in this model to be higher incomes, and thus would desire less taxes. No agent would have a tax goal that exceeds its current tax rate.</p> <p>As early as Downs (1957), in his “An economic theory of political action in a democracy”, based on the rational choice theory where agents have been modelled as self-interested utility maximizers (Huddy, Levy, & Chong, 2013).</p>
2. Agents are heterogeneous	<p>The political behaviour of the top 10% is different from the bottom 90%, in that higher income earners tend to spend more on political contributions have the ability to better organize and allocate funds to politicians (TFAID, 2004), overcoming the free-rider problem more efficiently, and thus could invest in politics more effectively.</p> <p>Quoting Gilens & Page (2014) on the free rider problem:</p> <p>“[...] Collective action by large, dispersed sets of individuals with individually small but collectively large interests tends to be prevented by the “free rider” problem [...] individuals who would benefit from collective action may have no incentive to personally form or join an organized group. If everyone thinks this way and lets George do it, the job is not likely to get done.” (p567).</p> <p>And to quote the TFIAD (2004),</p> <p>“[...] Put simply, the already privileged are better organized through occupational associations than the less privileged.” (p9)</p>

Furthermore, the more wealthy are more willing to give campaign contributions especially with mounting costs of campaigns,

“[...] Campaign contributors are the least representative group of citizens. Only 12 percent of American households had incomes over \$100,000 in 2000, but a whopping 95 percent of the donors who made substantial contributions were in these wealthiest households [...] 56 percent of those with incomes of \$75,000 and more reported making some form of campaign contribution compared with a mere 6 percent among Americans with incomes under \$15,000” (TFAID, 2004, p7)

In terms of political donations and activity, income level affects behaviour too.

“[...] the most obvious source of influence over policy that distinguishes high-income Americans is money and the willingness to donate to parties, candidates, and interest organizations [...] not only the propensity to donate but also the size of donations increase with income level” (Gilens, 2005, p794)

In their article receiving more than 1200 citations on Google Scholar, Ansolabehere, Figueiredo & Snyder (2003) arguing that individual contributors donating small amounts are the engine of campaign contributions, emphasize on the income-dependence of such donations,

“[...] Indeed, survey researchers in political science and sociology have documented that income is by far the strongest predictor of giving to political campaigns and organizations.” (Ansolabehere, de Figueiredo & Snyder, 2003, 118)

Bonica et al (2013) also noted that the top 0.01% income earners capture around 5% of total US income, but contributed 40% of all campaign contributions given to politicians in the year 2012 (from less than 20% in 1980),

“Campaign contributions by individuals have grown over time, with 3,138,564 individuals making itemized contributions in 2012 compared to 224,322 in 1980. But this increased participation has also been marked by increased inequality in contributions. [...] the share of total income received by the top 0.01 percent of households is about 5 percent but that the share of campaign contributions made by the top 0.01 percent of the voting age population is now [2012] over 40 percent” (Bonica et al, 2013, p111)

	<p>Furthermore, Gilens (2005) argued that high income Americans have a higher propensity to donate and donate substantially larger amounts as we ascend the income distribution, which reflects different patterns of consumption or investment across the population.</p>
<p>3. Winning elections is proportional to campaign expenditure</p>	<p>Based on Ferguson, Jorgensten & Chen (2016) and Hall (2016), there is a proportionality between campaign expenditure and winning elections. This is due to the mass mobilization and advertisement efforts that could Get Out The Vote on election day. Of course it is not a purely deterministic process and there is uncertainty in money translating to votes. The Center for Responsive Politics, a research group dedicated to tracking the effect of money on US electoral, and policy outcomes, cite that since the year 2000 (the earliest they have data) the highest spenders have an average winning probability of 92.6% in the house of representatives, and 81.2% chance of winning in US senate races (Center for Responsive Politics, 2018).</p> <p>To quote Ferguson, Jorgensten & Chen (2016),</p> <p>“[...] spending by major political parties is indeed, at first sight, strongly related to the proportion of votes they win and has been for as long as we have data. We consider this finding, in its own right, to be a significant result. If the pattern had been noticed a generation ago, discussions of politics and money might have taken a different turn. (p16).</p> <p>Hall (2016) argued that money is salient because of the enormous amount of time politicians dedicate to fundraising. Lessig (2011) noted that politicians spend from 30% to 70% of their time in office fundraising.</p> <p>“[the] positive effect of spending on elections should be unsurprising, given two well-known empirical facts about elections. First, candidates devote an enormous amount of effort to fundraising. [...] Although it is possible that this behavior is the result of a systematic misperception among political operatives, a more likely explanation is that candidates and campaigners believe, correctly, that campaign funds help them improve their electoral fortunes [outcomes]. The second fact reinforces the views of those participating in political campaigns. A large literature in political science documents directly how “Get Out the Vote” (GOTV) efforts can increase turnout [...] By spending money on turnout efforts among targeted populations, campaigns can convert money into votes. Advertising, too, can be used for similar purposes.” (Hall, 2016, p354)</p>

<p>4. Campaign contributions are made on a consumption basis</p>	<p>This is a prudent assumption. The debate on whether donors give money to politicians for ideological consumption (Ansolabehere, de Figueiredo & Snyder, 2003), or as an investment (Stratmann, 2005) to gain access to politicians with the intention of profiteering, is unresolved. For the purposes of this model, the author assumed that all campaign contributions are made to stem from ideological consumption motives, thus assuming the most benign motives in political spending.</p> <p>It has been proven empirically that more affluent supply disproportionately large portions of all campaign contributions in the US, as noted in assumption 2 ‘agents are heterogenous’.</p>
<p>5. Legislature campaigns are a free market subject to the forces of demand and supply</p>	<p>Due to failed attempts to enforce campaign finance regulation by the Federal Elections Commission, with the US Supreme Court striking down attempts at regulation justifying that political spending is a form of free speech guaranteed by the First Amendment of the US Constitution (Dawood, 2015), it is assumed that unfettered money flowing into political campaigns is a deregulated/ liberalized industry, or a free market as the definition of liberalization is as quoted from the Encyclopaedia Britannica,</p> <p style="padding-left: 40px;">“[...] Liberalization is often treated as synonymous with deregulation—that is, the removal of state restrictions on business [...] in practice both terms are generally used to refer to the freeing of markets from state intervention.” (Smith, 2013)</p> <p>Issacharoff (2010) argued that a potential corruption of the political elections system is through the flow of large amounts of money from a highly concentrated group, capturing the marketplace of political ideas,</p> <p>Moreover, Dawood (2015) pointed out to the reliance on private sector for campaign contributions in the US legislative elections,</p> <p style="padding-left: 40px;">“An important feature of the electoral process in the United States is that political parties and candidates are largely dependent on private donations to fund their campaigns. These campaign contributions are made by individuals, corporations, and special interests. In addition to donating to political campaigns, private individuals and groups can also spend money to support or oppose a candidate or political party by, for example, purchasing political advertising.” (p330)</p>
<p>6. Lobbying expenditures are made on an</p>	<p>Regarding tax policy, given assumption 1, ‘Agents are rational’, the agents are lobbying in order to pay less taxes. This means that there is an intended policy objective to which each agents expends lobbying money, in order to increase the chances of implementing such policy. This is best explained by the quote below,</p>

investment basis	<p>“The difference between consumption - and investment - oriented political expenditures comes down to the following: expenditures in the former category are never expected to yield pecuniary returns for the donor, whereas those in the latter may do so under certain conditions. Any account of contributor behavior seeking to reaffirm an investment motivation must, given rational expectations, proceed on the premise that contributors are getting something in return for their money.” (Gordon, Hafer & Landa, 2007, p1058)</p> <p>By definition, lobbying is an attempt to influence a government official, in order to influence policy through legislation, regulation, policy, among other aspects of government (United States Senate(b), 2019).</p> <p>Thus any money expended to reduce taxes by influencing the legislator, yields a monetary return for the individual or group expending it. It is thus may be modelled as investment. This is best described via the words of Richter, Samphantharak & Timmons (2009) in their study on corporate political expenditures,</p> <p>“[...] firms with higher lobbying expenditures in one year pay lower effective tax rates in the following year; we did not find that all firms that lobby obtain tax benefits. These findings are consistent with a view of tax lobbying that is both opportunistic and defensive [...] Corporations have many ways they can spend money to attempt to influence politics. We do not find it surprising that they spend the most money on lobbying since it has a quantifiable payoff in at least one important area, taxes.” (p907)</p> <p>It is worth noting here that no distinction is made by the author between corporations and high earning individuals because modern business firms in the US are hierarchal organizations where corporate strategy, including political expenditure, is decided at the board level, composed of wealthy individuals at the top of the income distribution. The corporation is a means for participating in lobbying for wealthy individuals,</p> <p>“One common explanation for why affluent citizens tend to be more successful at getting their preferences translated into policy is that industries that tend to share their opinions (finance, real estate, etc.) are well represented among professional lobbyists in Washington and statehouses across the nation.” (Flavin, 2015, p305)</p>
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	<p>Figueiredo & Richter (2014) noted that around 86% of total Federal lobbying expenditure in the US is made by corporations and large trade associations.</p> <p>Moreover, Dawood (2015) noted that the US Supreme Court does not consider access to legislators and influence over policy to be considered as corruption, and are both protected under the First Amendment. Money spent in pursual of such goals is a form of free speech as well, especially by corporations.</p> <p>Finally, Hacker & Pierson (2010) argued that labour unions are the single actor concerned with the economic interests of the poor and middle class Americans, and thus lobbying by unions is the counterweight to business lobbying on economic issues.</p> <p>“It is the <i>political</i> role of organized labor on issues of economic and social policy that matters most in the political economy [...] In the American context, unions represent by far the most significant organized interest with a sustained stake in the material circumstances of those with modest means. The decline of organized labor has greatly diminished the pressure on policy makers to sustain or refurbish commitments to social provision made in the middle decades of the last century.” (Hacker & Pierson, 2010, p179-180)</p>
<p>7. Lobbying efforts operate in a free market subject to the forces of demand and supply</p>	<p>Lobbying conducted professionally by attorneys, and former politicians (Bonica et al, 2013) is a costly and technical. Hall & Deardorff’s account on lobbying is that it is not a broad-based commodity.</p> <p>“Some can afford lobbying efforts costing millions of dollars for a single lobbying campaign. Others operate on a shoestring, if they operate at all.” (Hall & Deardorff, 2006, p80)</p> <p>This means that influence through lobbying may be modelled as a commodity that some people can afford, while others cannot. Some people are interested in spending money to attain such influence while others are not. This is consistent with Flavin’s (2015) account on lobbying, pointing out that lobbying is disproportionately conducted on behalf of business interests, implying a higher willingness of such interests to lobby,</p> <p>“[...] among the most valuable assets a lobbyist can provide to state legislators and their staffs is rigorously researched information about a particular policy area. Given the resource-constrained environment [...] this information can be of great value in helping them to decide which issues to prioritize and, ultimately, how to cast their vote on pending legislation [...] a series of studies</p>

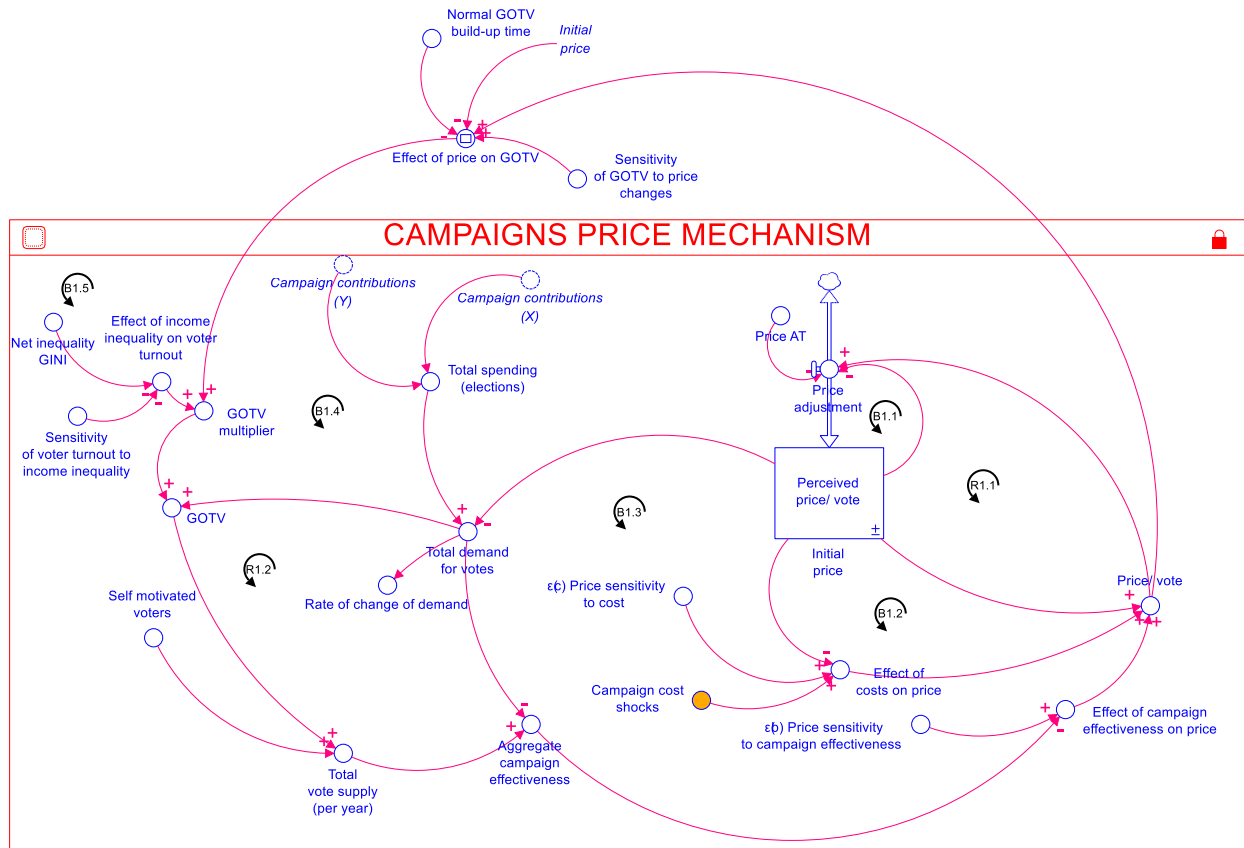
	<p>over several decades have documented the high proportion of business and other for-profit interests among lobbyists, interest organizations, and political action committees.” (p306)</p> <p>The above evidence suggest lobbyist services are expensive, and organized groups in society make decisions whether to employ their services, or forego them. It is clear that some members of society, typically the smaller more organized, and wealthier business interests tend to lobby more than the general public.</p>
8. Agents lobby those who already share their worldview	<p>Based on Hall & Deardorff (2006), ‘lobbying as a legislative subsidy’. The below aspects of their theory are observed in the model:</p> <ul style="list-style-type: none"> • Lobbyists lobby legislators who already share their policy objectives, each side lobbying its own allies not those with inapparent commitments. • Lobbyists will not lobby enemies or those who are undecided on where they stand in regards to the lobbyist’s policy objectives. • The activity of the subsidized legislator will increase, especially the strong allies. If a non-ally was lobbied they would not become more active in pursuing the lobbyist’s policy objective, but will not oppose it. • Concerning public interest groups, they have access to, and increase the participation of, their allies even though they offer no re-election assets because they offer policy information, political intelligence, and legislative assistance to the legislator. <p>The above assumptions indicate that exerting influence over legislators is not a form of coercion or convincing, rather a support to those who already share the policy positions of the group lobbying, the clients of the lobbyist.</p>
9. Policy is shaped by the legislative enterprise of active legislators	<p>Having a sympathetic legislator in office is not sufficient to yield policy outcomes preferred by a certain group,</p> <p>“[...] Groups that are better able to pay the costs of information-gathering, policy analysis, and lobbying will be advantaged in addition to whatever advantages they might accrue from better grass roots organization and more contributions to congressional campaigns.” (Hall & Deardorff, 2006, p81).</p> <p>“[...] disadvantaged citizens do not enjoy the same level of representation among professional lobbyists, and correspondingly exert less influence over the policy decisions made by elected officials.” (Flavin, 2015, 305)</p>

	<p>This means that influence is proportional not only to the number of legislators sympathetic to a certain agent or group's policy position, but also to the amount of (costly) information such agent or group are able to provide to the legislator to advance their cause.</p> <p>Moreover, lobbying has been observed to improve corporate outcomes, especially through corporate lobbying (Stratmann, 2005; Richter, Samphantharak & Timmons, 2009) Thus the ability to shape policy is not restricted to campaign contributions, but proportional to lobbying, the expenditure of which exceeds that of campaigns a multiple of times (Figueiredo & Richter, 2014).</p>
<p>10. Inequality reduces participation rates of eligible voters in legislature elections</p>	<p>There has been several theories on why less affluent Americans don't participate in politics as much as the more affluent ones. Below are some accounts on the effect of economic inequality on voting behaviour:</p> <p>“[...] The analysis confirms that participation rates fell for all groups as economic inequality rose sharply. These findings contradict the expectation, common in developmental accounts of capitalism and democracy and in historical debates over the franchise, that disadvantaged citizens will mobilize in response to rising economic inequality to press for political change and redistribution.” (Soss & Jacobs, 2009, p107-108)</p> <p>“[...] Rising economic inequality may discourage less privileged voters [...] Less advantaged Americans vote less because they lack the skills, motivation, and networks that the better advantaged pick up through formal education and occupational advancement. In addition, political parties and campaigns focus their resources on citizens who are affluent and are already active politically.” (TFAID, 2004, p7).</p> <p>Furthermore,</p> <p>“[...] Inequality in economic resources, by leading the political agenda to be dominated by the issues that divide more affluent citizens to the exclusion of those that poorer citizens would like debated, works to depress participation in elections. This process, he contended, particularly discourages participation among the poor and therefore leads to an electorate that is more biased by income [...] The high levels of income inequality found in the United States</p>

	are crucial to understanding why electoral participation is so low and so different across income groups.” (Solt, 2010, p297).
11. Public outcry delays, and dilutes policy that would increase inequality	<p>Olzak et al (2016) found that competition between mass protests and lobbyist organizations generally ended up with the lobbyists shaping policy outcomes. This suggests that the cumulative effect of inequality on public outcry would not weaken Agent (X)’s legislative enterprise, rather dilute policy outcomes under mass-public pressure.</p> <p>“Scholars from the opportunity structure perspective often claim that protests by social movement advocates are effective in determining key policy outcomes, however the empirical picture is decidedly more mixed.” (Olzak et al, 2016, p215)</p> <p>Agnone (2007) introduced an ‘Amplification model of policy impact’, whereby protests enable public opinion to dominate the policy choices of legislators due to the process of ‘rational anticipation’, where legislators wanting to get re-elected respond to salient electorate concerns. To quote the author,</p> <p>“[...] protest affects legislative action independent of public opinion as suggested by dramatic event theorists, whereas the impact of public opinion on legislative action depends on the level of protest. In other words, changes in public opinion have a greater impact on public policy when amplified by protest. [...] protest amplifies the effect of public opinion on policy gains by raising an issue’s salience for legislators. Without protest, public opinion is less likely to impact policy outcomes.” (Agnone, 2007, p1597)</p> <p>Giugni (2007) suggested that social movements succeed only when other institutional factors are favourable, and public opinion is sympathetic,</p> <p>“[...]The findings suggest that social movements can be effective in producing policy changes only when they can take advantage of favorable political opportunities and public opinion.” (Giugni, 2007, p70)</p> <p>Thus for the purposes of this model, public outcry was not modelled to reduce the L.E of Agent (X), but rather to delay the agent’s ability to enact policy.</p>

12. Appendix 3: Model structure (by sector)

12.1. Campaign price mechanism:



This sector outlines the interaction between demand for votes via campaigners, the supply of voters as a result of those campaigns, and the price (cost for politicians) per vote received by a politician.

“Perceived price/ vote” is an anchor that smooths the “Price/ vote” over a period of “Price AT” (B1.1).

“Price per vote” is anchored in “Perceived price/ vote” (R1.1) subject to 2 effects. The first is “Effect of costs on price” which responds to shocks in campaign costs let it be new technology, change in regulation that causes an increase in costs etc., or any other reason. For example, the heavy use of social media and web tools in the 2008 US Presidential election has been cited as one of the reasons Barack Obama won the race. Since this comes at a cost, it is suitable to be included in the model. The effect of these costs on price is evaluated in proportion to the “Perceived price/ vote”, the higher the perceived price is, the less of a proportion a given shock would be (B1.2). The variable “Campaign cost shocks” is measured on a per vote basis for comparison to the price. “Price sensitivity to cost” tunes the magnitude of the effect of a shock on price, less sensitivity means less change in price as a result of a cost-shock.

The second effect is that of supply/demand balance, in this case chosen as “Aggregate campaign effectiveness” which compares “Total supply of votes (per year)” of votes (“The sum of “Self-motivated

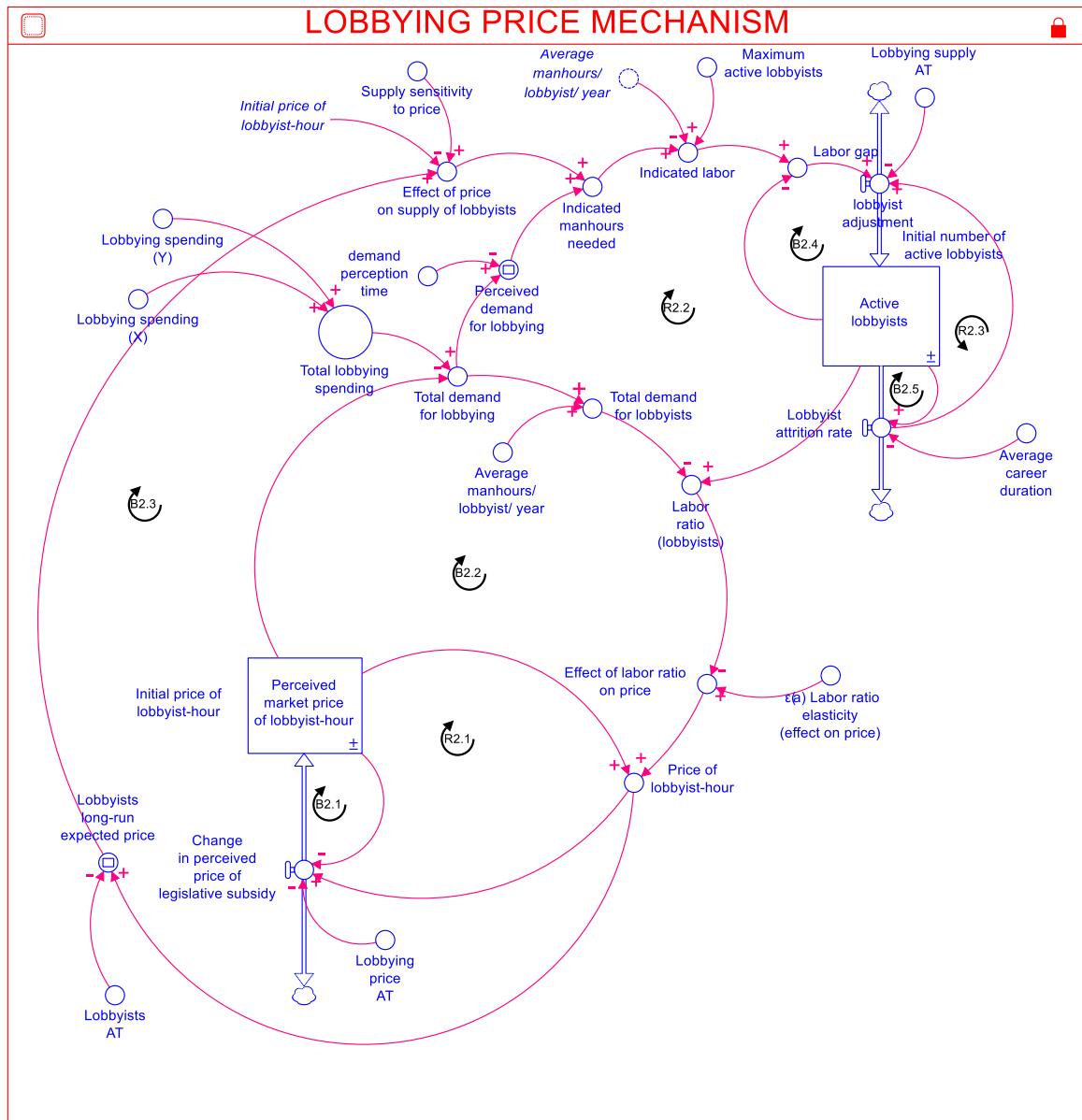
voters” and “GOTV”) to demand for votes (“Total spending (elections)” divided by the “Perceived price/ vote”). For a given supply of votes, an increase in spending causes an increase in “Total demand for votes” which would decrease the ratio between supply and demand, “Aggregate campaign effectiveness”, and result in an upward pressure on price through a higher “Effect of campaign effectiveness on price” (B1.3).

However, supply is not independent to price. The vote supply is composed of a fraction who are politically involved and intrinsically motivated to vote, and another fraction of people who are responsive to campaigns and are extrinsically motivated. There are three assumptions here: that GOTV is a function of demand for votes, yet since demand is a function of price, a higher price would result in less demand (B1.3). Thus politicians, for a given amount of campaign contributions would be satisfied with paying more and getting less votes, which is unrealistic.

An effect is missing, namely another balancing loop that justifies paying more per vote. This is (B1.4), the supply adjustment loop to close the gap represented in “Aggregate campaign effectiveness”. It is assumed that a higher price/ vote represents scarcity of votes, but also invokes strategies by candidates to GOTV, measured by a smooth of the immediate “Price/ vote” divided by “Initial price” raised to a “Sensitivity of GOTV to price changes”. It usually takes time to develop and implement a strategy leading to an election, thus “Normal GOTV build-up time” is the duration upon which the effect of higher spending materializes. Moreover, income inequality is linked to less voter turnout, thus the higher the GINI Index, the less effective campaigns will be in increasing the supply of votes, which means that increasing income inequality will result in a decreasing supply-demand balance, and an upward pressure of price/ vote in campaigns. This is represented by loop (B1.5) which suppresses attempts to increase GOTV, by reducing the effect of (B1.4).

Finally, if “Price/ vote” increased for a given campaign, demand would fall for a given level of campaign contributions. This leads to less GOTV, as it is a function of demand. This is a vicious cycle where less GOTV reduces supply, which creates scarcity through a lower “Total participation” which raises price further (R1.2).

12.2. Lobbying price mechanism:



This sector outlines the interaction between demand for lobbying by the two agents and the supply of lobbying by both qualified professionals, and lobbying institutions. It is a simple price mechanism subject to a supply/demand balance. Given that lobbying activities include several aspects (indicated by Hall & Deardorff (2006) as “legislative enterprise”) such as reports and publications requiring data that is expensive to gather, analyses by experts, as well as staff/ aides to politicians whose salaries are paid for by the organizations they represent (Hall & Deardorff, 2006; Gerken & Tausanovitch, 2014), an aggregation of such different aspects is reasonably assumed to be professional Hours. This is because lawyers, engineers, and consultants charge their services by the Hour. The unit of price is thus USD/ hour.

The price paid by the special interests of the agents is the immediate price, “Price of lobbyist-hour”. It is anchored in “perceived market price of lobbyist-hour” (R2.1) and adjusts to fluctuations in supply and demand, represented in “labor ratio”. The perceived price is a smooth of the price over a “lobbying price

AT” (B2.1). Labor ratio is supply divided by the demand for lobbyists. Supply is the stock of “active lobbyists”, while the demand is total demand for lobbying, measured in hour per year, divided by the “average manhours/ lobbyist per year”. It is a dimensionless variable since both its numerator and denominator have units of “lobbyist”. The higher the demand, the lower is the labor ratio, and the higher the supply, the higher is labor ratio.

When supply exceeds demand, there is a downward pressure on price, thus “Labor ratio” has a negative causal link with “effect of labor ratio on price”, while “labor ratio elasticity” is positive. Many modellers including Sterman (2000) use a demand/supply balance instead combined with a negative elasticity, yet the outcome is the same. It is more intuitive to use labor ratio as actual (supply) over desired (demand) as Yamaguchi (2019), such that one may track the workforce as a percentage of the desired, for example a labor ratio of 0.5 means that the workforce is half of what is needed.

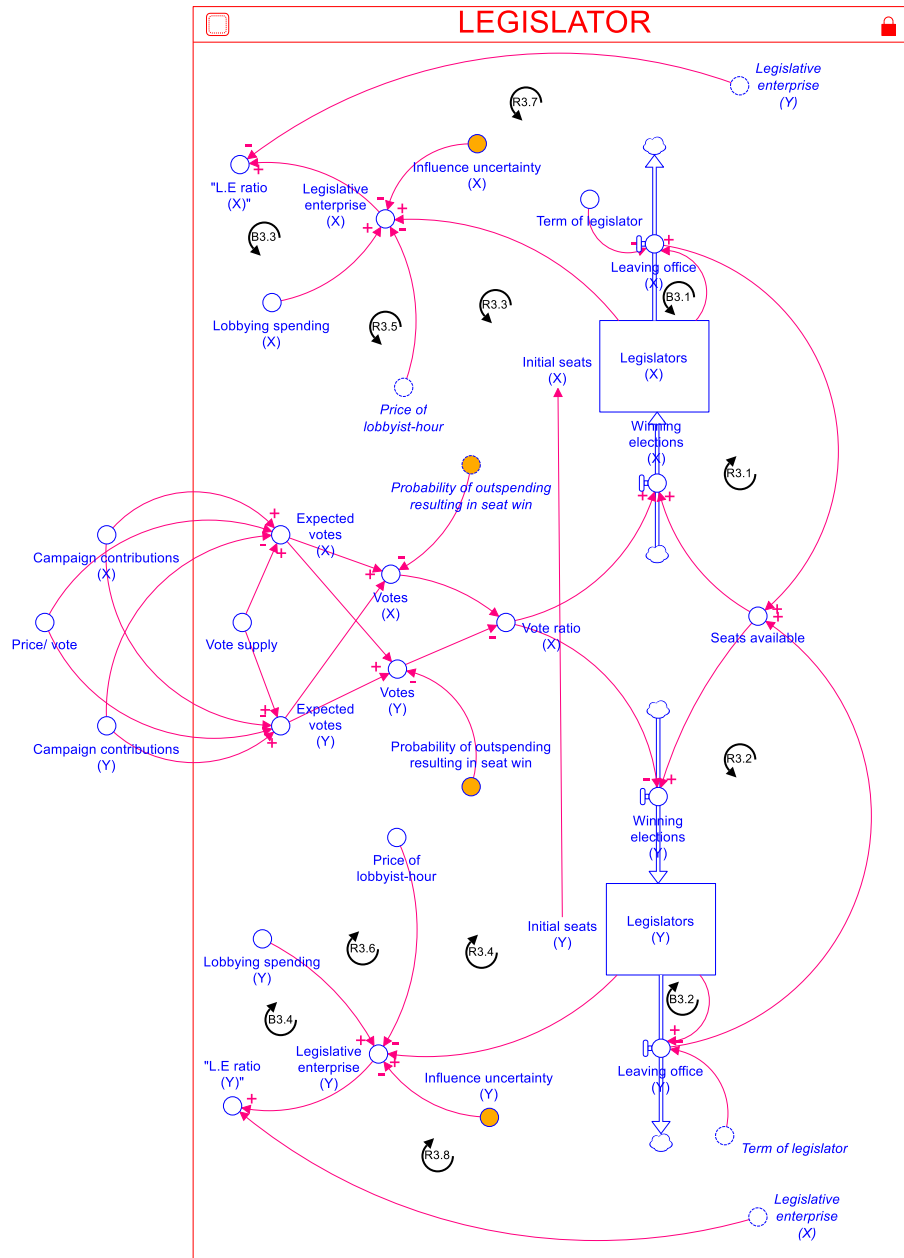
Total demand for lobbying is the total lobbying spending divided by the “perceived market price of legislative subsidy”, where total lobbying spending is the sum of spending by the two agents in the model. The higher the “total demand”, the lower “labor ratio” is, which leads to a positive pressure on price through an increase in “effect of labor ratio on price”. This increase the price, and the perceived price, which feeds back into “total demand” reducing it. This is because a higher price means that for a constant “total lobbying spending”, less hours may be purchased at the new price. An initial increase in demand results in a reduced demand hence this loop is balancing (B2.2).

The “demand for lobbying” is monitored by the lobbyists organizations, and triggers a response in the recruitment of new professionals. “Indicated manhours needed” is a function of “perceived demand for lobbying”, a smooth of “demand for lobbying” as it takes time for the industry to perceive a sustained change in demand to justify higher capacity-building through recruitment. Dividing “indicated manhours needed” by “average manhours / lobbyist/ year” yields “indicated labor” which is subject to “maximum active lobbyists”, a constraint that will be used for experimentation in this model. This represents the goal for the stock of “active lobbyists”. The higher the goal, the higher the inflow to the stock of “active lobbyists”, which increases labor ratio, which reduces the price, and hence increase demand via “total demand for lobbying”. This results in yet a higher indicated manhours needed, and a higher indicated labor. An initial increase in “indicated labor” feeds back to increase it further, thus it is a reinforcing loop (R2.2).

“Price of lobbyist-hour” is also monitored by the lobbyist organizations, and has an “effect of price on supply of lobbyists”. This effect is a function of the ratio between “lobbyists long-run expected price” and “initial price of lobbyist-hour”, multiplied by the sensitivity to price. A higher price yields a positive effect on “indicated manhours needed”, which results in a higher number of “active lobbyists”. This results in a higher supply, which leads to a reduction in market price, resulting in a reduction in “indicated manhours needed”. An initial increase in “indicated manhours needed” feeds back to reduce it, hence it is a balancing loop (B2.3).

Active lobbyists is the stock of labor workforce, and is subject to attrition, simply the stock divided by “Average career duration” (B2.4), and “lobbyist adjustment” a bi-flow which corrects the value of the stock to meet the goal “Indicated labor” (B2.5) over a “lobbying supply AT”, as well as cover for the attrition rate (R2.3).

12.3. Legislator:



The total number of legislators is fixed, as there are 100 senators, 2 for each state. The term for each legislator is 6 years, with a staggered elections pattern, rendering a third of the senate up for elections every two years. This has been converted to continuous time by getting the equivalent yearly “seats available” as a fixed $33/2 = 16.7$ seats/ year.

“Seats available” is always constant, yet the specific pattern and value of each outflow is a function of the stocks “Legislator (X)” and “Legislator (Y)”, which differs throughout the simulation, and across simulations. “Leaving office (X)” is equal to “Legislator (X)” divided by “Term of legislator” (B3.1). Similarly, “Leaving office (Y)” is equal to “Legislator (Y)” divided by the constant “Term of legislator” (B3.2).

The inflows “Winning elections” are a function of the sum of outflows “Leaving office (X)” and “Leaving for office (Y)”. The more legislators leave office from (X), the more “Seats available” there is, and the more the inflow “Winning elections (X)” (R3.1).

The same logic applies to agent (Y), leading to a higher inflow of “Winning elections (Y)” (R3.2). In summary, every year a fixed number of seats is distributed proportionally to the votes each agent has won through campaigns. The variable “Vote ratio (X)” represents how much of the votes agent (X) managed to win and thus “Winning elections (X)” is equal to “Vote ratio (X)” multiplied by “Seats available”. “Winning elections (Y)” is equal to “1-Vote ratio (X)” multiplied by “Seats available”.

Note that there will always be distortion and uncertainty in translating campaigns to votes to seats. The higher spending candidate does not always win the race and “Probability of outspending resulting in seat win” accounts for that. If outspending results in winning 80% of the time, and agent (X) outspent agent (Y), then the vote advantage of (X) is multiplied by 0.8 resulting in a reduced “Vote ratio (X)”. By default, the difference will go to agent (Y) winning more seats.

“Expected votes (X)” is the number of votes gained as a result of (X)’s campaign. It is “Campaign contributions (X)” divided by “Price/ vote”. To control for not having votes exceeding vote supply, a MIN function is introduced where the votes gained by agent (X) is the minimum of “Vote supply” multiplied by “Campaign contributions (X)” divided by the sum of “Campaign contributions (X)” and “Campaign contributions (Y)”, or “Campaign contributions (X)” divided by “Price/ vote”. The same logic applies to “Expected votes (Y)”.

“Campaign contributions (X)” is a function of “Disposable income (X)” which is affected by “Tax rate (X)”. Note that the details of variables outside the sectoral boundaries are aggregated for simplicity of demonstrating the loops, and are described in detail in their respective sectors. “Tax rate (X)” is determined by the “Legislative Enterprise (L.E) ratio (X)”, a measure of the relative strength of the “Legislative enterprise (X)” compared to “Legislative enterprise (Y)”.

“Legislative Enterprise (X)” is an aggregate of the number of seats possessed by legislators sympathetic to the cause of (X), “Legislators (X)”, and lobbying enterprise/ capacity represented by “Lobbying spending (X)” divided by “Price of lobbyist-hour”. The stronger the “Legislative enterprise”, the larger the impact over policy. This means that a larger a “Legislative enterprise ratio”, will add more weight to the desired outcomes of the agent compared to the desired outcomes of the other agent. If (X) has a high L.E. ratio, they will get less taxes since it is assumed the agents are rational and aim to maximize their benefit, thus will always desired less taxes for themselves than their opponent desires for them.

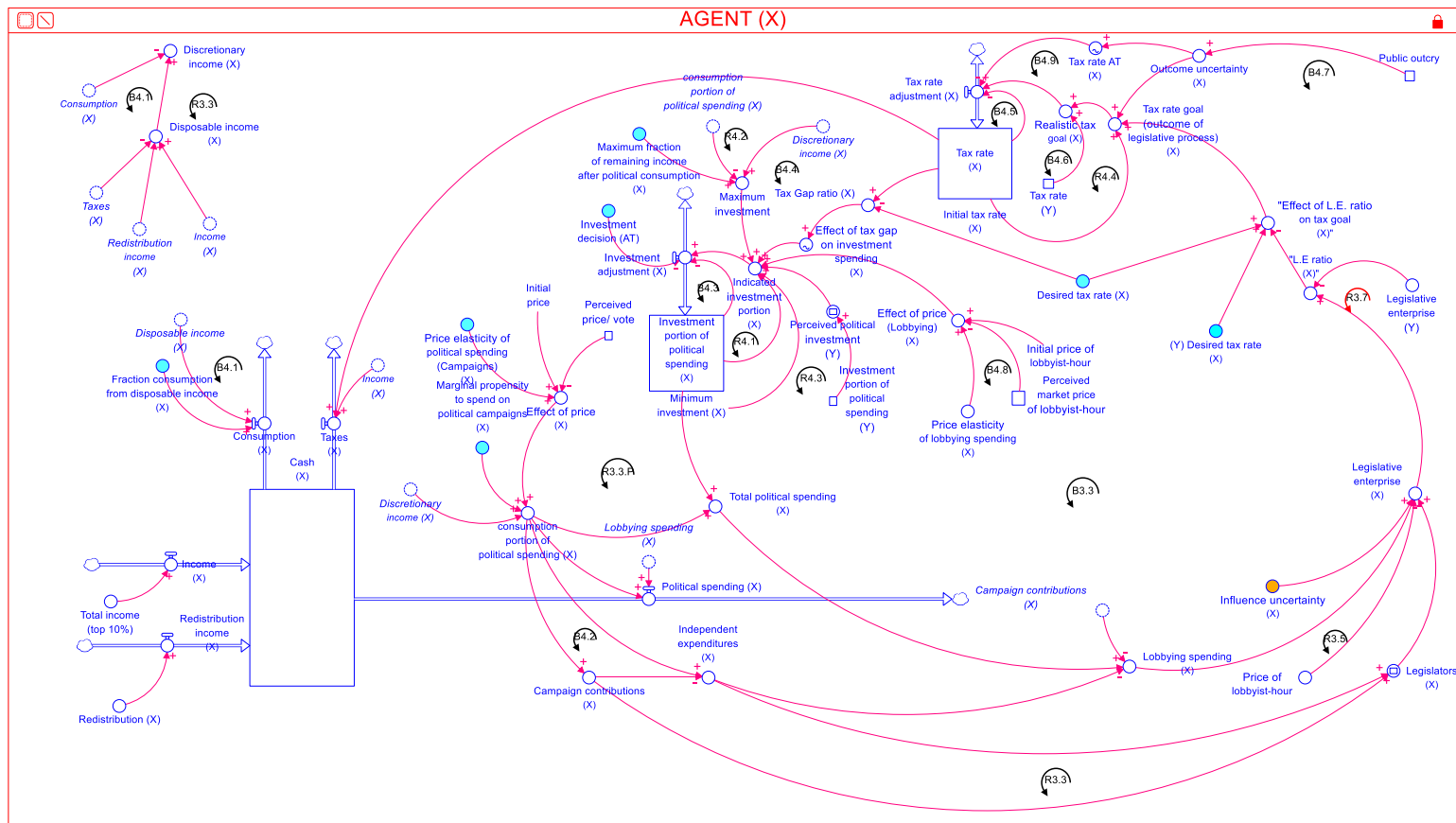
Note that Legislative enterprise is affected by “Influence uncertainty”, as influence through campaign contribution and lobbying is never absolutely certain because there is no written, enforceable contract between donors and politicians, in fact if such contracts existed they would be criminal. “Influence uncertainty” weakens legislative enterprise, representing politicians who would not always act the way their donors/ lobbyists expect. Such expectation may be based on instruction or based on assumptions given donor/ lobbyist and politician share the same worldview (Hall & Deardorff, 2006).

Furthermore, the price of lobbying affects the influence one Agent would get from spending on lobbying, as “Legislative enterprise” is equal to Lobbying spending divided by “Price of lobbyist-hour”. A higher price would mean that the influence gained through lobbying spending decreases through a reduced “Legislative enterprise”, which slows down the rate of closing the tax gap, and thus would propel this agent to spend more on lobbying, which escalates price even further (R3.5) and (R3.6).

A higher number of legislators leads to more influence, less taxes, more disposable income, and more campaign contributions (a function of disposable income). More campaign contributions leads to more votes, and thus more seats won in the legislator (R3.3) and (R3.4). Furthermore, the higher the legislative enterprise of the opponent, the less influence of the above reinforcing loops due to a balancing effect (R3.7) and (R3.8).

Finally, lobbying spending is a function of policy gap, in this model it is “Tax gap ratio”. If the gap is closed, lobbying will ideally be zero, but in this model there is a minimum lobbying spending, as in reality agents would always keep a channel of communication with lobbyists even if they did not need their immediate services, as a way to maintain communication with politicians. Thus it is a goal-seeking process, which is why legislative enterprise should decrease, for a given distribution of legislator seats, as the tax gap for each agent closes via loops (B3.3) and (B3.4).

12.4. Agent (X):



This sector outlines the behavioural patterns of Agent (X) – the top decile in terms of income in the US – in terms of political spending. “Wealth (X)” is a stock that decouples money inflows and outflows. The two inflows modelled are “Income (X)” and “Redistribution income (X)” which come from government’s redistribution spending. It could be the case that the top income decile receive no redistribution benefits at all, and this may be experimented on, yet if we included them this is the conservative estimate, as some wealthy individuals may have access to, for example, free education or free healthcare and all kinds of welfare spending. Then choosing not to use it is a different question.

Furthermore, the outflows modelled are “Consumption (X)”, “Taxes (X)” and “Political spending (X)”. Investment has been omitted as the rate of return on investment is one of the drivers of income inequality based on Piketty & Saez (2007). Given that it will only exacerbate the phenomenon of income inequality, and given that Incomes are exogenous data series, it has been omitted.

Consumption is modelled as a percentage of disposable income, and the percentage is different between Agent (X) and Agent (Y). There is a balancing loop here, in that consumption is a function of “Disposable income”, thus the more disposable income there is, the more consumption there would be, the less “Discretionary income” Agent (X) will have, which leads to less political spending. This leads to higher taxes and less disposable income leading to less consumption (B4.1). Concurrently, (R3.3) marks the effect

of higher “Discretionary income (X)” on consumption political spending leading to more legislators, less taxes and more “Disposable income (X)” which leads to more “Discretionary income (X)”. It has a code starting with “3.” As it is an inter-sectoral loop and has already been first mentioned in sector “Legislator”. The loops including “Redistribution income (X)” are explained in Chapter 12.8 (Government).

“Taxes (X)” is a product of “Income (X)” and “Tax rate (X)”. “Political spending (X)” is the sum of “Consumption portion of political spending (X)” and “Investment portion of political spending (X)”.

“Consumption portion of political spending” represents what Ansolabehere, Figueiredo & Snyder (2003) described as people donating money to campaigns of politicians whose views on salient issues match with theirs. It is a function of “Disposable income (X)”, a “Marginal propensity to spend (X)” on politics, and an effect of “Price on political spending (X)”. The latter being an indicator for the feeling of insignificance of one’s donation when huge amounts of money are being spent on campaigns. This is a deterrent to political spending and thus the effect is inversely proportional to price (B4.2). The marginal propensity to spend is also different between Agents (X) & (Y) representing different agent characteristics (heterogeneity) which have been (See TFIAD, 2004; Soss & Jacobs, 2009; Bonica et al, 2013).

“Investment portion of political spending” is a stock that adjusts based on an “Indicated investment goal (X)” that is anchored in the stock itself (R4.1), and takes into account an “Effect of tax gap on investment spending”. The larger the effect, the larger the goal will be. This adjustment occurs over an “Investment decision Adjustment Time (AT) in (B4.3).

This investment goal is controlled for a maximum, and a minimum value. “Maximum investment (X)” indicates that the agent will not invest more money than they receive through income, thus its upper limit is “Discretionary income (X)” minus “Consumption portion of political spending (X)”. More discretionary income raises the ceiling for investment spending, which feeds back through lower taxes to increase “Discretionary income (X)” (R4.2). More discretionary income also increases “Consumption portion of political spending (X)” which balances (R4.2) via (B4.4).

The lower limit of the “Indicated investment goal (X)” is a smooth of Agent (Y)’s investment. It is a smooth because data on elections spending is not immediately available and takes time to publish through the FEC (Federal Elections Commission). This creates a reinforcing effect (R4.3), as more investment spending by Agent (Y) will lead to benchmarking by Agent (X) preventing Agent (Y) from fulfilling its tax goals for (X) (*please refer to chapter 12.5: Agent (Y) for more details*), resulting in an escalation structure (R4.3).

“Tax gap ratio” determines “Effect of tax gap ratio on investment spending (X)”. the gap ratio is a comparison between desired tax rate and actual tax rate. It is calculated via the following equation:

$$\text{“Tax gap ratio”} = \frac{\text{“Tax rate”}}{\text{“Desired tax rate”}} - 1$$

Treating the agents as rational actors, an inherent assumption is that they will always want to pay less taxes to maximize their disposable income. This applies here in Agent (X) as well as for Agent (Y) in Chapter 12.5.

“Tax rate (X)” is a stock that adjusts over “Tax rate AT” to close the gap between the stock level and the “Realistic tax goal” (B4.5). This goal is the minimum of the “Tax rate (Y)” and “Tax rate goal (outcome of legislative process (X))”. This assumes that the more affluent Agent (X), cannot allow themselves to pay less taxes than the rest of the population coming from a sense of fairness, and in worry of triggering mass protest. This leads to an effect that is outlined in detail in Chapter 12.5, where Agent (X) attempts to reduce tax rate for Agent (Y) to be able to lower their own. The more influence Agent (X) possesses, represented in this model by “Legislative enterprise (X)”, the lower “Tax rate (Y)” will eventually become, leading to lower taxes for (X), and thus lowering lobbying spending (X), hence this is a balancing loop (B4.6).

“Tax rate goal (outcome of legislative process (X))” is expressed as a weighted average of the current “Tax rate (X)” and the “Effect of L.E. ratio on tax goal (X)”, using “Outcome uncertainty” as the weight. This means that when uncertainty is high, more weight is given to the status quo, i.e. resistance to change, and the goal is anchored in the stock (R4.4). When “Outcome uncertainty” is low, more leeway is given for Agent (X) to influence policy proportional to their “Legislative Enterprise” as described in the below equation.

$$\begin{aligned} &\text{“Tax rate goal (Outcome of legislative process (X))”} \\ &= [\text{Outcome uncertainty"} * \text{“Tax rate (X)"}] \\ &+ [(1 - \text{“Outcome uncertainty"}) * \text{“Effect of L.E. ratio on tax goal"}] \end{aligned}$$

The “Effect of L.E. ratio on tax goal (X)” is itself a weighted average of the goals of each agent concerning the tax rate of Agent (X), with their Legislative Enterprises as the weight “L.E. ratio (X)”. The higher an agent’s Legislative Enterprise, the more weight is given to their goal for Agent (X)’s tax rate, as shown below.

$$\begin{aligned} &\text{“Effect of L. E. ratio on tax goal (X)"} \\ &= [\text{L.E. ratio (X)} * \text{Desired tax rate (X)}] \\ &+ [(1 - \text{L.E. ratio (X)}) * (\text{Y}) \text{ desired tax rate (X)}] \end{aligned}$$

Where “L.E. ratio (X)” is the fraction of “Legislative enterprise (X)” over the sum of both legislative enterprises of (X) & (Y).

$$\text{"L. E. ratio (X)" = } \frac{\text{"Legislative enterprise (X)"}}{(\text{"Legislative enterprise (X)" + "Legislative enterprise (Y)"})}$$

“Legislative enterprise (X)” is the product of the number of legislators (X) has in office, meaning how many legislators come from the top decile of the income distribution and share the same world-view as the majority of members of Agent (X), and the “Lobbying spending (X)”. This means that the higher the lobbying spending, the more L.E. ratio which would lead to lower taxes, and less “Tax gap ratio” which would reduce lobbying spending (B3.3). Increased lobbying spending leads to price increases in lobbying services which feed back to reduce lobbying spending via loop (B4.8).

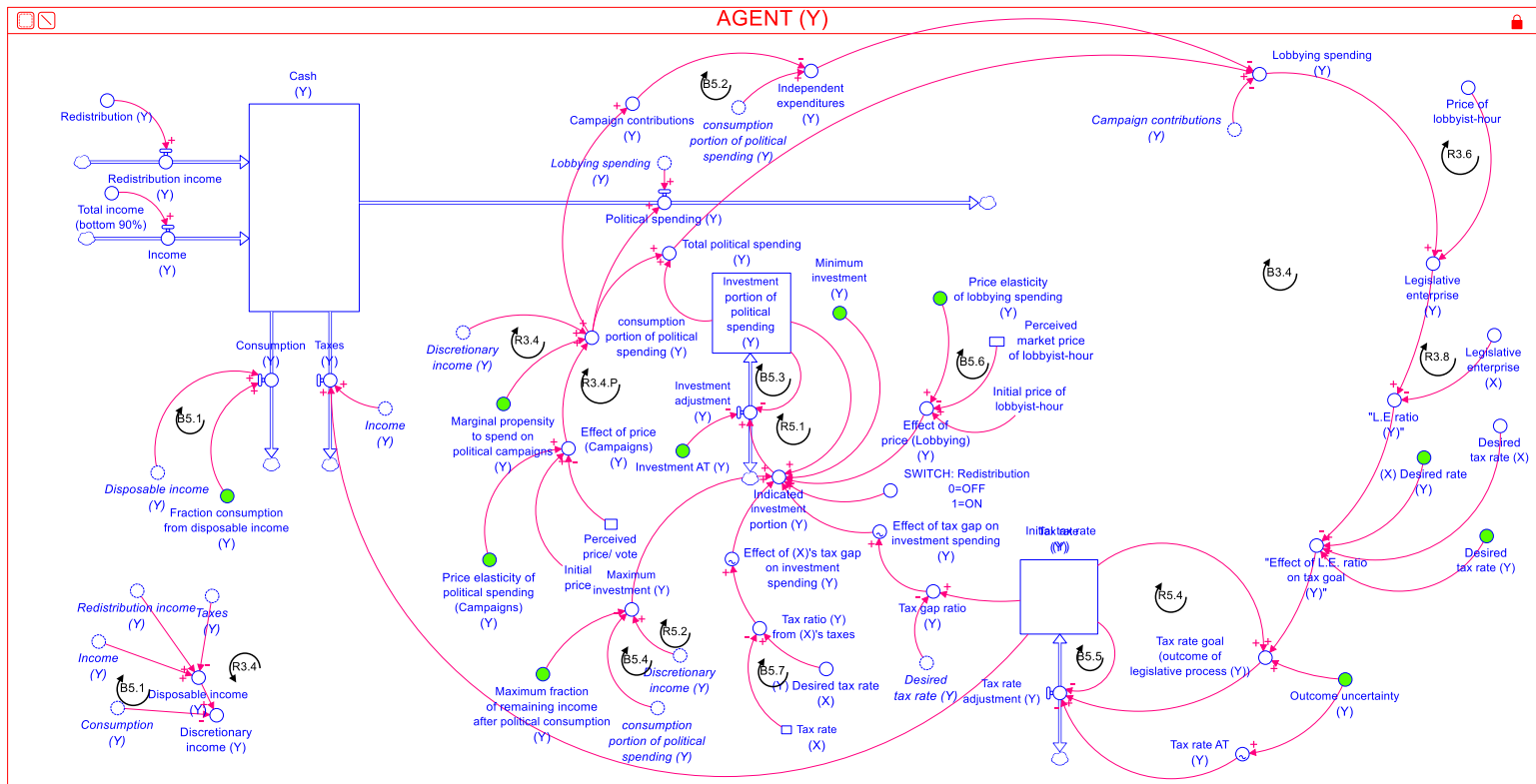
Loop (R3.7) represents the competition between the legislative enterprises of the two agents. It is reinforcing because if an agent had a higher legislative enterprise, they would be able to enact policies that would increase their legislative enterprise, in a vicious cycle.

Finally, “Outcome uncertainty” is not treated as exogenous in this model, it is a function of public outcry. More “Public outcry” leads to higher “Outcome uncertainty”. “Public outcry” is proportional to inequality expressed in “Net inequality GINI” (*please refer to Chapter 12.7 for details*). “Outcome uncertainty” has two effects, the first being on “Tax rate goal (outcome of legislative process (X))” as part of a negative feedback loop (B4.7) such that massive tax cuts result in a rise in net inequality, which increases outcry, slowing down tax change.

The second effect of “Outcome uncertainty” is on “Tax rate AT (X)” such that higher outcome uncertainty leads to a greater delay in revisiting the tax agenda. Since “Outcome uncertainty” is a function of “Public outcry”, more public outcry leads to a slowdown in the tax cuts Agent (X) seeks to achieve, which via loop (B4.9) slows down changes in inequality and thus slows down “Public outcry”.

Depending on the scenario run on the model, “Lobbying spending” could equal to the “Investment portion of political spending”, when “Campaign contributions” is equal to the “Consumption portion of political spending”. It could also equal a fixed fraction of “Total political spending”, the sum of both investment and consumption.

12.5. Agent (Y):



This sector outlines the behavioural patterns of Agent (Y) – the sum of the 9 lower deciles of the income distribution in the US – in terms of political spending. “Wealth (Y)” is a stock that decouples money inflows and outflows. The two inflows modelled are “Income (X)” and “Redistribution income (X)” which come from government’s redistribution spending. It is assumed that the bottom 90% of the income distribution receive “Redistribution income from the government on a per capita basis.

Furthermore, the outflows modelled are “Consumption (X)”, “Taxes (X)” and “Political spending (X)”. Investment has been omitted here as well because including investment would only exacerbate the inequality in incomes between the agents as per Piketty & Saez (2007).

Consumption is modelled as a percentage of disposable income, and the percentage is different between Agent (Y) and Agent (X). There is a balancing loop here, in that consumption is a function of “Disposable income”, thus the more disposable income there is, the more consumption there would be, the less “Discretionary income” Agent (X) will have, which leads to less political spending. This leads to higher taxes and less disposable income leading to less consumption (B5.1). Concurrently, (R3.4) marks the effect of higher “Discretionary income (Y)” on political spending leading to less taxes and more “Disposable income (Y)” which leads to more “Discretionary income (Y)”. It has a code starting with “3.” As it is an inter-sectoral loop and has already been first mentioned in sector “Legislator”. The loops including “Redistribution income (Y)” are explained in Chapter 12.8: Government redistribution.

“Taxes (Y)” is a product of “Income (Y)” and “Tax rate (Y)”. “Political spending (Y)” is the sum of “Consumption portion of political spending (Y)” and “Investment portion of political spending (Y)”.

“Consumption portion of political spending (Y)” represents what Ansolabehere, Figueiredo & Snyder (2003) described as people donating money to campaigns of politicians whose views on salient issues match with theirs. It is a function of “Disposable income (Y)”, a “Marginal propensity to spend (Y)” on politics, and an effect of “Price on political spending (Y)”. The latter being an indicator for the feeling of insignificance of one’s donation when huge amounts of money are being spent on campaigns. This is a deterrent to political spending and thus the effect is inversely proportional to price (B5.2). The marginal propensity to spend is also different between Agents (Y) & (X) representing different agent characteristics (Heterogeneity) which have been observed empirically (See TFIAD, 2004; Soss & Jacobs, 2009; Bonica et al, 2013).

“Investment portion of political spending” is a stock that adjusts based on an “Indicated investment goal (X)” that is anchored in the stock itself (R5.1), and takes into account an “Effect of tax gap on investment spending”, and the “Effect of (X)’s tax ratio on investment spending (Y)”. The larger these effects are, the larger the goal will be. This adjustment occurs over an “Investment decision Adjustment Time (AT)” in (B5.3).

“Effect of (X)’s tax ratio on investment spending (Y)” is a representation of Agent (Y)’s perceived gains that could be had if “Tax rate (X)” was brought to the goal “(Y) desired tax rate (X)”, which incentivizes Agent (Y) to invest in politics in order to achieve such gains. It is thus expressed in the following equation:

$$\text{“Tax ratio (Y) from (X)’s taxes”} = \frac{\text{“(Y) desired tax rate (X)”}}{\text{“Tax rate (X)”}}$$

The numerator is chosen as such because it will always be higher than the actual tax rate, and the higher this ratio, the higher the “Indicated investment portion (Y)”.

This investment goal is controlled for a maximum, and a minimum value. “Maximum investment (Y)” indicates that the agent will not invest more money than they receive through income, thus its upper limit is “Discretionary income (Y)” minus “Consumption portion of political spending (Y)”. More discretionary income raises the ceiling for investment spending, which feeds back through lower taxes to increase “Discretionary income (Y)” (R5.2). More discretionary income also increases “Consumption portion of political spending (X)” which balances (R5.2) via (B5.4). Furthermore, increased investment spending has an inflationary effect on lobbyist services (demand-pull inflation) which feeds back to investment goal via loop (B5.6).

The lower limit of the “Indicated investment goal (Y)” is “Minimum investment (Y)”.

“Tax gap ratio (Y)” determines “Effect of tax gap ratio on investment spending (Y)”. This gap ratio is a comparison between desired tax rate and actual tax rate. It is calculated via the following equation:

$$\text{“Tax gap ratio (Y)”} = \frac{\text{“Tax rate (Y)”}}{\text{“Desired tax rate (Y)”}} - 1$$

Treating the agents as rational actors, an inherent assumption is that they will always want to pay less taxes to maximize their disposable income. And Agent (Y) will always want Agent (X) to pay more taxes.

“Tax rate (Y)” is a stock that adjusts over “Tax rate AT (Y)” to close the gap between the stock level and the “Tax rate goal (outcome of legislative process) (Y)” (B5.5). This goal is the minimum of the “Tax rate (X)” and “Tax rate goal (outcome of legislative process (Y))”.

The goal of this loop is itself anchored in the stock “Tax rate (Y)”, via loop (R5.4). The equation of “Tax rate goal (outcome of legislative process) (Y)” is expressed as follows:

$$\begin{aligned} &\text{“Tax rate goal (Outcome of legislative process (Y))”} \\ &= [\text{“Outcome uncertainty (Y)”} * \text{“Tax rate (Y)”}] \\ &+ [(1 - \text{“Outcome uncertainty”}) * \text{“Effect of L.E. ratio on tax goal (Y)”}] \end{aligned}$$

Thus the tax goal is the weighted average of the current “Tax rate (Y)” and the “Effect of L.E. ratio on tax goal (Y)”, using “Outcome uncertainty” as the weight. This means that when uncertainty is high, more weight is given to the status quo, i.e. resistance to change, and the goal is anchored in the stock (R5.4), dominance. When “Outcome uncertainty” is low, more leeway is given for Agent (Y) to influence policy proportional to their “Legislative Enterprise”.

The “Effect of L.E. ratio on tax goal (Y)” is itself a weighted average of the goals of each agent concerning the tax rate of Agent (Y), with their Legislative Enterprises as the weight “L.E. ratio (Y)”. The higher an agent’s Legislative Enterprise, the more weight is given to their goal for Agent (Y)’s tax rate, as shown below:

$$\begin{aligned} &\text{“Effect of L. E. ratio on tax goal (Y)”} \\ &= [\text{“L.E. ratio (Y)”} * \text{“Desired tax rate (Y)”}] \\ &+ [(1 - \text{“L.E. ratio (Y)”}) * \text{MIN(“X) desired tax rate (Y)”, “Tax rate (X)”}]] \end{aligned}$$

The above equation indicates that a stronger “Legislative enterprise (Y)” will lead to more weight given to “Desired tax rate (Y)”, and a stronger “Legislative enterprise (X)” will lead to Agent (X) dictating the tax rate of (Y), which would be either the pre-set goal “(X) desired tax rate (Y)”, or in case Agent (X) is seeking to lower their own taxes, they will seek to lower it for Agent (Y) as well in order to justify such tax cuts maintaining the fairness principle (The high income earners do not pay lower rates than the less affluent).

“L.E. ratio (Y)” is the fraction of “Legislative enterprise (Y)” over the sum of both legislative enterprises of (X) & (Y).

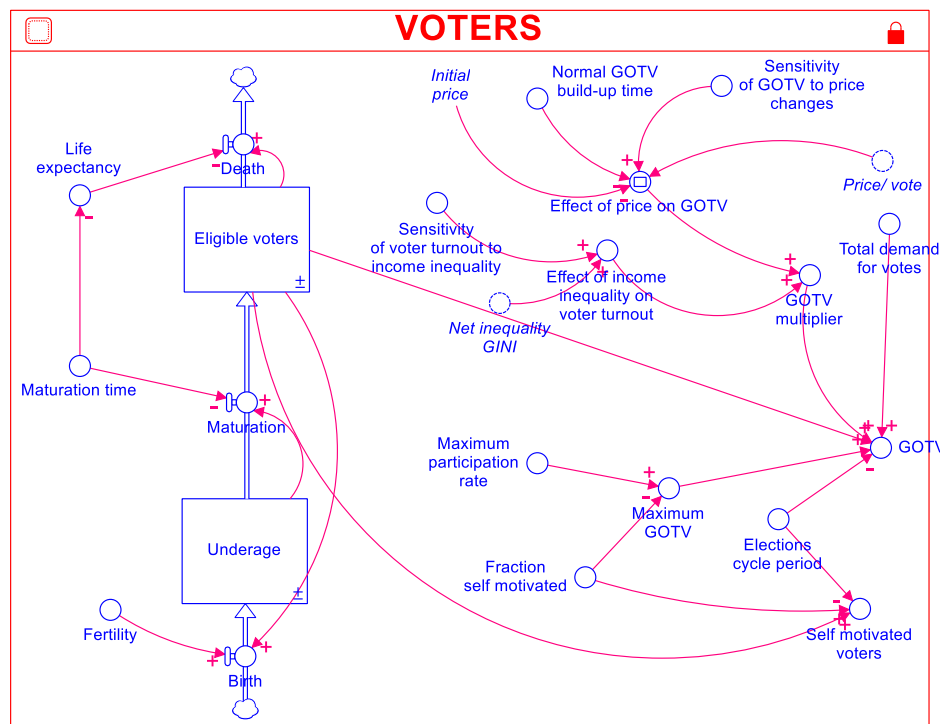
$$\text{"L. E. ratio (Y)" = } \frac{\text{"Legislative enterprise (Y)"}}{(\text{"Legislative enterprise (X)" + "Legislative enterprise (Y)"})}$$

“Legislative enterprise (Y)” is the product of the number of “Legislators (Y)” in office, meaning how many legislators come from the 9 lower deciles of the income distribution and share the same world-view as the majority of members of Agent (Y), and the “Lobbying spending (Y)”. This means that the higher the lobbying spending, the more L.E. ratio which would lead to lower taxes, and less “Tax gap ratio” which would reduce lobbying spending (B3.4). The effect of “Legislative enterprise (X)” is in loop (R3.8) which opposes loop (B3.4) in that a higher “Legislative enterprise (X)” would not only result in higher wins for Agent (X), but would also limit the political influence of Agent (Y) in striving for its own goals which further enhances Agent (X)’s political influence.

Finally, “Outcome uncertainty (Y)” is treated as exogenous in this sector, having two effects: the first being a status quo bias that uses the current stock value and assigns it weight against the newly decided tax goal as an outcome of legislative competition, and the second is an increase in the ‘Tax rate AT (Y)’ such that higher outcome uncertainty leads to a greater delay in revisiting the tax agenda.

Depending on the scenario run on the model, “Lobbying spending” could equal to the “Investment portion of political spending”, when “Campaign contributions” is equal to the “Consumption portion of political spending”. It could also equal a fixed fraction of “Total political spending”, the sum of both investment and consumption.

12.6. Population



This sector is the supply engine for the model. A simple population structure is used to account for eligible voters defined as population above voting age (18 years). This stock of “Eligible voters” depletes through a death outflow based on life expectancy which is total life expectancy minus the maturation time of a “Underage” to “Eligible voters”. It is increased through an inflow of “Maturation” which is the stock of “Underage” over its residence time, which is the voting age. “Underage” are members of the population below voting age, depleted through maturation into “Eligible voters” and increased by the inflow of “Birth”. Birth is equal to eligible voters multiplied by a fertility rate.

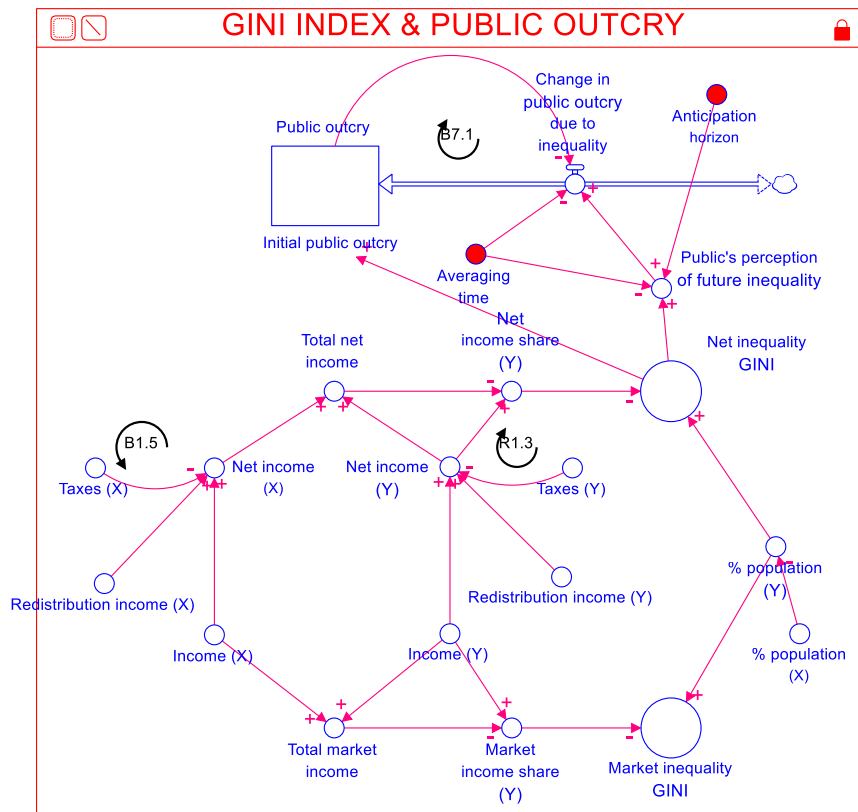
There are two types of voters, those intrinsically motivated and politically involved based on their interests, and another group of extrinsically motivated voters who are mobilized by Get Out The Vote (GOTV) efforts by politicians and political parties through campaigns. Intrinsically motivated voters are named “Self-motivated voters” and are a fixed fraction of the population of “Eligible voters”.

“GOTV” voters are individuals who wouldn’t otherwise vote if there were no political campaigns. They are a function of “Total demand for votes” by politicians, since they are proportional to campaigning efforts represented in this model as “Campaign contributions” divided by “Perceived price/ vote”. If there was no spending on campaigns, there would be no demand for “GOTV” voters, and thus this variable would be equal to zero. There are two effects influencing “GOTV”, one is “Effect of income inequality on voter turnout” which reflects an inversely proportional relationship between inequality and political participation. This is a problem witnessed in the US, and has been cited by Solt (2010) and Hacker & Pierson (2010). The second effect is that of increased price/ vote stimulating creative ways for increasing campaign effectiveness. This is the counterpart of an increased price in commodity markets stimulating supply. A lower price leads to the utilization of less cutting-edge tools for campaigning which would be less effective than for example leading data-consultants who harness social media platforms for directing focused ads to GOTV.

These two effects interact to result in a GOTV supply, which in addition to the “Self-motivated voters” aggregate to total vote supply. Since elections in the US senate are held every two years, “Election cycle period”, and the model is continuous, “Total vote supply (per year)” is the sum of the two types of voters divided by “Election cycle period”.

This supply of votes is contrasted with “Total demand for votes” in the Campaigns Price Mechanism sector to affect the “Price/ vote” which influences elections and legislators in office.

12.7. GINI index & public outcry



This structure has no internal loops, yet it is an input-output for important loops in the model. Its output, Net inequality GINI, is part of loops (R1.3) and (B1.5) that influence “Campaign Price Mechanism” as well as loops representing policy resistance to Agent (X) (*please refer to chapter 12.4*). Its input is “Income (X)” and “Income (Y)” which are exogenous parameters to the model, to calculate Market inequality GINI, and its output in “Net inequality GINI” takes into account two endogenous mechanisms, namely Taxes paid by each agent and redistribution of income by government. This is explained further in section 12.8, but taxes could be high with varying levels of redistribution thus government policy and the factors affecting it are important for understanding how taxes interact with inequality.

Gini coefficient is normally calculated by plotting the Lorenz curve, but for the purposes of this model and since the population is divided into two segments only (Agent (X) and Agent (Y)) this structure is a rough approximation of Gini. This is because it assumes a linear approximation to millions of individuals within each group. Thus all members of Agent (X) are assumed to receive the same income, and members of Agent (Y) also all receive the same income. To account for probabilistic distributions in incomes a spreadsheet-based input-output may be applied for calibration purposes, but the goal of this structure is to express policies based on trends. This means that it shows an effect on inequality due to different loops in the model, and gives an indication to whether the policies enacted would have an impact on Gini.

“Market inequality GINI” index is calculated via subtracting “Market income share (Y)” from “% population (Y)”. (*For the rationale behind this approximation please refer to Chapter 19: Appendix 6*) Market income

share (Y)” is calculated as the “Income (Y)” divided by “Total market income”, the sum of “Market income (Y)” and “Market income (X)”.

“Net inequality GINI” is “% population (Y)” minus “Net income share (Y)”, calculated as the “Net income (Y)” divided by “Total net income”. “Total net income” is the sum of “Net income (Y)” and “Net income (X)”. Net income is equal to Taxes subtracted from Income adding Redistribution income. Thus more taxes reduce Income and more redistribution increases the net income which is a determinant of “Net inequality GINI”.

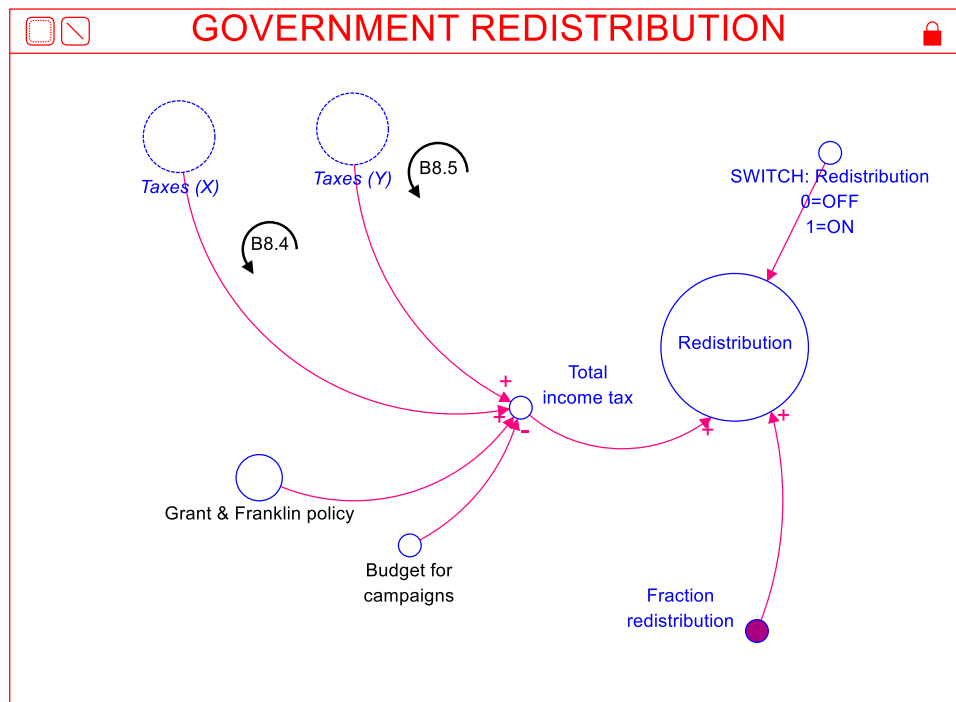
It is assumed in this model that “Public outcry” is a function of “Net inequality GINI”, yet a significant factor is that higher inequality does not translate instantaneously to outcry. First of all, it has been argued that an important factor in public outcry over policy is the future outlook on such policy. If the public are undergoing hardship but believe things are going to get better in the future, they are more likely to be patient and endure, out of their belief in the American dream (Bartels, 2005; TFIAD, 2004). If their view of the future is more dire than the present, they are more likely to rise and object on their current situation. To express that, Public outcry is a function of the forecast of “Net inequality Gini”, which is “Public’s perception of future inequality”. This forecast is dependent on two other variables apart from inequality, “Anticipation horizon”, and “Averaging time”.

“Averaging time” is the period upon which the public recalls/ measures the change in inequality trend. For example if “Averaging time” was equal to 6 years, this means that the public looks back at the previous 6 years and observes the trend of inequality through “Net inequality GINI”. If it was 12 years, then the trend of inequality is captured over the previous 12 years. A higher averaging time dampens any changes in the trend of inequality and delays its detection, given it is a function of the first order smooth of “Net inequality GINI”.

Such trend is the basis upon which the public base their expectations on whether inequality will decrease, stabilize, or increase in the future. “Anticipation horizon” is the projection of the trend calculated over the “Averaging time” into the future. It addresses the question of “how long into the future does the public expect the current trend to continue?” A higher forecast horizon means that any shocks introduced at time (t) will be extrapolated long into the future, even if the system stabilizes shortly after the introduction of the shock resulting in an overestimation of the effect of shocks in inequality.

“Public outcry” is a smooth of “Public’s perception of future inequality”, in that there is a delay between perception and action. The same “Averaging time” upon which the trend is calculated is assumed to be the smoothing time for “Public outcry”.

12.8. Government redistribution



This sector outlines the role of government redistribution in increasing the disposable incomes of agents. Government collects taxes and decides on its budget how to allocate such tax revenues. Thus the sum of tax money received from 'Taxes (X)' and 'Taxes (Y)' is summed up in 'Total income tax'. Of course government has other sources of revenue which were excluded from this model such as corporate tax and wealth tax. The purpose of this sector is to test different allocations of government redistribution endogenously. Given that only income tax was modelled, a fraction of income tax is used to determine the per capita redistribution income received by the agents. It is assumed that redistribution is granted equally on a per capita basis which means that Agent (Y) gets nine times the redistribution received by agent (X). It may be argued that Agent (X) will not receive redistribution at all, but since this model is highly aggregated, redistribution spending includes benefits such as access to public services as healthcare and education, which may be argued to affect every citizen. Loops (B8.4) and (B8.5) are balancing because as agents get more disposable income they will spend more on political consumption, gaining them a higher legislative enterprise which they would use to cut taxes for themselves (rational agents) thus reducing the total tax revenue to be used for distribution in the following dt.

13. Appendix 4: Model testing

13.1. Direct structure tests

As per Barlas (1996) given that this study is theoretical, the below tests may be categorized as theoretical direct structure tests. The purpose of this chapter is to build confidence in the model by subjecting it to an array of tests including structure-confirmation test, parameter confirmation test, dimensional consistency test, and the direct extreme condition test.

13.1.1. Structure-confirmation test

Feature	Dynamic behaviour	Assumptions	Formulation	Supporting literature
Campaign market mechanism	Ch 4.3.1	Ch 11: Assumption 5	Ch 12.1	Sterman (2000) adapted for the free-market of campaigns
Lobbying market mechanism	Ch 4.3.2	Ch 11: Assumption 7	Ch 12.2	Sterman (2000) adapted for the free-market of lobbying
Voters ageing structure	Ch 4.3.1 & 4.3.6	-	Ch 12.6	Typical SD population model, as the one is Yamaguchi (2019), simplified and adapted for the purpose of this research. In determining the participation rate, elements from Sterman (2000) were used to account for price effect on supply, while effect of inequality from Solt (2010), Soss & Jacobs (2009) and TFIAD (2004) were incorporated.
Agents' consumption political spending	Ch 4.3.1	Ch 11: Assumption 4	Ch 12.4/ Ch 12.5	Consumption equation adapted from Yamaguchi (2019), evidence that it is actually consumption spending is adapted from Ansolabehere, Figueiredo & Snyder (2003)
Agents' investment political spending	Ch 4.3.2	Ch 11: Assumption 6	Ch 12.4/ Ch 12.5	Goal seeking behaviour adapted from Sterman (2000). The rationale for claiming it to be reflective of investment political spending is adapted from Gordon, Hafer & Landa (2007), and Stratmann (2005).
Legislator behaviour	Ch 4.3.3/ Ch 4.3.4	Ch 11: Assumption 8/ 9	Ch 12.3	'Lobbying as a legislative subsidy' theory of Hall & Deardorff (2006) was adopted for this sector. The consequences of operationalizing this theory into an SD model are stated in the model assumptions.
Government redistribution	Ch 4.3.5/	-	Ch 12.8	Alvaerdo et al (2018), and Forster & Levy (2014) on the role of redistribution in raising net income.
Inequality	Ch 4.3.5	Ch 11: Assumption 10	Ch 12.7	Simplified calculation of Gini index

Confirming that the relationships in the model exist in literature is the first step of confidence building in the presented dynamic hypothesis. In the table above, key features in the model are cited as well as the sources used to build them. It is worth noting that this research aimed to break new ground by synthesizing a well-studied and vastly applied mechanism in System Dynamics, Sterman's theory on commodity markets (Sterman, 2000), with elements from Yamaguchi's Macroeconomic model (Yamaguchi, 2019) to represent the free market of political influence, with the theoretical work of Hall & Deardorff (2006) on lobbying and several empirical findings on US elections and campaigns. When limited data or uncertainties on the system structure were encountered in the literature, the author tried to adhere to existing modelling guidelines, making the assumptions explicit and clear so that critique of the selected structure is facilitated, advancing the debate on inequality and the political process in the US.

13.1.2. Parameter-confirmation test

The parameter-confirmation test ensures that all model variables reflect counterparts in the real system (Senge & Forrester, 1980). In building this model, given that it is theoretical, there were two categories of variables, the first being those from disciplinary literature, such as political science and economics, as well as variables that are usually used in system dynamics such as ratios. Making sure that parameters used in this model meet conceptual validity, model parameters were drawn from literature, and their numerical confirmation was ensured by using plausible ranges of parameter calibration to reflect the heterogeneity of Agent (X) and Agent (Y). Where there was high uncertainty or lack of data on a given parameter, such as the marginal propensity to spend on politics, sensitivity analysis was conducted on the partial model as per Homer (1983), as well as the full model, to test if changes in parameter range changed the generated behaviour.

13.1.1. Dimensional consistency

Dimensional consistency tests for internal consistency (Barlas, 1996). It ensures that equations present in the model have no errors, building confidence in the model. No dummy variables were used to correct units in this research, and STELLA Architect 1.5.2. automatically verified that there were no unit errors in both the full model as well as the policy model, making them dimensionally consistent.

13.1.2. Direct extreme-condition test

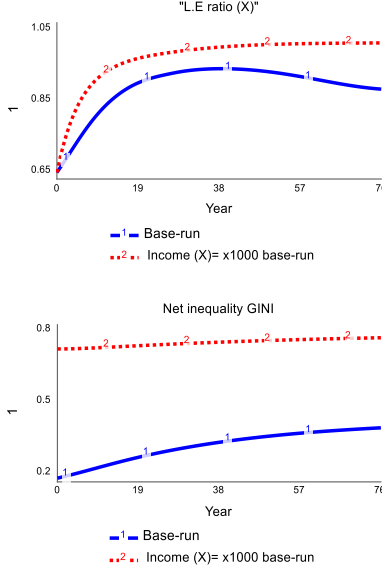
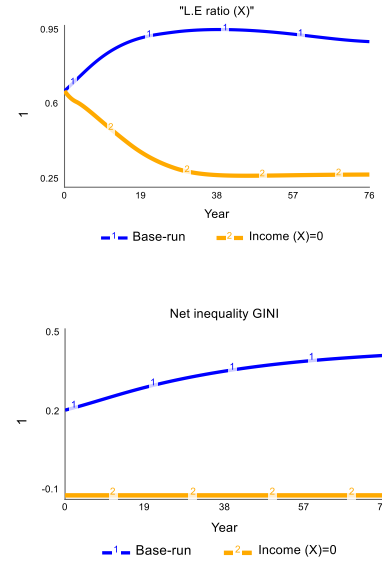
Direct extreme conditions testing evaluates the model equations under extreme conditions (Barlas, 1996). Given that it does not involve simulation, each individual equation is tested by providing extreme inputs and observing whether the equation output reflects the expected behaviour compared to the real system. Below are selected equations (containing complex logical functions) to provide an example of direct structure tests conducted for this model.

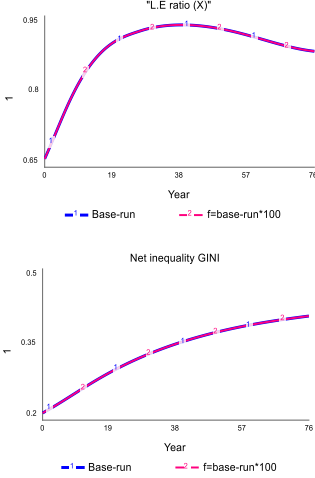
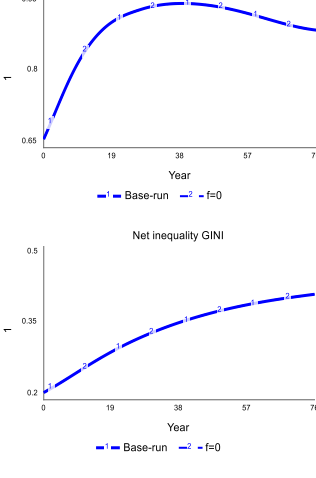
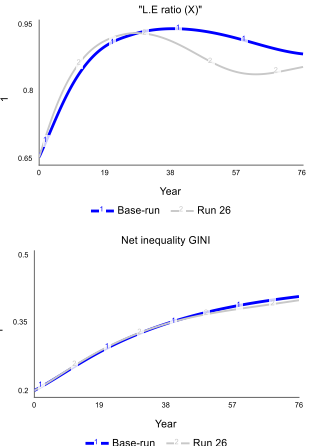
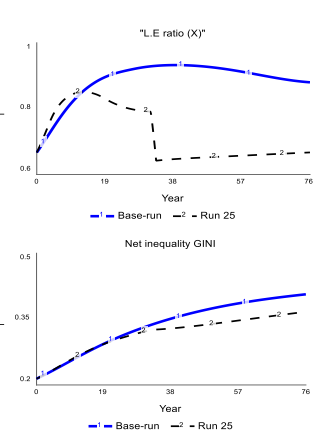
Variable	Equation	Upper extreme condition	Results	Lower extreme condition	Results
Expected votes (X)	IF(Price/ vote =0) THEN(Total vote supply (per year) /2) ELSE(MIN(SAFEDIV(Campaign contributions (X) , Price/ vote),SAFEDIV(Campaign contributions (X) , (Campaign contributions (X) + Campaign contributions (Y)) * Total vote supply (per year)))	Price = 1000 Campaign contributions (X) = 1000,000,000 Campaign contributions (Y) = 100,000,000 Vote supply = 26 million	Expected: 1000,000 Actual: 1000,000	Price =0 Campaign contributions (X) = 100,000 Campaign contributions (Y) = 50,000	Expected: 13 million Actual: 13 million
Indicated investment portion (X)	MIN(MAX(MAX("Perceived political investment (Y)", "Investment portion of political spending (X)")*"Effect of tax gap on investment spending (X)"*"Effect of price (Lobbying) (X)", "Minimum investment (X)"), Maximum investment)	Perceived political investment (Y) = 10,000,000 Investment portion of political spending (X) = 100 Effect of tax gap on investment spending (X) = 2 Maximum investment = 10,000 Minimum investment=5,000	Expected: 10,000 Actual: 10,000	Maximum investment = 0	Expected: 0 Actual: 0

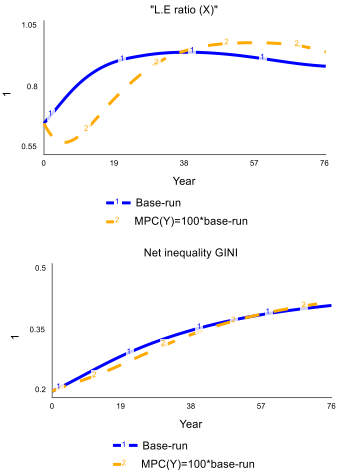
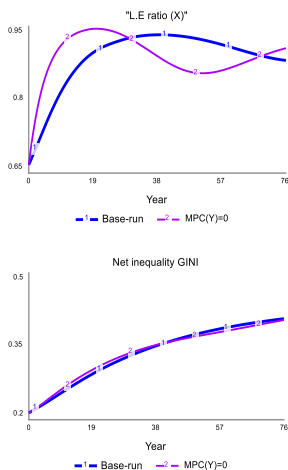
13.2. Structure-oriented behaviour tests

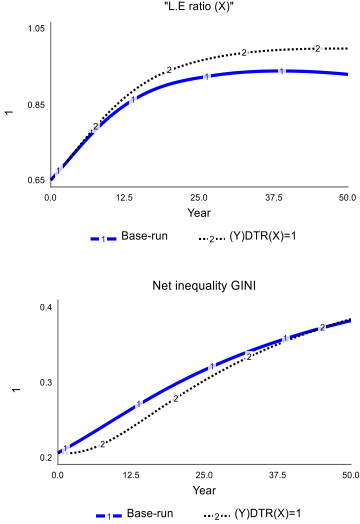
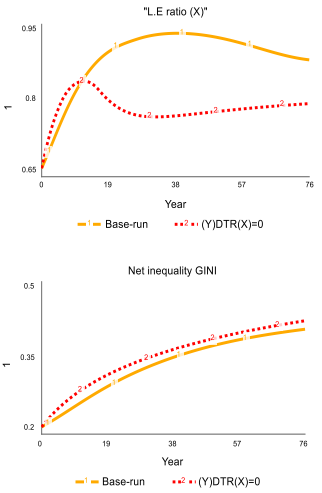
13.2.1. Extreme-condition test

Extreme-conditions test (stress test) is assigning extreme values to a set of selected parameters, simulating, and comparing the generated behaviour to behaviour expressed, or is anticipated to express, by the real system under the same extreme conditions (Barlas, 1996). Being theoretical, this study aimed to test the plausibility of the generated behaviour under extreme conditions by comparing against anticipation rather than to historically generated behaviour from the real system. Stress-testing was conducted on a sectoral basis (partial model testing as per Homer (1983)) yet also at the full-model level. The below results provide an example of the tests conducted and brief reflections on their plausibility. It is worth noting that the actual tests for the full model were not conducted compared to the base-run calibration, rather using very high and very low parameter values, a thousand times the calibrated value or zero, but are described below in relation to the base-run calibration, and in fact results are also compared to the base-run, to give the reader a sense of context.

Upper extreme condition				Lower extreme condition		
Variable	Value chosen	Expected system behaviour	Simulated system behaviour	Value chosen	Expected system behaviour	Simulated system behaviour
Income (X)	1000*base-run value	'L.E. ratio (X)' will be overwhelmingly high, and so will net inequality		0	'L.E. ratio (X)' would fall to levels well below base run, and inequality will be negative	
Conclusions from test	<p>When 'Income (X)' increased a thousand fold, income inequality became exceptionally high, and the 'L.E. ratio (X)' approached 1, which is what was expected. The model assumes that Agent (X) are richer than Agent (Y). the equation of GINI index is 'Net income share (Y)' subtracted from '% population (Y)'. when the income of Agent (X) went to zero, the next income share of Agent (Y) exceeded 0.9, and thus subtracting it from the '% populaton (Y)', it yielded a negative number. If everyone became equal, which is an extreme condition in and of itself, Agent (X) will have 10% of the income share, making GINI index = 0.</p>					

Fertility (rate)	100* base-run value	No effect		0	No effect	
Conclusions from test	Given that aggregate income is calculated from the per capita income multiplied by the income per capita (market income), and changes in fertility rates will be abtanced by changes in incomes. Thus even though demand for votes and supply of votes will be different under different population sizes, the supply/demand balance of campaigns, and thus legislative enterprise, will be the same as the base-run, resulting in the same effects on taxes and thus inequality.					
Maximum active lobbyists	100* base-run value	Reduced 'L.E. ratio (X)' and reduced inequality, because as price falls to values below base-run, loop (B5.6) will be less dominant, giving Agent (Y) a 'Legislative enterprise' advantage compared to base-run conditions		0	Reduced 'L.E. ratio (X)' and reduced inequality, because as price increases to extreme values, the balancing effect of (B4.8) and (B5.6) will reduce lobbying spending to its minima	

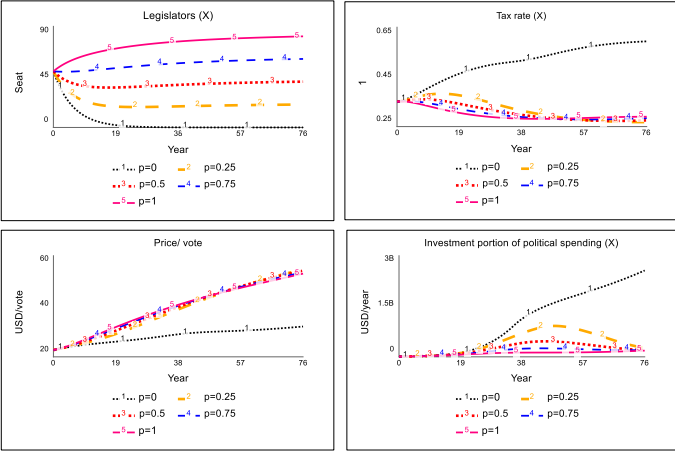
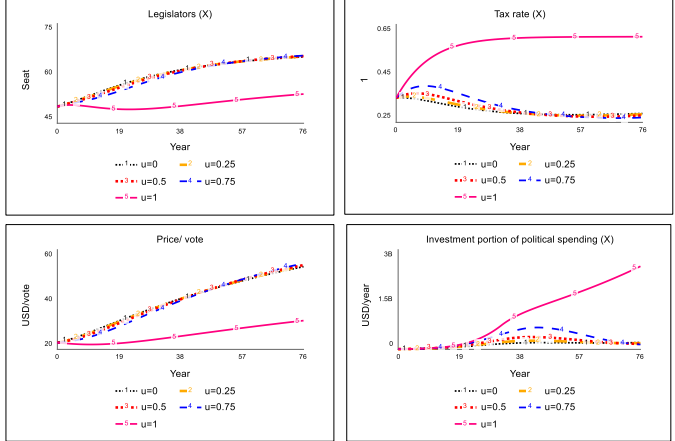
Conclusions from test	<p>The systems showed plausible behaviour under extreme conditions of ‘Maximum active lobbyists’. When there was virtually no limit on supply of lobbyists, price fell below levels experienced in the base-run, which weakened loops (B4.8) and (B5.6), giving Agent (Y) an advantage in adjusting their ‘Indicated investment portion (Y)’, thus gaining a larger legislative enterprise. The effect of inequality wasn’t pronounced because the difference in ‘Tax rate (X)’ wasn’t large enough to substantially increase ‘Disposable income (Y)’. In the lower extreme limit, dramatic price increases reduced indicated investment for both agents to levels below their minimum spending in the model. Such reduction was constrained by the MAX functions in the goals for investment, which caused the sudden drop in ‘L.E. ratio (X)’ observed above. Furthermore, at these minimum levels of investment, lobbying spending of Agent (X) is only double that of Agent (Y), which is well below the ratios reached in the base-run</p>					
Marginal propensity to spend on political campaigns (Y)	100*base-run value	Lower ‘L.E. ratio and lower inequality while (B3.3) build up Agent (X)’s legislative enterprise		0	There will be a higher ‘L.E ratio (X)’ and higher inequality while (B5.7) builds up Agent (Y)’s legislative enterprise	
Conclusions from test	<p>When Agent (Y) stops spending on political consumption, they lose seats in the legislature which increases ‘L.E. ratio (X)’, and hence increase inequality. When ‘L.E ratio (X)’ increases they cut their own taxes, to which Agent (Y) responds by increasing their ‘Investment portion of political spending (Y)’ because the gap from Agent (X)’s taxes motivates them to lobby for more redistribution(B5.7). When Agent (Y) spends more on consumption political spending (upper extreme case), they have more legislators and thus ‘L.E ratio (X)’ declines, and so does inequality because taxes are raised on Agent (X). This causes loop (B3.3) to activate via ‘Tax gap ratio (X)’ and build up ‘Legislative enterprise (X)’ until it overtakes Agent (Y), increasing inequality compared to the base-run.</p>					

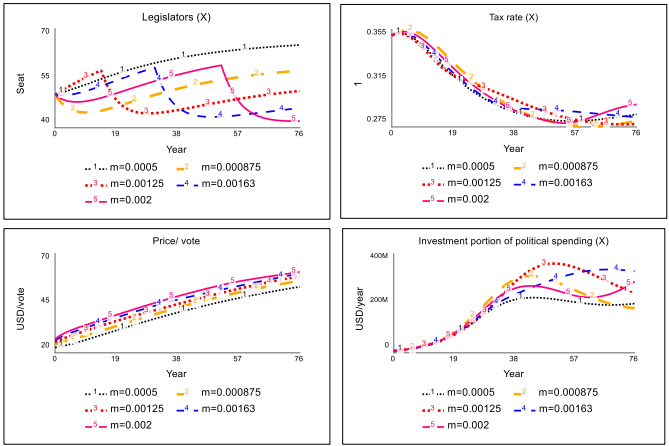
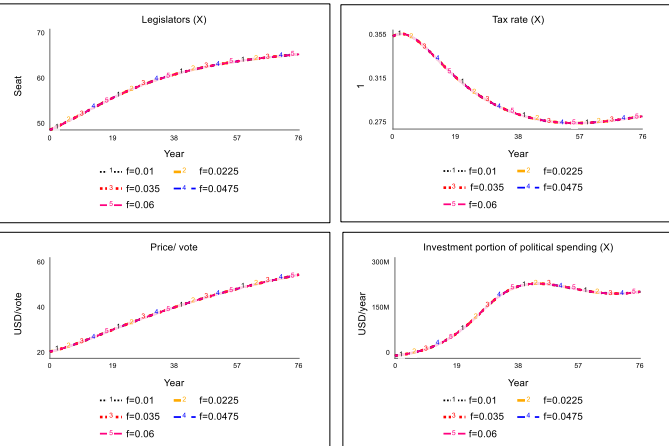
(Y) desired tax rate (X)	1	'L.E. ratio (X)' will increase to completely overpower Agent (Y)		0	Agent (X) will accomplish their goals, reduce their lobbying spending, and thus Agent (Y) will still have some legislative enterprise, yet inequality will be higher	
Conclusions from test	<p>If Agent (Y) decided they want to tax all the earnings of Agent (X), given that at $t=0$ both agents have equal seats in the senate, Agent (Y) will be able to raise taxes on Agent (X), triggering (B3.3), which escalates as a result of loop (R4.1), surpassing Agent (Y)'s legislative enterprise. With the higher taxes enacted by Agent (Y) in the beginning of the simulation run, Agent (Y) gain more disposable income and thus inequality is lower than the base-run, until Agent (X) manages to reduce their tax rates to levels lower than the base-run, afterwhich inequality is higher than the base-run. When Agent (Y)'s goal for 'Tax rate (X)' is zero, (B3.3) activates only slightly because the tax gap faces no persistence of competition between loops (B5.7) and (B3.3), thus tax rate is reduced to yield a very low 'Tax gap ratio (X)' thus lobbying of both agents doesn't escalate to levels observed in the base-run. This is why the 'L.E ratio (X)' does not reach as high as it did in the base-run. Yet because of the lower redistribution, inequality is higher.</p>					

13.2.2. Behaviour sensitivity test

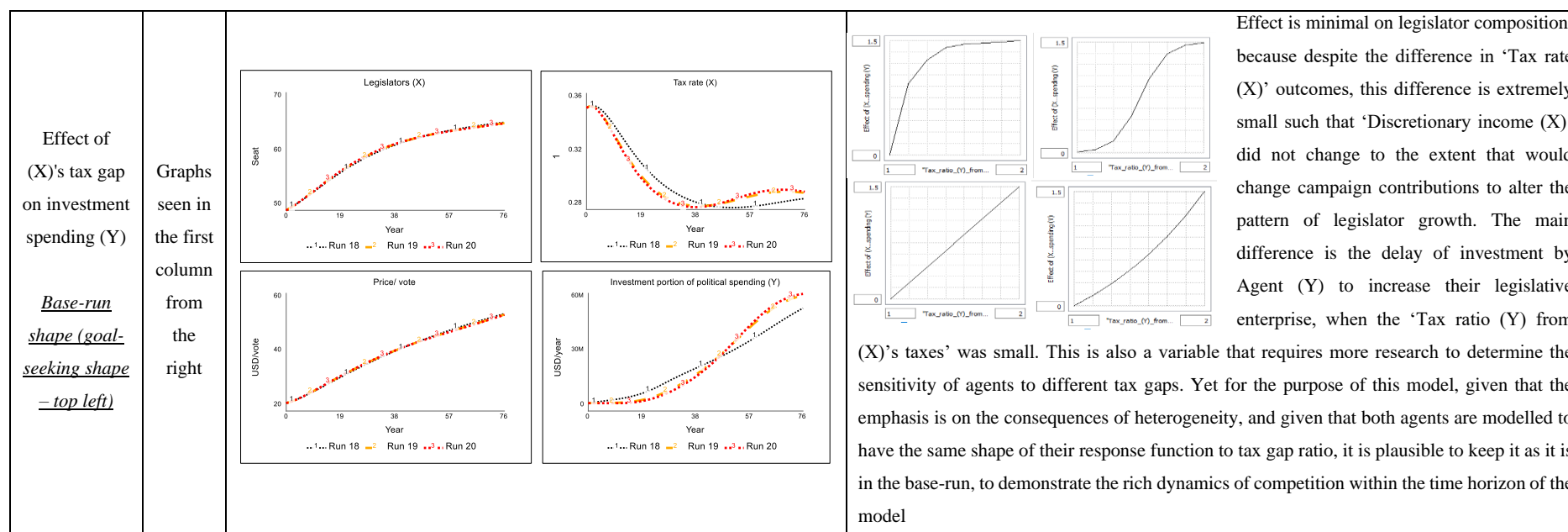
Behaviour sensitivity test aims at locating leverage points in the system by identifying parameters to which the system is highly sensitive (change behaviour mode with changes in such parameters) (Barlas, 1996). These leverage points can be useful in policy formulation that seeks, by its definition, to alter behaviour. Sensitivity analysis also helps deal with uncertainty, where numerical data is scarce or highly uncertain running a sensitivity analysis helps build confidence in a range of values for model parameters which produce the behaviour expected, or observed in the real system. In this research, being theoretical, with limited access to numerical data, a more drastic approach was taken to sensitivity analysis compared to the norms in SD of $\pm 20\%$ by Sterman (2000), where sometimes the sensitivity range exceeded $\pm 100\%$. A comparison would then be made, if behaviour was observably divergent from the base-run, on whether this adheres to the empirical observations of heterogeneity between the agents, or the system generally. If not, then the runs displaying fundamentally different behaviours were considered to be outliers, and changes to the parameter calibration were not made.

It is worth noting that the model in this research displayed low sensitivity to all analyses run on it. This may be explained by referring to the multitude of balancing feedback loops that dampen any changes to the system, including the four feedback loops in the price mechanisms included in this model (B1.3), (B1.4), (B2.2), and (B2.3), as well as the lobbying loops (B3.3), (B5.7), and (B3.4) that compensate for any changes in legislator seat composition (and thus tax rates) by changing investment portion of political spending stocks. Below are some examples of sensitivity runs that were analysed during the validation stage of this study. The number of runs has been unified as 5-runs per test for ease of interpretation and tracking by the reader.

Parameter	Input range	Observed variables	Comments
Probability of outspending resulting in seat win <u>Base-run value = 0.8</u>	0 - 1		The lower the ‘probability of outspending resulting in seat win’, or (p), the less seats Agent (X) will get in the legislator, and thus the higher the legislative enterprise of Agent (Y), enabling ‘Tax rate (X)’ to increase based on ‘(Y) Desired tax rate (X)’. This doesn’t last long, however, because Agent (X) increase their ‘Investment portion of political spending (X)’ to bring ‘Tax rate (X)’ down closer to ‘Desired tax rate (X)’. Note that in RUN-1, where (p=0), because Agent (Y) reached a 100% control over the legislator seats, Agent (X)’s investment (or lobbying) money had no effect because their legislative enterprise was dwarfed by that of Agent (Y). Higher taxes on Agent (X) reduced inequality which increased vote supply, reducing price per vote, while Agent (X) continued to spend billions on lobbying in an attempt to reduce their taxes. Apart from that the system converged in all runs (not sensitive) to bring ‘Tax rate (X)’ to 0.27 to 0.29 (much less than Agent (Y)’s goal of 0.6, and closer to agent (X)’s goal of 0.25)
Influence uncertainty (X) <u>Base-run value = 0.1</u>	0 - 1		The system is not significantly sensitive to changes in influence uncertainty, unless it is perfectly deterministic at 100%, then ‘Legislative enterprise (X)’ is completely useless, Agent (Y) overpowers Agent (X), and ‘Tax rate (X)’ is raised to reach ‘(Y) desired tax rate (X)’ of 0.6. Agent (X)’s investment political spending skyrockets due to the action of (B3.3) in an attempt to bring down ‘Tax gap ratio (X)’. In all the other runs, ‘Investment portion of political spending (X)’ managed to bring tax rate down despite Agent (Y)’s ability to raise ‘Tax rate (X)’ due to Agent (X)’s influence uncertainty. Lobbying harder reduced ‘Tax gap ratio (X)’ afterwhich investment begins to fall.

<p>Marginal propensity to spend on political campaigns (Y)</p> <p><u>Base-run value = 0.0005</u></p>	<p>0.0005 - 0.001</p>		<p>Runs 1 & 2, campaign contributions paid by Agent (Y) started off as lower than those paid by Agent (X) through consumption spending. In the other three runs, Agent (Y) started off as paying higher contributions, thus getting more votes and winning more seats in the legislator. In all runs, however, ‘consumption portion of political spending (Y)’ decreased throughout the simulation run because of three reasons: 1) Market incomes for Agent (X) increased at a higher rate thus increasing ‘Discretionary income (X)’, 2) ‘Tax rate (X)’ fell in all scenarios also increasing ‘Discretionary income (X)’, and finally increase in price caused a larger % decrease in ‘Consumption portion of political spending (Y)’, than that of Agent (X). Because of these three reasons, all runs experienced a decline in vote share of Agent (Y). In Run-3, Run-4, and Run-5, Agent (Y) crossed from being the higher contributor, thus winning more votes, to the less contributing agent. At the point where Agent (X) overtakes Agent (Y), the uncertainty in winning votes by outspending causes a shift in votes when the two agents switched roles of higher spending. The extra votes won by Agent (Y) due to this uncertainty (being the lower spender gains them more votes) caused ‘Legislators (X)’ to immediately drop, stimulating more lobbying spending by Agent (X). The tax rates converge.</p>
<p>Fertility</p> <p><u>Base-run value = 0.0306</u></p>	<p>0.01 - 0.06</p>		<p>There was no effect because increase in fertility rate did increase supply, however it also increased income for both agents as it is calculated on a per capita basis. This means that any increase in voter supply was balanced by an increase in demand via campaign contributions, as aggregate incomes rose at the same rate as population did. Thus any divergence between runs in supply was mirrored by the divergence in demand.</p>

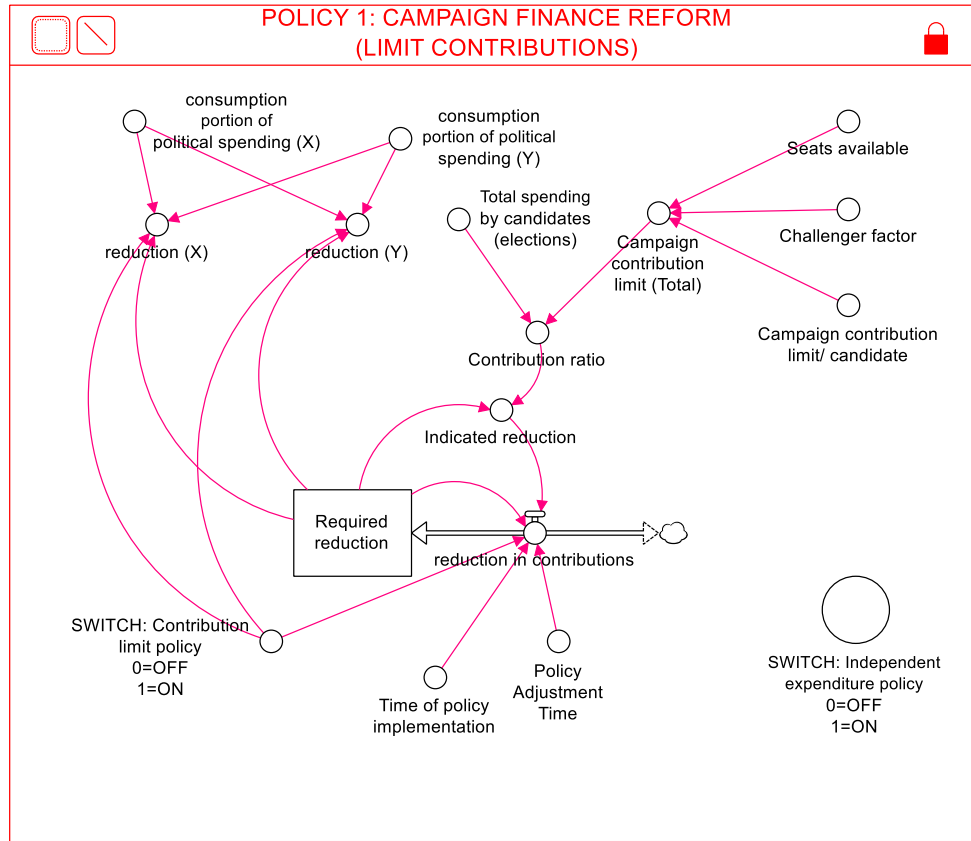
<p>Investment AT (Y)</p> <p><u>Base-run</u> <u>value = 6</u></p>	<p>3 - 12</p>		<p>The main difference between the different runs is not the shape of the graphs, but the phase and amplitude of the graphs (notice ‘Investment portion of political spending (X)’ peaking at different times across runs and reaching different maxima). This is because the lower Agent (Y)’s investment adjustment time, the more vigorous their lobbying spending becomes. A higher lobbying spending by Agent (Y) increases their legislative enterprise and thus they can keep ‘Tax rate (X)’ higher (compared to other runs) for longer (the wavelength of ‘Tax rate (X)’ is highest in Run-1 (where AT=3). Agent (X) balances that increased lobbying of Agent (Y) by increasing their own investment portion of political spending (X)’ via loop (B3.3).</p>
<p>Effect of tax gap on investment spending (X)</p> <p><u>Base-run</u> <u>shape (goal-</u> <u>seeking shape</u> <u>= top left)</u></p>	<p>Graphs seen in the first column from the right</p>		<p>There is a major difference between the base-run shape of this function and the other 3 shapes. The base-run shape is extremely sensitive to small ‘Tax gap ratio (X)’, which explains why the base-run showed a substantially different behaviour to the other runs. Higher investment in political spending resulted in lower ‘Tax rate (X)’, allowing Agent (X) to spend more on campaigns through consumption spending, and thus win more legislators. This points out to an assumption in the model that requires further validation, the sensitivity of investment efforts to small tax gap ratios.</p>



Further behaviour sensitivity tests were conducted on each sector separately during partial model testing as per Homer (1983). Please refer to Appendix 7 for more details.

14. Appendix 5: Policy structure

14.1. Policy (A)



This structure first calculates the total amount of money that ought to be circulating per year (in continuous time) in US Senate elections. This is accomplished by multiplying the limit per candidate (mandated by the law that would be issued), by the number of seats available per year. Yet this assumes that only one individual is running per available seat. To fix that, a ‘Challenger factor’ is multiplied by the limit and number of seats. It is assumed that for every seat, 1.5 challengers will contend.

This ‘Campaign contribution limit (total)’ is compared with the actual campaign money in circulation ‘Total spending by candidates (elections)’, to calculate how much more money is in actual circulation. A ratio approach is used thus the equation below:

$$\text{Contribution ratio} = \frac{\text{Total spending by candidates (elections)}}{\text{Camapign contribution limit (total)}}$$

A hill climbing structure is used to first probe the money in circulation by assuming an arbitrary initial value (probe) of 1 million USD of required reduction, multiplying that amount by the 'Contribution ratio' to determine the 'Indicated reduction'. Required reduction is a stock that adjusts to meet that goal over a 'Policy adjustment time' of one year. This process does not operate unless the policy switch is on. That stock value of 'Required reduction' is then allocated to the two agents using their 'consumption portion of political spending' as the weight. Such reductions are then subtracted from each agent's campaign contributions.

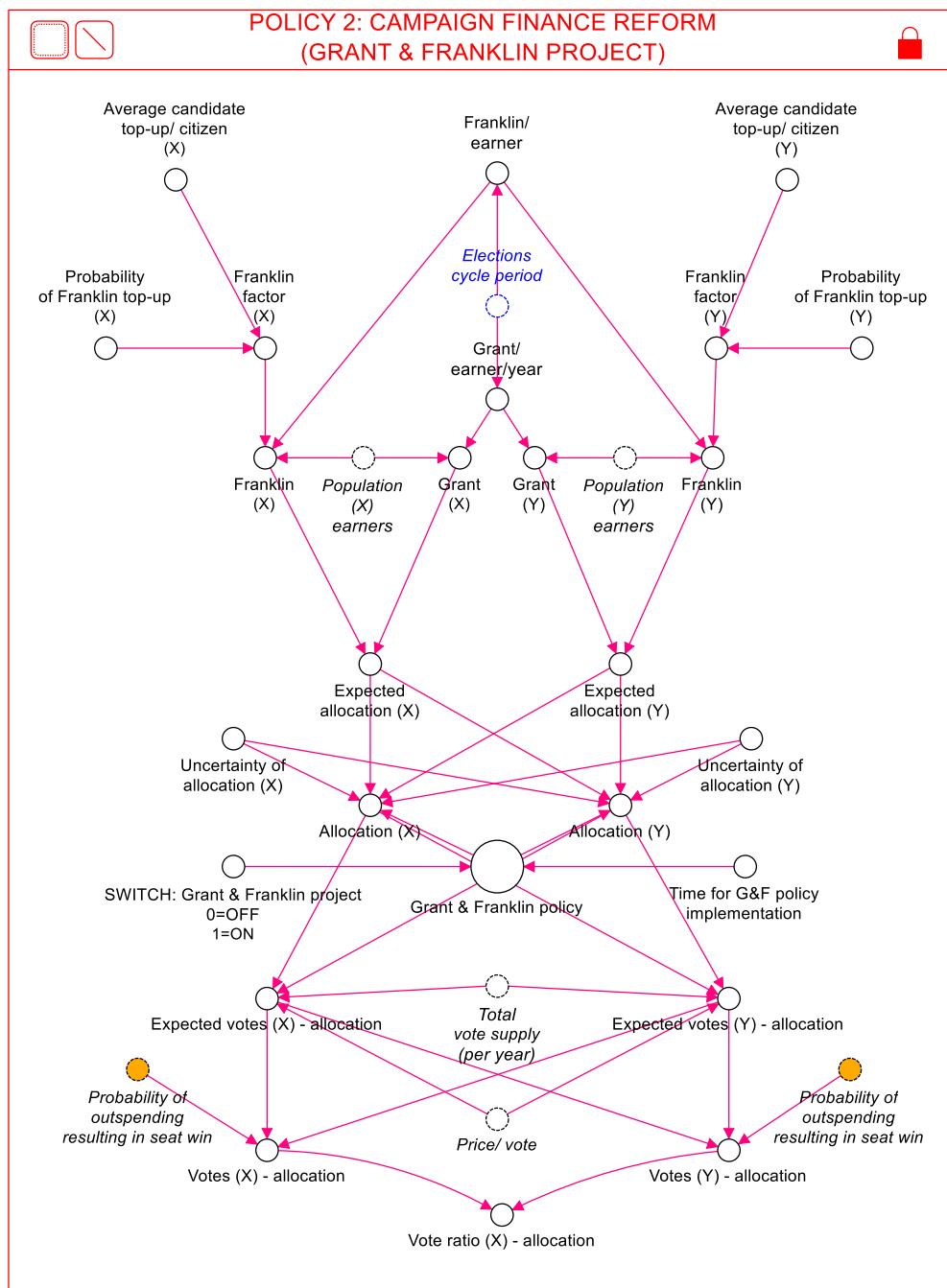
An interesting feature of US campaign finance reform is that contribution limits are deemed constitutional by the US Supreme Court, but not expenditure limits (Issacharoff, 2010). This means that if contribution limits were applied, money would flow into independent expenditures (Issacharoff & Karlan, 1998), which are not given to the candidate running for office, but would be used for political campaigning against the candidate's opponent, or supporting causes on the candidate's agenda. Issacharoff (2010) stated that campaign contributions are regulate-able as they may corrupt, or be viewed by American citizens as corrupting the political process, but political expenditures are seen by the current US Supreme Court as a form of free speech that the state may not infringe upon.

The implications of this distinction between campaign contributions and campaign spending is that if campaign finance reform policy applied contribution limits, then the variables 'Campaign contributions (X)' and 'Campaign contributions (Y)' will be reduced to meet the contributions requirement, but the consumption political spending of the agents will flow to independent expenditure, aimed at convincing voters to vote in a certain direction. Its effect on the campaigns marketplace is still inflationary as it maintains 'Total demand for votes' dependent on large sums of money that go into media campaigns even though they are uncoordinated by the political candidates themselves. It is assumed that the effectiveness of such independent expenditures will be less than money spent directly by the politician to convince eligible voters to actually vote thus the equation of 'Total demand for votes' is expressed as shown below:

Total demand for votes

$$= \frac{\text{Total spending by canddiates (elections)}}{\text{Perceived price/ vote}} + \frac{(\text{Total independent expenditures}) * \text{Effectiveness of independent expenditure}}{\text{Perceived price/ vote}}$$

14.2. Policy (B)



This policy is adapted from Lessig (2011). It's approach may be framed as a combination between making public the now private marketplace of US elections, and maintaining a certain private aspect to it. By using Tax-payer money as the basis for funding campaigns, the project aims to increase the role of small donors in fund-raising for political campaigns. The 'Grant' in the project's name represents Former US President (number 18) Ulysses S. Grant, whose image is printed on the 50 USD bill. He proposed that the state reserves 50 USD of taxes paid by each eligible voter (tax-payer) issuing a voucher for the amount of 50 USD. Each voter then

gets to allocated her voucher to one or more politicians for a given election. Furthermore, each voter may top-up their voucher with a maximum of 100 USD per candidate. This explains the ‘Franklin’ in the name of the project, as the image of founding father Benjamin Franklin is printed on the 100 USD bill.

Determining agent shares in ‘Grant’ is a simple calculation of ‘Grant/earner/year’ multiplied by the population of earners coming from that agent. The ‘Franklin’ shares are more tricky because they involve choices by the donors, which brings us back to the problem of heterogeneity in attitudes between Agent (X) and Agent (Y). This is reflected in the ‘Franklin factor (X)’, and ‘Franklin factor (Y)’. Firstly given that the top-up of 100 USD is voluntary, there must be probabilities of each agent attempting to top-up. For Agent (Y) is assumed to be only 20%, while for Agent (X) it is assumed to be 20%. Furthermore, to how many candidates will each agent/ earner top up? Following the concept of heterogeneity, it is assumed that Agent (X) will top-up to 2.5 candidates, while Agent (Y) will top-up half of that, 1.25 candidates. The ‘Franklin factor’ is the product of those two attributes, outlined below:

Attribute	Agent (X)	Agent (Y)
Probability of Franklin top-up	0.8	0.2
Average candidate top-up/ citizen	2.5	1.25
Franklin factor	2.0	0.25
Uncertainty of allocation	0.1	0.3

There is uncertainty in whether all members of Agent (X) will allocate their Grants and Franklins to candidates coming from their income group, thus an ‘Uncertainty of allocation’ is added to reflect cross-agent allocations. The sum of all Grants, and all Franklins represents the total budgets, and spending of legislator campaigns per year. The same mechanism for determining votes gained per agent is used, using ‘Expected allocation’ for each agent in place of ‘Campaign contributions’ of each agent. There is an uncertainty in the effectiveness of money translating to votes, represented in ‘Probability of outspending resulting in seat win’.

Comparing the allocations of each agent, and taking uncertainty into account, the ‘Vote ratio’ is calculated. Based on that ‘Vote ratio (X) – allocation’ Agent (X), and consequently Agent (Y) each get a share of the seats available in the legislature. Independent expenditures are mitigated, and no agent may donate any money outside the ‘Grant & Franklin Project’ to any political candidate.

If Agent (Y) constitutes 90% of the population, this means that the ratio of Grants (Y) versus Grants (X) will be 9:1. In order for Agent (X) to counter that through Franklins they need to spend 4.5 times the amounts Agent (Y) spend in order to get equal share of contributions. Given that there are limits of 100 USD per candidate per donor, Agent (X) will not be able to concentrate their Franklins so as to counter Agent (Y)'s mass-based contributions. To clarify this point, if nine Agent (Y) voters donated all their Grants to one candidate, if there was only one Agent (X), given the population ratio, and that agent wanted to counter their campaign funds, they could only allocate one Franklin for every single candidate and thus they will not be able to neutralize the emancipatory effect of the 'Grant' scheme. On the other hand, in a population sample of 100 voters, if Agent (X) allocated all their Grants and Franklins to a single candidate, given that all Agent (X) voters topped-up their Grants with Franklins, the total campaign funds raised would be calculated as shown in the below equation:

$$\text{Expected allocation (X)} = \text{Grant (X)} + \text{Franklin (X)} \text{ -----(1)}$$

$$\text{Grant (X)} = \text{Grant per earner per year} * \text{Population (X) earners} \text{ -----(2)}$$

$$\text{Franklin (X)} = \text{Franklin per earner} * \text{Population (X) earners} *$$

$$\text{Probability of Franklin topup} * \text{Average candidate topup per citizen} \text{ -----(3)}$$

Assuming that the voters of Agent (X) will try to influence all candidates in a given election cycle, there are 16.7 seats available per year, thus substituting in equ(3) yields the following:

$$\text{Franklin (X)} = 100 * 10 * 1 * 16.7 = 16,700$$

Substituting in equ (2),

$$\text{Grant (X)} = 50 * 10 = 500$$

$$\text{Therefore} \quad \text{Expected allocation (X)} = 500 + 16,700 = 17,200 \text{ USD}$$

For Agent (Y) to counter that amount, by substituting in equ(2), their Grants would amount to 4,500. Their Franklins can be calculated through equ(3), applying for Agent (Y),

$$\text{Franklin (Y)} = 100 * 90 * \text{Probability of Franklin topup} * 16.7$$

Where the Probability of Franklin topup is the unknown.

$$17,200 = 4500 + 150,300 * \textit{Probability of franklin topup}$$

Solving the equation above yields a probability of 8%. This means that if at least 8% of Agent (Y) donated to all candidates, while 100% of Agent (X) made the same donations, the total amounts raised will be equal and thus the vote share would be equal. If more than 8% of Agent (Y) made top-ups, while 100% of Agent (X) chose to top-up, the Vote share of Agent (Y) would surpass that of Agent (X). Comparing this to the base-run results shows a dramatic change in the system, as mentioned earlier in this chapter that loops (R3.3) and (R3.4) are dismantled in this policy scenario. Of course, there is a high level of aggregation in the above equation and in reality not all voters will top-up all candidates which is why in the calculation of Franklins in the policy structure a variable named 'Franklin factor' is calculated to contrast the number of candidates as well as the probability of top-up by the agents. Furthermore, in the real situation, voters are not expected to give to all candidates of the senate in all states as Senators run for elections on a state-basis. But including the extreme case can inform on the plausibility of the assumptions of the policy structure. In the policy run a vast heterogeneity is assumed in voter behaviour in terms of Franklins, such that the 'Franklin factor (X)' is eight times that of Agent (Y).

15. Appendix 6: Key parameters (Other than heterogeneity parameters)

Variable	Units	value	Description	Justification
Probability of outspending resulting in seat win	Dmnl	0.8	How many of the votes calculated through campaign contributions divided by price for the highest spending agent actually go to that agent?	It would be unreasonable, and empirically disproven, to assume that the higher spending agent wins all the races
$\varepsilon(a)$ Labor ratio elasticity (effect on price)	Dmnl	1	The elasticity of price to imbalances in the supply/demand balance	It is assumed to be linear so as not to add an extra element of nonlinearity to the model
Lobbyist supply sensitivity to price	Dmnl	1	How sensitive is supply to changes in price, does it over invest (>1) or under-invest (<1) at an increasing price?	
$\varepsilon(b)$ Price sensitivity to campaign effectiveness	Dmnl	1	The elasticity of price to imbalances in the supply/demand balance	
$\varepsilon(c)$ Price sensitivity to cost	Dmnl	1	Strength of the effect of cost shocks in campaign media on price per vote	
Sensitivity of GOTV to price changes	Dmnl	1	Strength of loop (B1.4) in response to price changes	
Sensitivity of voter turnout to income inequality	Dmnl	1.5	Strength of loops (B1.5) and (R1.3)	Assumed to be higher than loop (B1.4) since in reality voter turnout for senate elections is around 40%
Fraction self-motivated	Dmnl	0.1	% eligible voters who do not GOTV mobilization in order to vote	Assumed to include both the top 10% (who vote more) as well as some political active voters from Agent (Y)

Normal GOTV build-up time	Year	2	Normal time for GOTV to adapt to prospects in increasing price	Assumed to perceive changes in price every election cycle (6 year terms staggered, thus every 2 years) – ‘Mid-terms’
Fraction redistribution	Dmnl	0.5	% of government tax revenue spent on redistribution	Observed social spending is around 40% of total tax revenue (this is only income tax)
Averaging time	Year	6	How far back does the public observe inequality?	These are assumed to be a term of one senator in a given state, 6 years back and 6 years ahead
Anticipation horizon	Year	6	How far ahead does the public project perceived inequality trends?	

16. Appendix 7: Sectoral analysis (partial model testing)

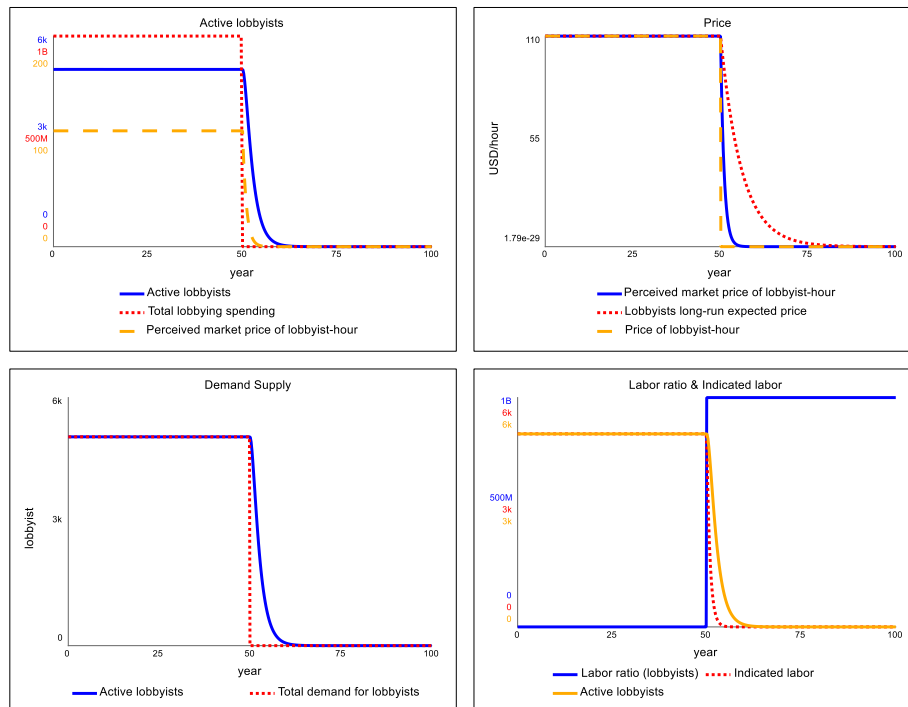
16.1. Lobbying

The sector is initialized in preparation for the below experiments. Base run is initialized at 1 Billion USD lobbying spending/ year. Furthermore, the time horizon of the model is 36 years historically, and 36 years of projection. The tests are run on 100 years, and shocks are introduced in year 50.

16.1.1. Experiment 1: Effect of zero spending on lobbying price mechanism

Total spending is reduced to zero at $t=50$

Results:



Interpretation of results:

When lobbying spending drops to zero, price immediately falls to zero, since the demand-supply balance becomes equal to zero, but since labor ratio is a supply-demand balance, it tends to infinity (for software purposes infinity is assumed to be a labor ratio of 1 billion). Perceived market price take time to adjust “Lobbying price AT”.

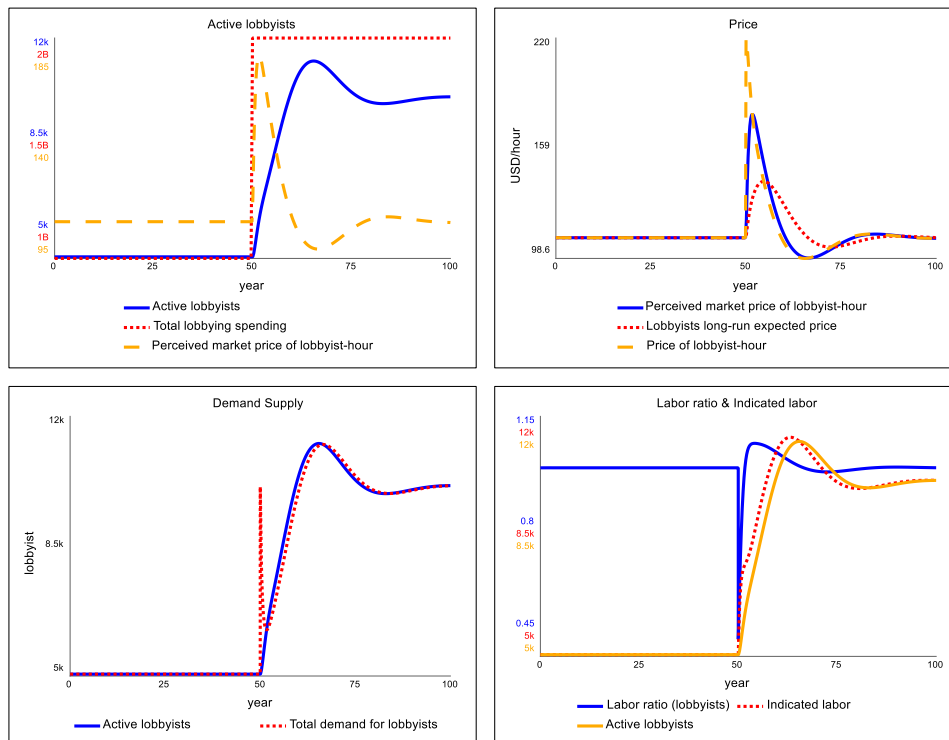
Lobbyist-long run expected price takes more time to adjust and thus reaches zero at $t=74$, because its AT is 6 years, and a known rule is a balancing loop needing 4AT rule to close 98%

of a gap. But “Indicated labor” doesn’t lag as much as “Long-run expected price” because it is a function of a “Perceived demand for lobbying” which adjusts at a faster rate. Thus the goal for (B2.4) reduces to zero in around 4 years, and “Active lobbyists” takes around 8 years to reach zero.

16.1.2. Experiment 2: Effect of doubling lobbying spending by one agent

Lobbying spending (X) is doubled at $t=50$

Results:



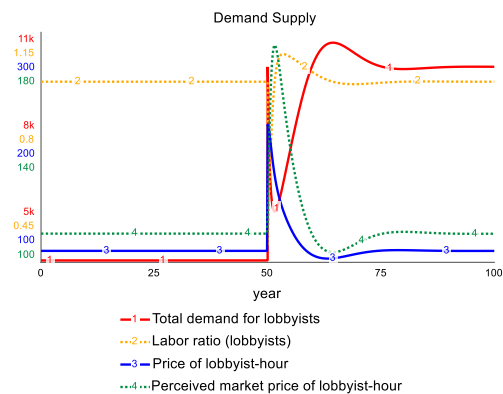
Interpretation of results:

When lobbying spending suddenly doubles, total demand for lobbyists immediately doubles, because it divides the new spending over the initial “Perceived price”. This triggers “Labor ratio” to halve, and thus price doubles. “Perceived market price of lobbyist-hour” lags behind “Price of lobbyist-hour”, as is shown in the graph of to the right, because it is a smooth of price.

As perceived price increases in response to the surge in price, “Total demand for lobbyists” fall over a very short period, which is why the red line (line 1) in the graph to the right has an

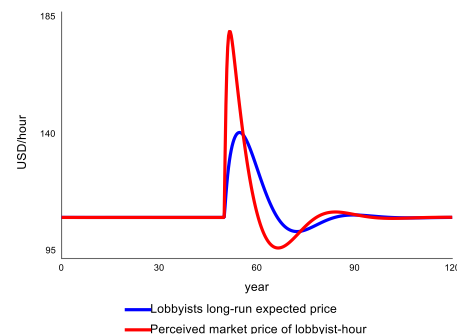
odd shape between $t=50$ to $t=51.68$. This is because of loop (B2.2) and (B2.1) where the initial increase in demand is balanced through the adjustment of price.

After “Perceived market price of lobbyist-hour” peaks at $t=51.68$, it starts to fall following the drop in “Price of lobbyist-hour”. This happens because labor ratio increased as “Total demand for lobbyists” fell in response to the increase in price, below the supply of lobbyists. Supply began to increase as a response to two loops, (B2.3) which reacted to the surge in price to stimulate a higher indicated labor, increasing the goal for (B2.4) that adjusts the number of “Active lobbyists” based on “Perceived demand for lobbying”, and “Effect of price on supply of lobbyists”.



At $t=52$, labor ratio jumps from being less than 1 to exceeding 1, due to the delay in (B2.3), “Labor ratio” overshoots. There is excessive recruitment of lobbyists, beyond the actual demand justifying it. Again this is because of perception delays in the price, and the demand for lobbyists. While supply is more than demand, labor ratio will be more than 1 exerting a downward pressure on price. A declining price leads to an increasing demand in hours/ year, which is why the demand graph increases beyond $t=52$.

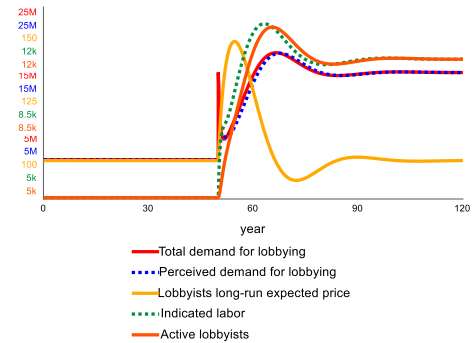
Delays in “Lobbyist long-run expected price” leads to persistence in the high expected price caused initially by the surge in spending reaching a peak at $t=53.8$ while “Perceived market price” peaks at $t=52$,



“Perceived demand for lobbying” is still increasing and peaks at $t=54$, as shown in the graph to the right.

The other delay in supply comes from a smooth of demand “Perceived demand for lobbying” which lags behind demand increasing as a result of a declining price. This indicates that supply will continue to increase to overtake demand requirements due to such delays.

“Perceived demand for lobbying” lags behind “Total demand for lobbying”, thus is of a lower value when demand is increasing, but given that “Indicated manhours needed” is a function of “effect of price on supply of lobbyists”, their product makes indicated labor peak at $t=63$, as shown in the figure to the right. This results in Active lobbyists to peak at $t=65$. This increase in supply



is reducing price and increasing demand further to peak at around $t=66$. Initially this is because of (R2.2), from $t=52$ to around $t=60$. But the behaviour of labor ratio becomes goal-seeking as a result of (B2.2) and (B2.1) decelerating it. As long as labor ratio is more than 1, price will be falling but goal of (B2.1) “Price of lobbyist-hour” is a dynamic goal that aims to match demand with supply, which is why the behaviour turns from negative exponential growth to goal seeking from $t=60$ to around $t=66$. At $t=66$, perceived price reaches its lowest point, concurrently demand is at its peak. Because of the delay in (B2.1), perceived price dips below the equilibrium price, and demand overtakes supply (until $t=84$).

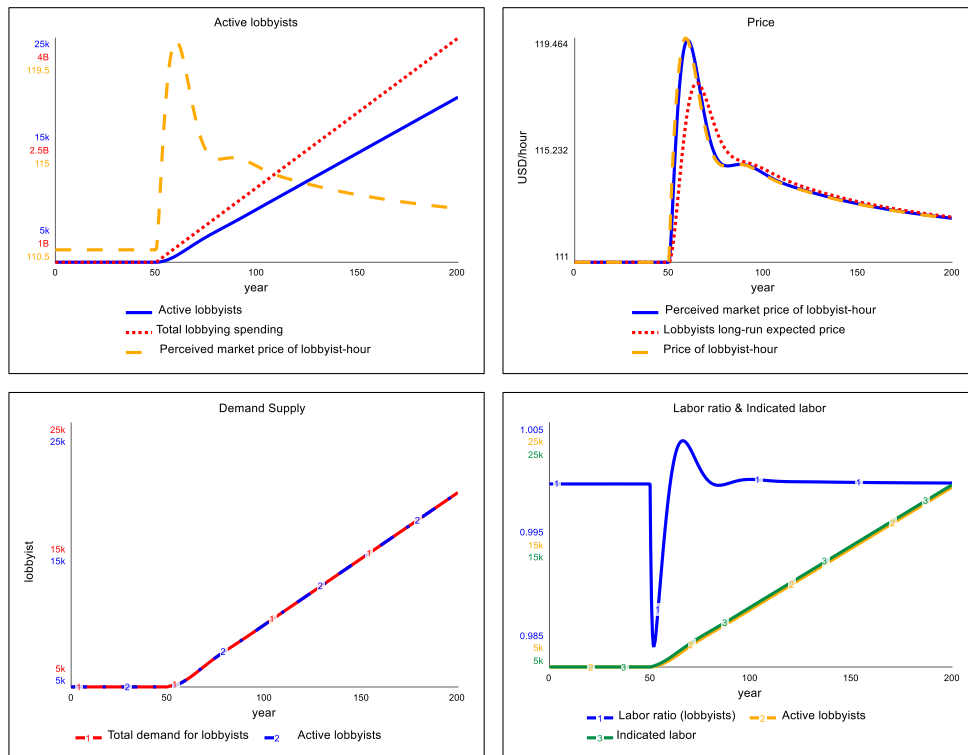
This labor ratio exerts an upward pressure on price, thus demand decreases, which increases labor ratio towards 1. Demand continues to fall as “Perceived market price” rises while supply declines in response to a falling “Indicated labor” which reaches its lowest point at $t=72$ (around 7 years after the trough of “Perceived market price”). After which the rise in “Lobbyist long-run expected price” triggers an increase in indicated labor at around $t=82$, when the “Effect of price on supply of lobbyists” becomes large enough. “Active lobbyists” adjusts accordingly and overtakes demand at $t=85$.

Labor ratio is just above 1, and continues to increase very slowly, until it stabilizes at around $t=100$.

16.1.3. Experiment 3: Effect of a RAMP-UP (linearly increasing) lobbying spending by one agent

Lobbying spending (X) is increased via RAMP function of 10 Million USD/ year at $t=50$.

Results:



Interpretation of results:

When Lobbying spending begins to increase at $t=50$, “Total demand for lobbying” increases, as it is a function of “Total lobbying spending” over “Perceived market price of lobbyist-hour”. This causes a drop in “Labor ratio”, which raises “Price of lobbyist-hour”. Price keeps rising while “Labor ratio” is less than 1. Price is increasing decreasingly because of “Labor ratio”, which started increasing as soon as the rate of change of “Active lobbyists” exceeded that of “Total demand for lobbyists”. The former being a function of “Indicated labor” which is influenced by “Perceived demand for lobbying” and “Lobbyists long-run expected price” increase, and result in an accelerated recruitment.

Since “Active lobbyists” takes time to adjust to its goal, it will always lag and be less than “Indicated labor” at increasing demand. But this “Indicated labor” does not represent accurately market demand.

This is because “Perceived demand for lobbying” lags behind, and is less than “Total demand for lobbying”. Yet “Lobbyist long-run expected price” lags behind “Price” and thus keeps increasing for longer, and when it drops, it is higher than market price. Given that “Indicated labor” is a function of both perceived demand, and perceived price, if the “Effect of price on supply of lobbyists” overpowers the underestimation of

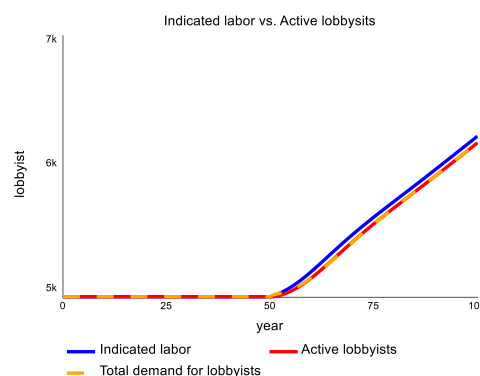
“Total demand for lobbying”, “Indicated labor” is overestimated. It is a classical case of an increasing goal in which the stock never catches up to the goal. This explains why despite “Active lobbyists” being equal to “Total demand for lobbyists”, “Indicated labor” is still higher than both.

“Total lobbying spending” is increasing at a constant rate, but “Total demand for lobbying” is affected by perceived price, which means that as long as price is increasing, it has a negative effect on demand. The

fact that demand is increasing nonetheless means that the rate of increase of “Campaign contributions” exceeds the rate of increase of perceived price.

Due to the effects on supply, mentioned above, supply exceeds demand and “Labor ratio” exceeds 1. After this point price starts to decline. The declining price causes demand to increase at a delay, and reduces “Effect of price on supply of lobbyists”. When both effects combine to reflect a declining price (B2.3) dominates, “Indicated labor” causes “Lobbyist adjustment” to slow down, such that the increase in “Active lobbyists” is less than that in “Total demand for lobbyists”.

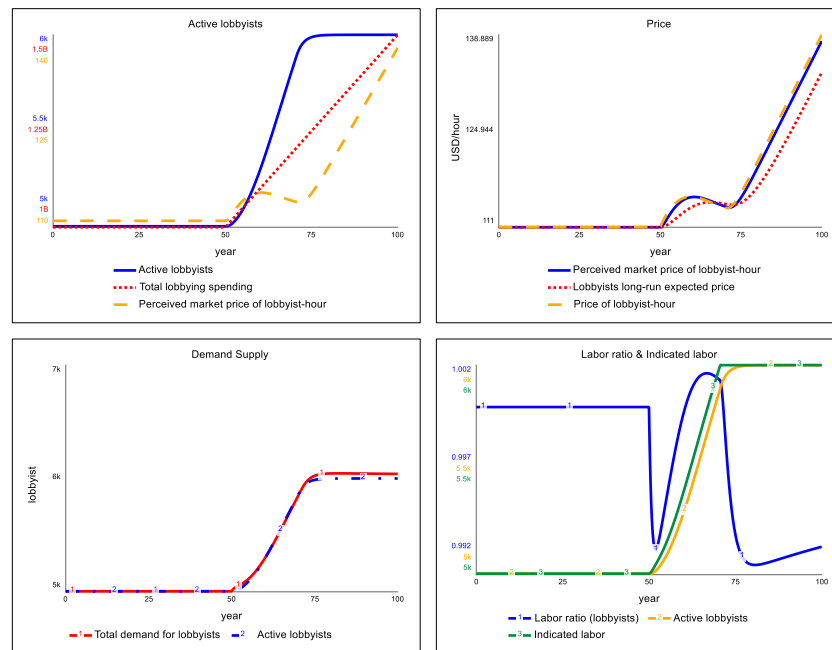
This continues until “Labor ratio” undershoots 1 again, due to over-adjustment again, as a result of the delay in perceiving demand and price. At that point price begins to rise in response and the cycle is repeated again. The system does not reach equilibrium as price is continuously decreasing due to a “Labor ratio” exceeding 1. This is because of the over-adjustment of “Active lobbyists” as a result of the “Effect of price on supply of lobbyists” as the new equilibrium price is above the initial price.



16.1.4. Experiment 4: Effect of a RAMP-UP (linearly increasing) lobbying spending by one agent with Supply constraint

Lobbying spending (X) is increased via RAMP function of 10 Million USD/ year at $t=50$. “Maximum active lobbyists” is capped at 6000 Lobbyist.

Results:



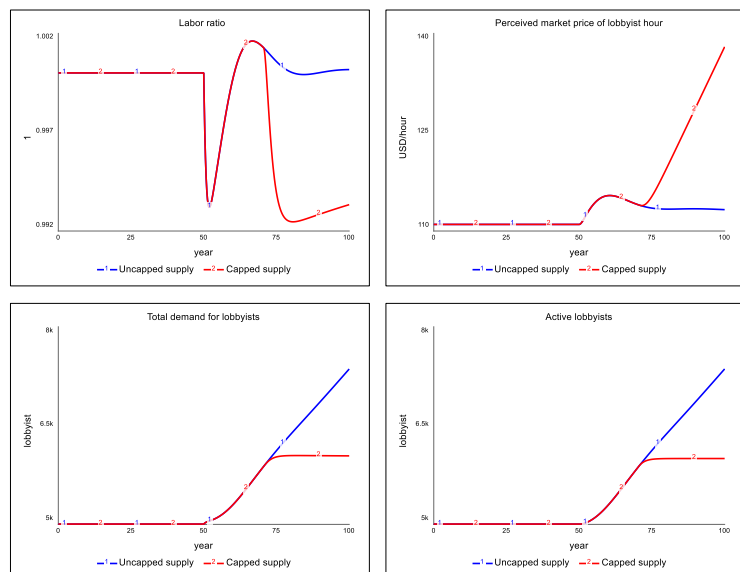
Interpretation of results:

Up to $t=71$, the behaviour of this experiment is identical to that of experiment 3 (section 1.1.2.3.), where “Maximum active lobbyists” is reached.

In the previous experiment, the supply constraint was relaxed such that the limit would not be reached within the simulation time.

As soon as the supply limit is

reached, as is shown in the comparative graphs below at $t=71$, “Labor ratio” immediately drops,

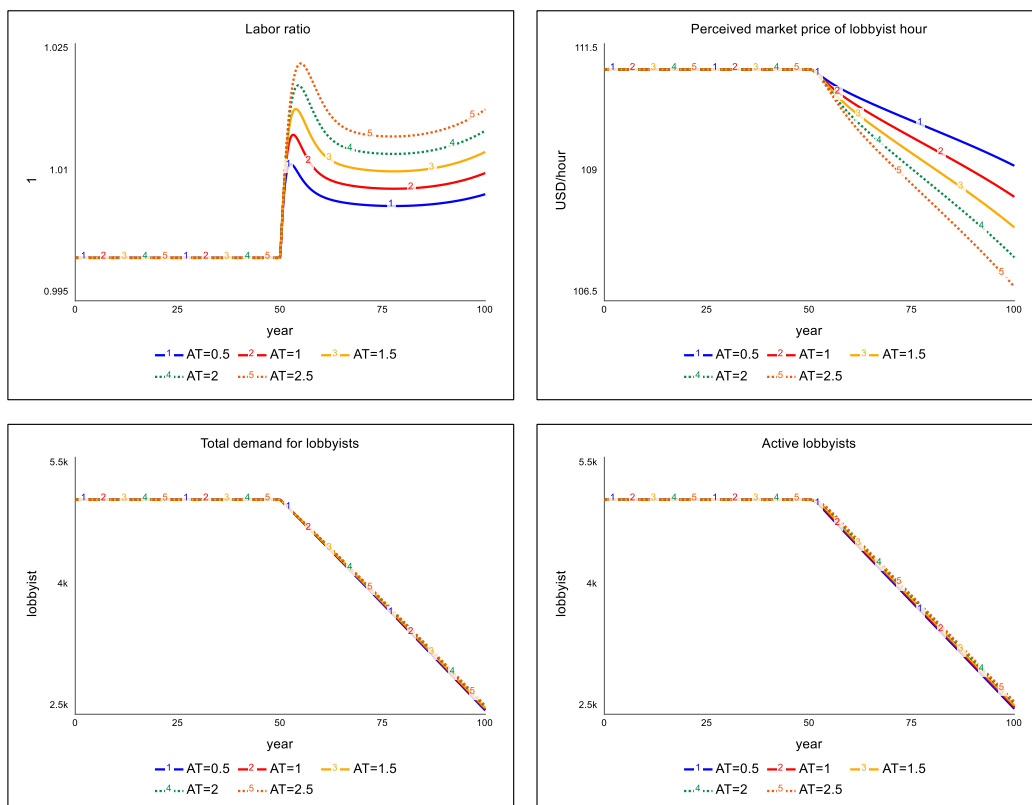


causing a surge in price, which reflects at a delay in “Perceived market price of lobbyist hour”, this reduces demand due to (B2.2), which attempts to restore “Labor ratio” to 1. (B2.3) is ineffective as it is undercut by the supply constraint, thus the increase in demand due to rising “Lobbying spending (X)” is compensated for by an increase in price. Price will never stabilize because of the increase in spending, and “Total demand for lobbyists” is always calculated on perceived price, which in an ever-increasing spending scenario, will always produce demand that is higher than what is indicated by instantaneous “Price of lobbyist-hour”.

16.1.5. Experiment 5: Effect of a RAMP-down (linearly decreasing) lobbying spending at different Supply Adjustment times

5 Runs: Lobbying spending (X) is decreased via RAMP function of (10) Million USD/ year at $t=50$. “Lobbying supply AT” is varied between 0.5 and 2.5 years.

Results:



Interpretation of results:

First of all, As “Lobbying spending” drops it triggers (B2.2) to reduce price in order to balance the change in demand, as well as (B2.3) to reduce supply via (B2.5). The rate at which supply

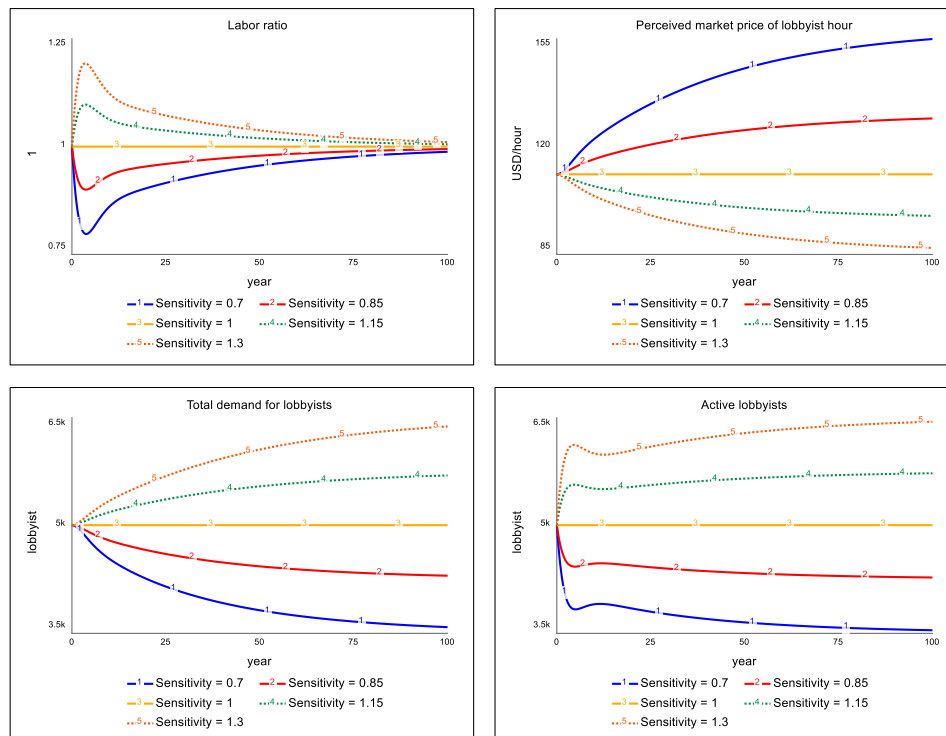
adjusts “Lobbying supply AT”, affects the amplitude of the change (increase) in “Labor ratio” immediately after $t=50$. The more time it takes for Supply to adjust (decrease) in response to the reduced demand, the higher supply/demand balance gets and thus the sharper the drop in price, as is shown in the graph below in “Perceived market price of lobbyist hour”. This can be interpreted in terms of the loops (B2.2) and (B2.3) and (B2.5).

If (B2.5) is slow, (B2.2) will be dominant in balancing “Labor ratio”, which will result in a lower price.

16.1.6. Experiment 6: Effect of different Supply Sensitivities to price at constant lobbying spending

5 Runs: Lobbying spending (X) is decreased via RAMP function of (10) Million USD/ year at $t=0$. “Supply sensitivity to price” is varied between 0.7 and 1.3.

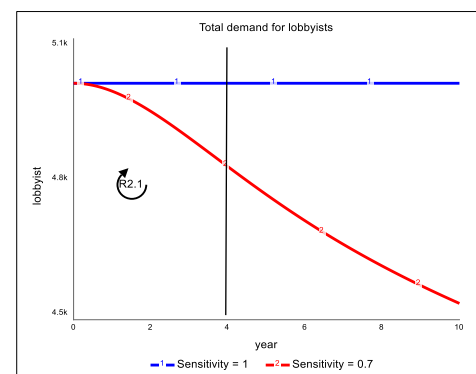
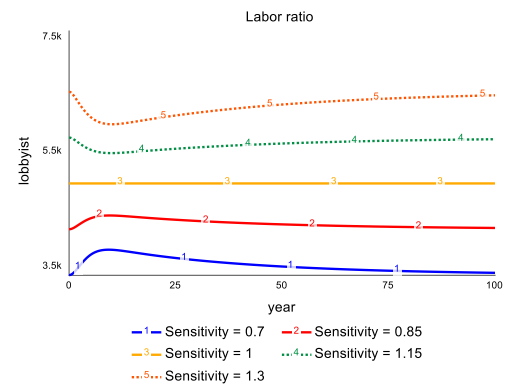
Results:



Interpretation of results:

At low “Sensitivity of supply to price”, the response of “Indicated labor” to changes in price is damped, which means that a decrease in price will not cause a strong enough reduction in “Active lobbyists” to reduce “Labor ratio”. The blue line of Run1, shows that there is a brief transient of about 4 years due to the initial conditions of the model. Because sensitivity is lower than the base run, The initial price indicates a lower number of “Active lobbyists” thus Active lobbyists drop further which pushed price up. This can be shown in the figure to the right where “Indicated labor” is less than the initial stock level. The first 4 years are a correction of this issue. While labor ratio is falling, (R2.1) is dominant over “Perceived market price of lobbyist-hour”, because labor ratio causes price to increase rapidly which creates an almost linear increase in “Change in perceived price of legislative subsidy”. This creates a behaviour similar to exponential growth in “Perceived market price of lobbyist-hour”, and since “Total demand for lobbyists” is a constant divided by perceived price, demand shows a negative exponential growth in the first 4 years, as can be observed below.

The effect of this rapidly decreasing demand is an increasing labor ratio



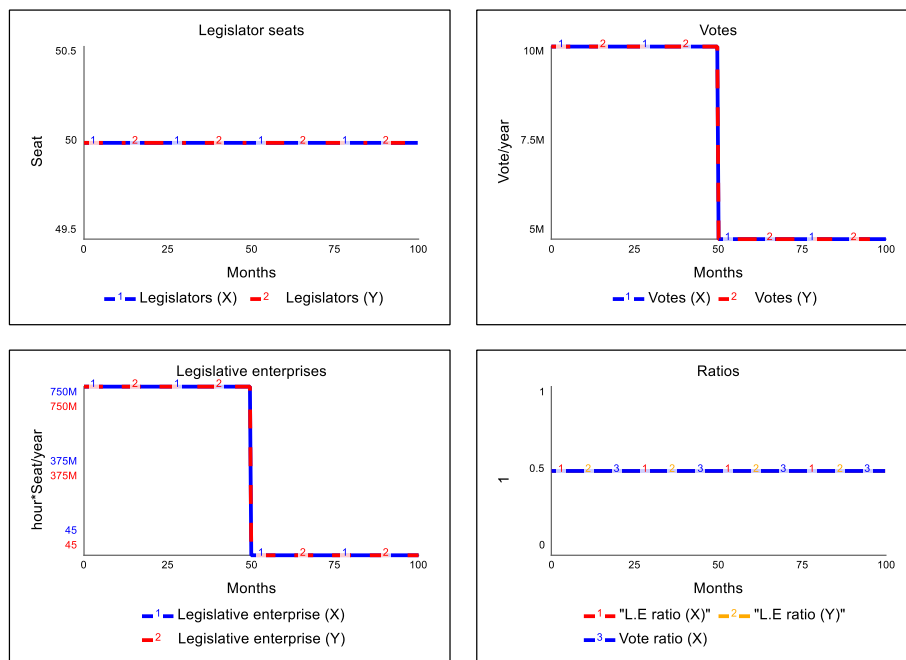
16.2. Legislator

Base run at equal campaign contributions at 100 Million USD per agent/ year, and lobbying spending 500 Million USD per agent/ year.

16.2.1. Experiment 1: Effect of zero campaign contributions and zero lobbying spending on legislators and legislative enterprise

“Campaign contributions (X)” and “Campaign contributions (Y)” reduced to ZERO via a step function at $t=50$. Moreover, lobbyist spending for both agents is reduced to zero at $t=50$.

Results:



Interpretation of results:

There is no relative advantage when both agents reduce their campaign contributions to zero. This leads to votes dropping from 10 Million for each agent to 5 Million each. This is because when there is no more campaigning the only voters who go to the ballot are the “Self-motivated voters” who are assumed to be equally distributed between the 2 Agents. Thus “Vote ratio” remains constant.

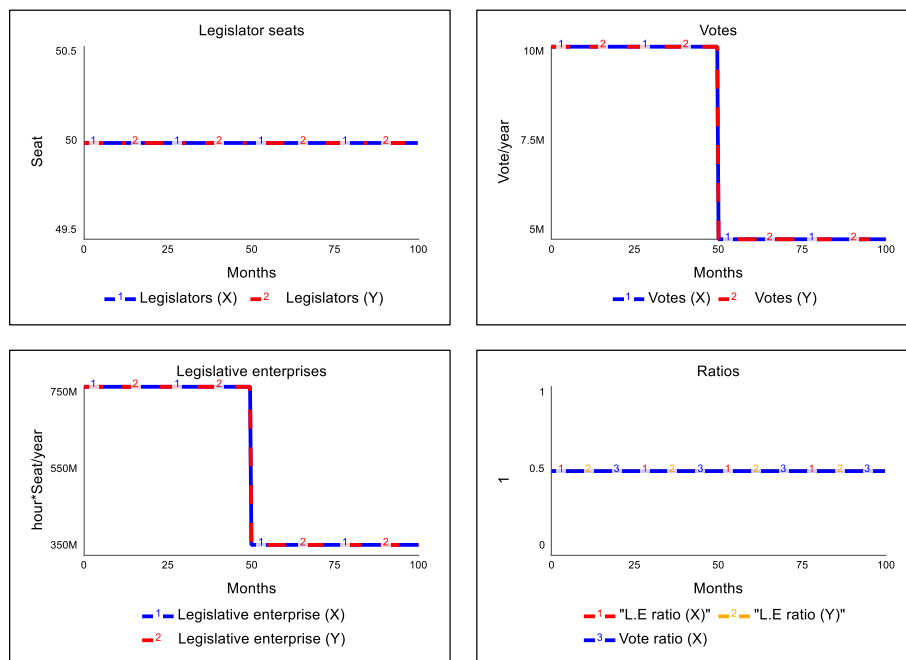
When lobbying spending drops to zero for both agents, their legislative enterprises sharply fall to 50 hour*seat/ year. This is because there is a MAX function which prevents the legislative enterprise from going to zero in case lobbying is blocked. It is realistic because then legislative enterprise is equal exactly to the number of seats each agent has.

Influence uncertainty is 0.1 for this run, which is why the number of legislators drops to 45 seats per Agent rather than 50. “L.E. ratio (X)” and that of (Y) are unchanged due to the symmetry in lobbying spending.

16.2.2. Experiment 2: Effect of price changes on legislators and legislative enterprise

For campaigns rice shock of 10 USD/ vote introduced at $t=50$, and for lobbying spending a price shock of 30 USD/hour introduced at $t=50$.

Results:



Interpretation of results:

Since initially the spending of both agents is equal, changes in market price does not affect the relative power between them and the purchasing power of both declines equally in response to price increase. Shown in the above graph that both votes and legislative enterprises decrease

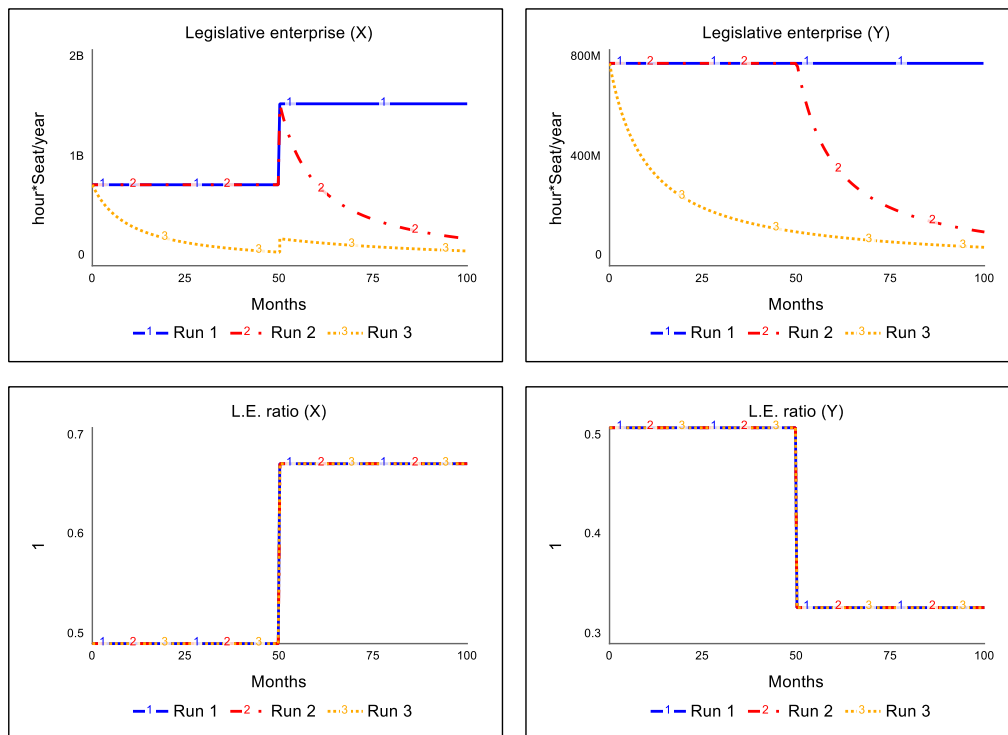
with the sudden increase in price, but since spending did not change, the ratios comparing Agent (X) and Agent (Y) have remained constant.

16.2.3. Experiment 3: Effect of lobbying spending changes and an increase in Lobbyist-hour price on Legislator enterprise

3 runs, in Run1, Lobbying spending (X) doubles at $t=50$, and Run2 is the same as Run1 in addition to an increasing price with a ramp of +3 USD/year at $t=50$, Run3 is the same as Run1 in addition to increasing price with a ramp of +3 USD/year at $t=0$.

There is no effect on campaigns since campaign contributions and “Price/ vote” are held constant.

Results:



Interpretation of results:

At constant price of lobbyist-hour, a sudden increase in spending by Agent (X) results in a surge in L.E. ratio (X) upwards from 0.5 to 0.67, and a decline of L.E. ratio (Y) to 0.33.

When price suddenly starts to ramp in the case of Run2, each year the constant amount of spending buys less hours, which is why the graph is diminishing for “Legislative enterprise (X)” and “Legislative enterprise (Y)”. They thus both decline but Agent (X) compensates by spending more at $t=50$, thus possess a higher enterprise starting $t=50$.

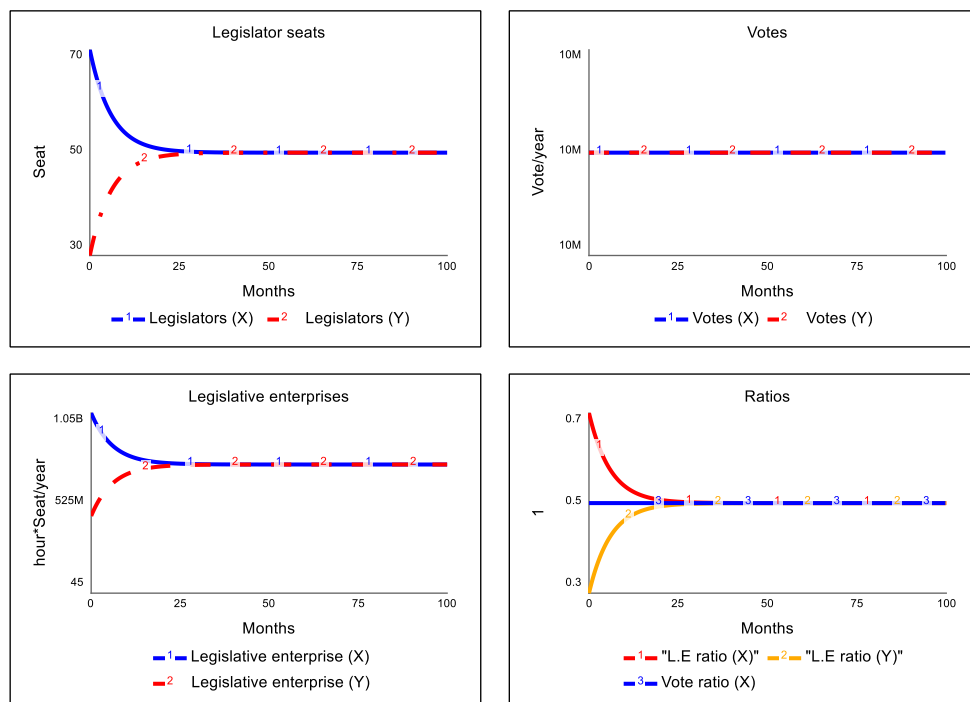
When price is rising starting $t=0$, Run3, both legislative enterprises are declining at the same rate but at $t=50$, “Legislative enterprise (X)” doubles from 125 million hour*seat/year to 250 million hour*seat/year while that of Agent (Y) is 125. Both continue declining as price increases but Agent (X) has gained an advantage that is sustained.

In all 3 cases, since the surge in spending by Agent (X) occurs at $t=50$, the L.E. ratios only change then, and since the amount of increased spending was the same the effect, regardless of what happens to price, is effect in relative terms is the same.

16.2.4. Experiment 4: Effect of equal campaign contributions on legislator seats at unequal initial seats per Agent

“Initial seats (Y)” is equal to 30 seats while “Initial seats (X)” is equal to 70 seats at $t=0$.

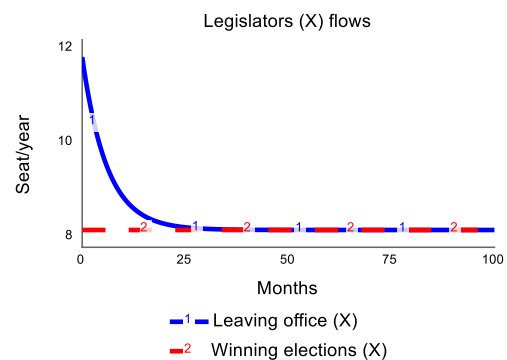
Results:



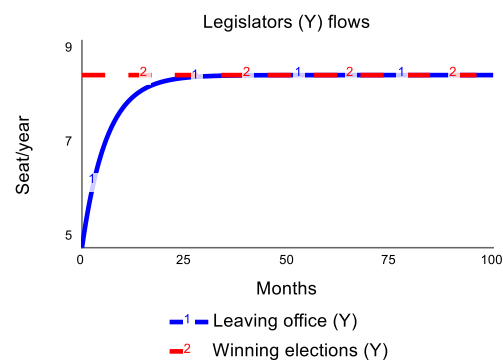
Interpretation of results:

“Vote ratio (X)” determines how many seats go to Agent (X) every time step. (1 - “Vote ratio (X)”) determines seats that go to Agent (Y). Since votes are proportional to campaign contributions, then regardless of initial values of seats in the stocks “Legislators (X)” and “Legislators (Y)” (R3.1) and (R3.2) are equal in strength. The sum of outflows of both stocks, namely “Seats available” is constant because the outflows are a function of a fixed “Term of legislator” and the stock value. Since the sum of the stocks is constant = 100 seats, then the sum of both outflows is equal to 100 divided by 6 years, the legislator’s term.

Thus for Agent (X) who started off with more seats, the inflow (constant) is less than the outflow (function of the higher stock value). This leads the stock to decrease. As the stock decreases so does the outflow “Leaving office (X)” because it is a function of the stock. This is why the behaviour shown on the right is goal seeking. It is (B3.1) balancing the stock such that outflow falls until it reaches the value of the inflow. At constant and symmetric lobbying spending, the legislative enterprise follows the pattern of the stock “Legislators (X)” until equilibrium is reached at around $t=24, 4$ “Leaving office”.



For Agent (Y), The inflow is greater than the outflow because the outflow is a function of the stock with less agents than the 50 required to equilibrate with the inflow. Thus the stock rises and so does the outflow. The more the stock rises, the less the net flow becomes, thus the stock continues to rise at a diminishing rate until inflow is equal to outflow at around $t=24, 4$.

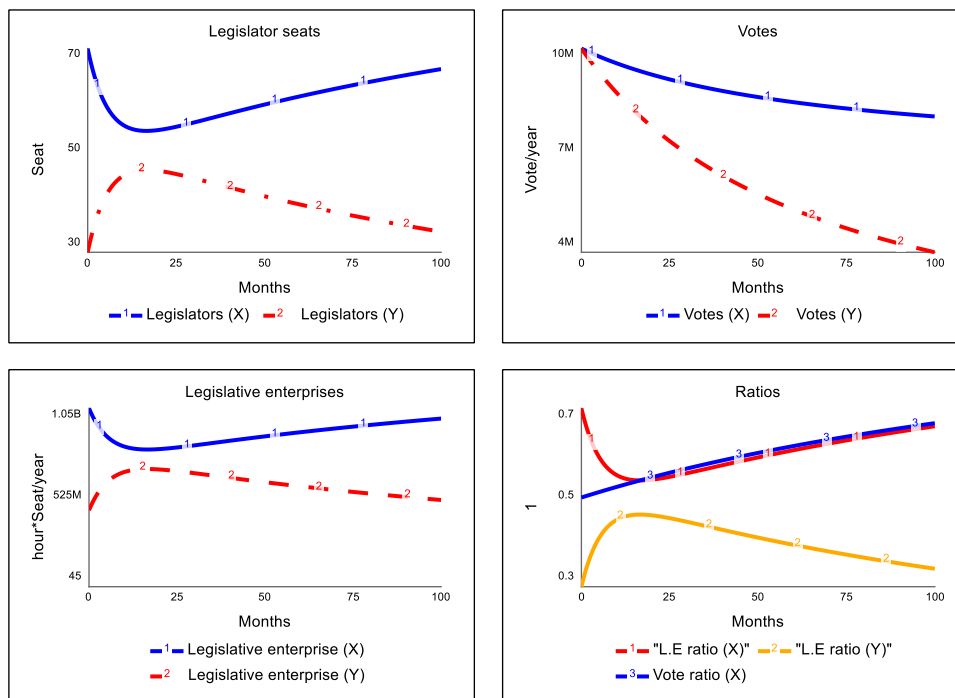


At constant symmetric lobbying spending, “Legislative enterprise ratio (Y)” follows the same pattern as the stock of “Legislators (Y)”.

16.2.5. Experiment 5: Effect of unequal campaign contributions ($X > Y$) on legislator seats at unequal initial seats per Agent ($X > Y$)

“Initial seats (Y)” is equal to 30 seats while “Initial seats (X)” is equal to 70 seats at $t=0$. “Campaign contributions (X)” includes a RAMP function (1 Million USD/ per year). Price/ vote” is expected to increase thus Price is changed with a RAMP (0.15 USD/year) to account for loop (B1.3)

Results:

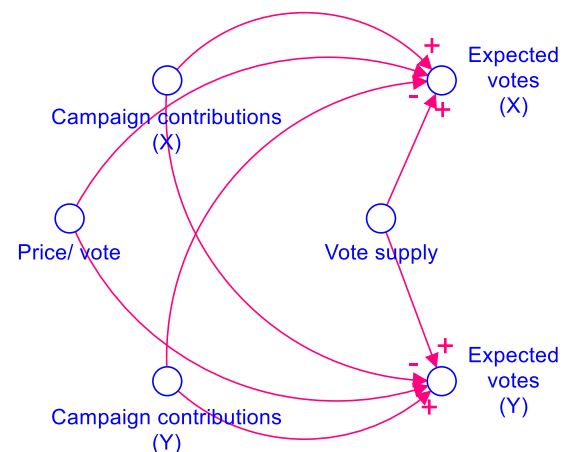


Interpretation of results:

It is important to understand the constraints put in place in the model to ensure its results are realistic.

In situations where “Price/ vote” is too little, having not caught up with a sudden increase in campaign contributions, a situation might arise in which the sum of “Expected votes (X)” and Expected votes (Y)” exceeds the total vote supply, which would be a logical mistake.

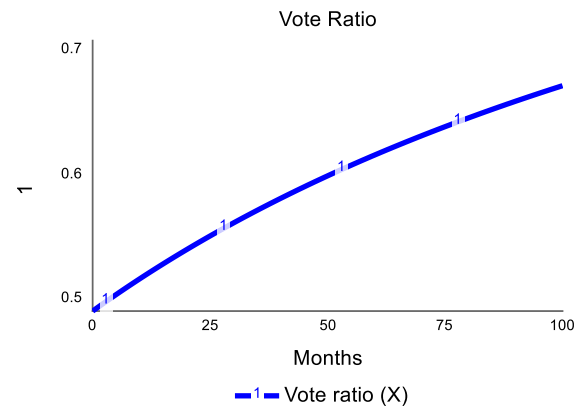
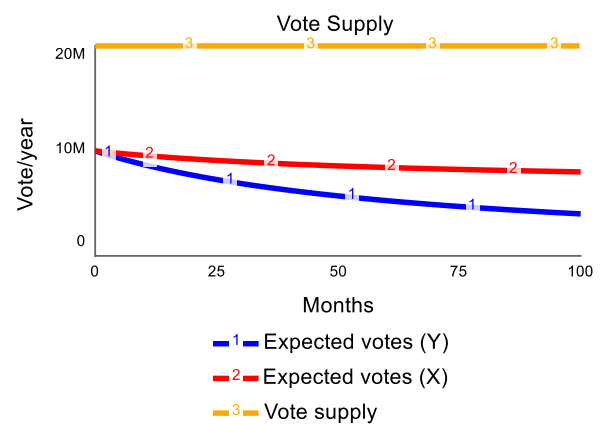
Thus a condition is set in this situation to make sure the votes are distributed realistically.



$$\begin{aligned}
 \text{"Expected votes (X)" = MIN("Campaign contributions (X)" / "Price/ vote",} \\
 \text{"Campaign contributions (X)" } \\
 * \text{"Vote supply" / ("Campaign contributions (X)" } \\
 + \text{"Campaign contributions (Y)")}
 \end{aligned}$$

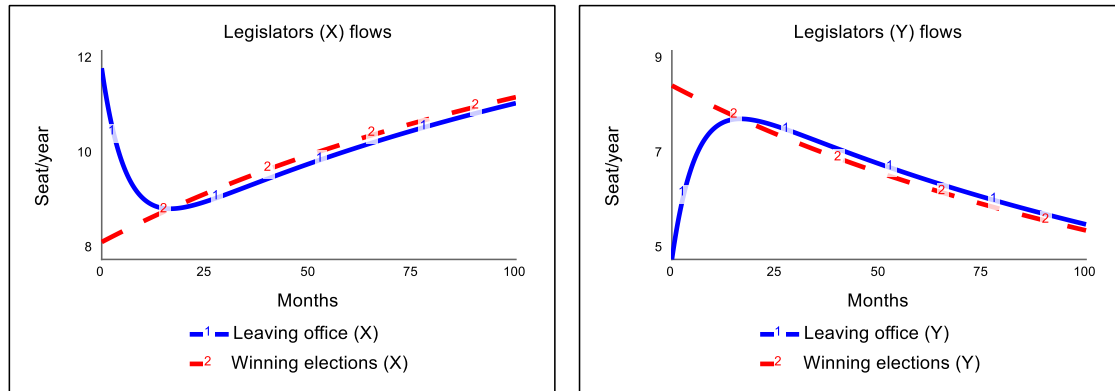
This equation makes sure that when price is too low, inconsistent with increased spending, that votes gained by both Agents does not exceed the total supply, which is then distributed based on the relative contributions of each.

In the case of experiment 5, since price is increasing corresponding to the increasing "Campaign contributions (X)", the aforementioned constraint does not apply, as is shown in the figure to the right. It may seem counterintuitive that the graphs of "Expected vote (X)" and that of (Y) are non-linear given the ramp functions are linear, however it has to do with the rates of change of both the "Campaign contributions" and "Price/ vote". If price is increasing at a faster rate, which could be due to supply constraints or a high sensitivity of price to changes in the supply/ demand balance, this could happen. Thus the denominator in the equation of "Expected votes (X)" is increasing at a higher rate than the numerator, which causes the slope of the graph to decrease with time, as is shown in the figure.



Given that the variable "Probability of outspending resulting in seat win" is 100%, "Votes (X)" follows the exact same pattern as "Expected votes (X)". Since the rate of decline of "Votes (X)" is less than that of "Votes (Y)", due to the fact that "Campaign contributions (X)" are increasing while Campaign contributions (Y)" are stagnant, "Vote ratio (X)" is increasing. Since the rate of decrease of both votes is decreasing, so does the "Vote ratio" increase decreasingly, as is shown in the figure describing "Vote ratio".

The effect of this is crystalized in the graphs below, where the inflow “Winning elections (X)” is increasing decreasingly, and “Winning elections (Y)” which is equal to “Seats available”, a constant, multiplied by $(1 - \text{“Vote ratio (X)”})$ is decreasing decreasingly.

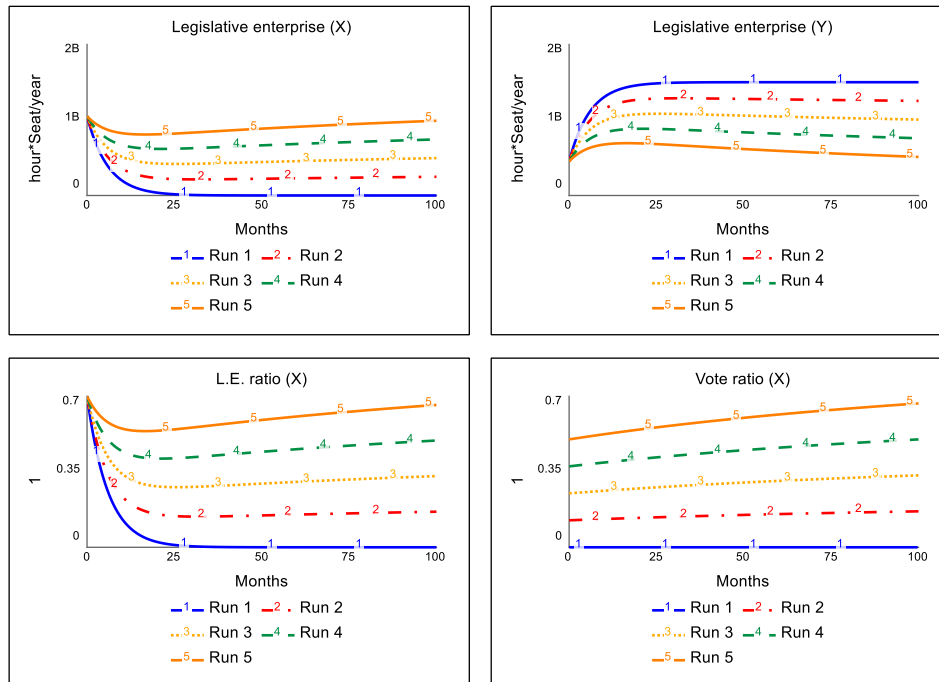


Before $t=16.6$, “Leaving office (X)” is higher than “Winning elections (X)” because the stock is too large having a large outflow, but because the net flow on “Legislators (X)” is negative, the stock is falling and so is the outflow. The stock does not equilibrate because in this experiment “Campaign contributions (X)” is not balanced and continues to increase beyond the equilibrium point. This causes inflow to outtake outflow and the stock of “Legislators (X)” increases, which increases “Leaving office (X)” beyond its minimum value at $t=16.6$.

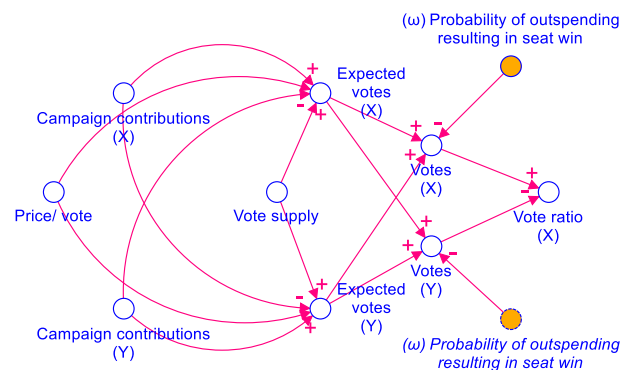
The opposite occurs in “Leaving office (Y)”, in the beginning the net flow is positive which results in an increasing stock “Legislators (Y)” and a corresponding increase in “Leaving office (Y)”. It does not equilibrate because “Winning elections (Y)” keeps declining beyond $t=16.6$, which switches net flow to negative and the stock is declining. Since the inflow is decreasing decreasingly, and the outflow is a function of the stock, then (B3.2) is also decreasing decreasingly, and the net flow is negative but becoming less negative.

16.2.6. Experiment 6: Effect of unequal campaign contributions ($X > Y$) on legislator seats at unequal initial seats per Agent ($X > Y$) under campaign uncertainty

Experiment 5 is repeated but with different values for “ (ω) Probability of outspending resulting in seat win”. 5 Runs: $0 \leq (\omega) \leq 1$

Results:**Interpretation of results:**

“(ω) Probability of outspending resulting in seat win” is a parameter that represents the uncertainty of campaign money translating into votes. It is why voting is split into 2 stages in the model: Campaign contributions divided by “Price/ vote” yields “Expected votes”, but taking uncertainty into account gives actual votes gained by each Agent.



It is structured in a way to yield the agent who spends more less votes than they expect. In this experiment Agent (X) spent more with a RAMP function stating $t=0$. The lower (ω) is, the higher the uncertainty thus lower values of (ω) gives Agent (Y) an advantage as demonstrated by the Results above. At (ω)=0, While Agent (X) outspent Agent (Y), all the votes went to Agent (Y), which is why the graph of “L.E. ratio (X)” approached zero. At (ω)=1, the same results as the previous experiment. The remaining values of (ω) shift the balance in favour of Agent (Y), such that at (ω)=0.75, the vote ratio begins at $0.75 \times 0.5 = 0.375$, to reach a value of 0.5 at $t=100$. Before reaching that value, Agent (Y) is getting more votes.

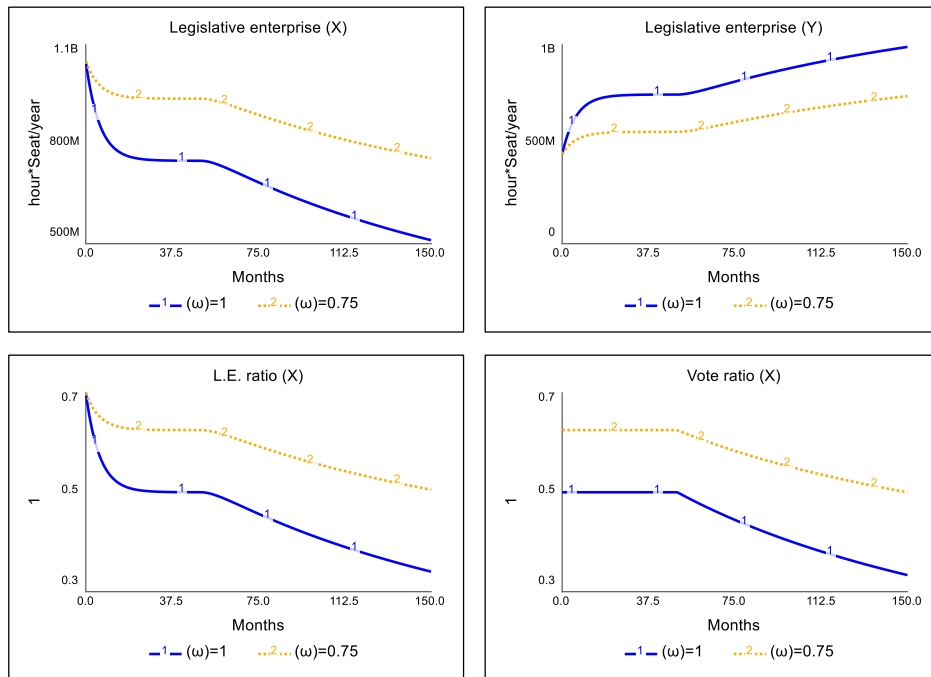
This is because the equation to calculate votes takes away the uncertain percentage of expected votes and transfers them to the agent who spent less, as is shown below:

$$\text{"Votes (Y)" = [(1 - \omega) * \text{"Expected votes (X)"}] + [\text{"Expected votes (Y)"}]}$$

16.2.7. Experiment 7: Effect of unequal campaign contributions (Y>X) on legislator seats at unequal initial seats per Agent (X>Y), under uncertainty

“Initial seats (X)” = 0.7, “Initial seats (Y)” = 0.3. Equal campaign contributions until t=50, a RAMP is introduced in “Campaign contributions (Y)”. 2 Runs: (ω)=1, (ω)=0.75.

Results:



Interpretation of results:

Up to t=50, “Legislators (X)” were higher than “Legislators (Y)” thus “Legislative enterprise (X)” is falling while “Legislative enterprise (Y)” is increasing. New votes are being distributed equally amongst candidates of the 2 Agents, thus for “Legislators (X)” outflow exceeds inflow until around t=24, where net flow=0 and the stock stabilizes. The opposite is happening to “Legislators (Y)”. When “Campaign contributions (Y)” begin to ramp up at t=50, they start getting more votes reflected in a decreasing “Vote ratio (X)” beyond t=50. At (ω) = 0.75, this

effect is dampened because the uncertainty of outspending resulting in a definite win of votes over the opponent transfers some of the votes from (Y) to (X).

This means that loops (R3.3) and (R3.4) can be disrupted if (ω) is reduced.

Both (R3.3) and (B4.2) are linked to “Consumption portion of political spending (X)” and thus their outcomes are represented by “Campaign contributions (X)” and thus “Legislators (X)”. Thus experiments will be conducted using different values for “Legislators (X)” which is kept exogenous in this sector.

Concerning Legislative enterprise, I cut loop (R3.5) with different values for “Price/ lobbyist hour”, (R3.7) with different values for “Legislator (Y)”, “Investment portion of political spending (Y)” and “Influence uncertainty (Y)”. Finally, I replace (R4.3) with different values for “Investment portion of political spending (Y)”.

For “Outcome uncertainty (X)”, and its effect on “Tax rate (X)” I change values for public outcry to experiment with loops (B4.7) and (B4.X).

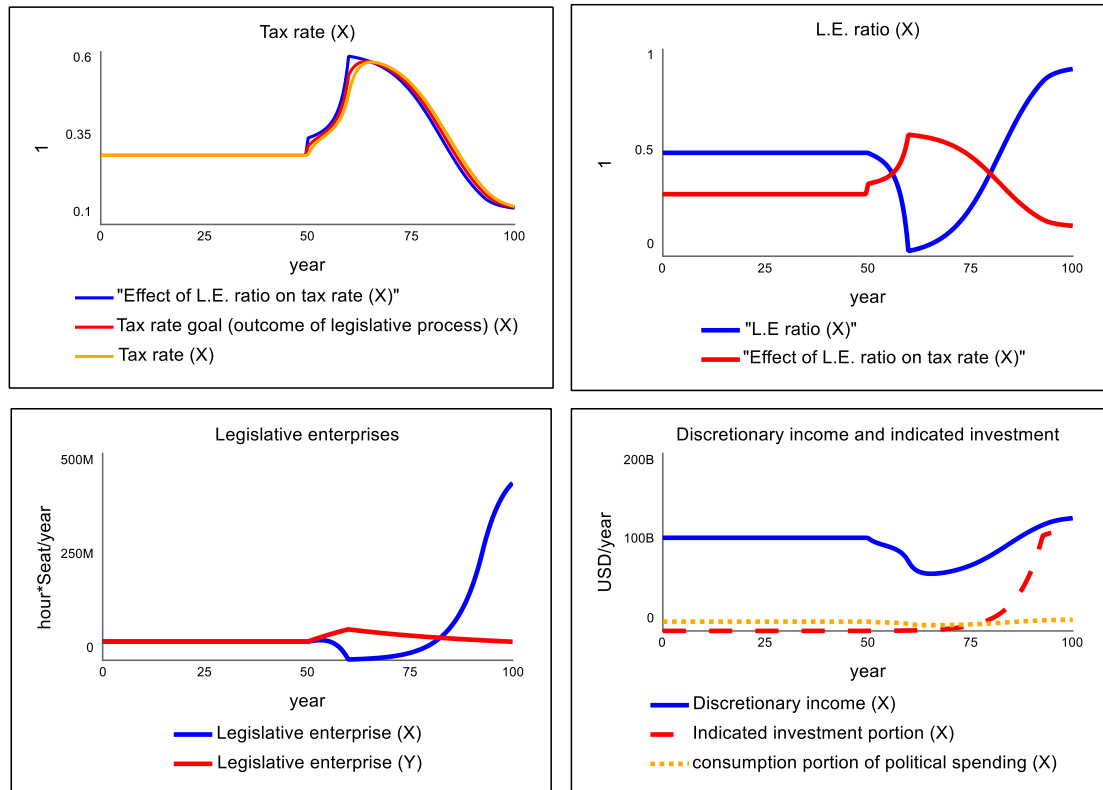
The model is initialized by keeping income constant, tax rate goals are met for both (X) and (Y), and “Investment portion of political spending (X)” is equal to that

16.3. Agent (X)

16.3.1. Experiment 1: Effect of zero Campaign contributions (X) on Tax rate (X)

Legislators is reduced via a RAMP of (-6) at $t=50$, with a minimum “Legislators (X)” of 0.5 seats.

Results:



Interpretation of results:

Dropping Campaign contributions (X) to 0 will result in a gradual depletion of legislators over a period of around 8 years (4 AT, whereby outflow has an AT of 2 years) and zero Campaign contributions would result in a very small number voting for the agent who spends less (as a result of the uncertainty associated with outspending resulting in wins)

Yet as long as there is uncertainty, Agent (X) will still get some votes and thus their total number of “Legislators (X)” will not be equal to zero. It is assumed that the minimum number of seats they have if they stopped campaigning altogether is 0.5 seats.

This condition is necessary to show how (B3.3) works, as any deficiency in the number of legislator seats will be compensated for by Lobbying spending, to attempt to close “Tax gap ratio”.

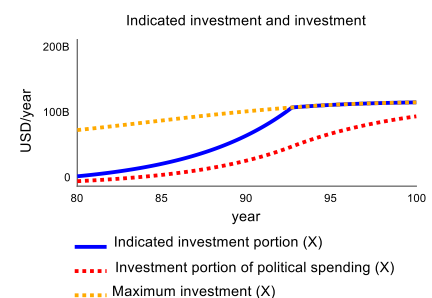
At $t=50$, “(Y) desired tax rate (X)” increases from 0.3 to 0.6, at the same time “L.E. ratio (X)” falls immediately after $t=50$, which causes a step in “Effect of L.E. ratio on tax rate (X)”. This causes tax rate to increase at a delay, which activates (B3.3). This results in an exponential growth in “Investment portion of political spending”, while the “Effect of tax ratio gap on investment spending” immediately maxes out (because of the large tax gap), (R4.1) causes “Indicated investment” to increase exponentially.

A stock with an exponentially increasing goal produces exponential growth. Till $t=59.9$, that causes exponential growth in “Lobbying spending”, which is multiplied by a steeply declining number of “Legislators (X)”, which results in negative exponential growth in “Legislative enterprise (X)”. During that same period, “Legislative enterprise (Y)” is increasing because of the seats “Legislators (X)” is losing. This results in the pattern of “L.E. ratio (X)” between $t=50$ and $t=59.9$, which results in an exponential growth pattern in “Tax rate (X)”.

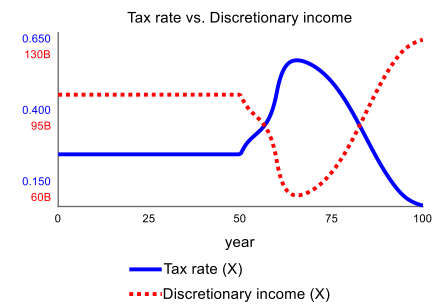
A minimum value was set for “Legislators (X)” at 0.5 seats, which is reached at $t=59.9$. Beyond that point, there is no further increase in “Legislative enterprise (Y)”, and all the change in “L.E. ratio (X)” originates from “Legislative enterprise (Y)”. Since legislator numbers stopped changing, the only change in “L.E. ratio (X)” after $t=59.9$ till $t=92$, is due to (B3.3).

S-shaped pattern of “Investment portion of political spending” causes the same pattern in “Lobbying spending”, “Legislative enterprise (X)” and dominates loop (R3.7) to cause the same pattern in “L.E. ratio (X)”. This translates to an inverted S-shape in “Effect of L.E. ratio on tax rate”, as it gives higher weight to the lower “Desired tax rate (X)”. “Tax rate (X)” follows that same inverted S-shaped pattern.

Starting $t=92.5$, Maximum investment is reached, which is a result of loop (R4.2). This can be seen clearly in the graph of “Indicated investment portion (X)” to the right.



Note that despite (R4.2) being a reinforcing loop, it follows a mirror image pattern of tax rate, which means that the reason for “Maximum investment (X)” having a somewhat goal-seeking behaviour is because it is proportional to discretionary income, which follows the mirror shape of Tax rate as is shown in the graph to the right.



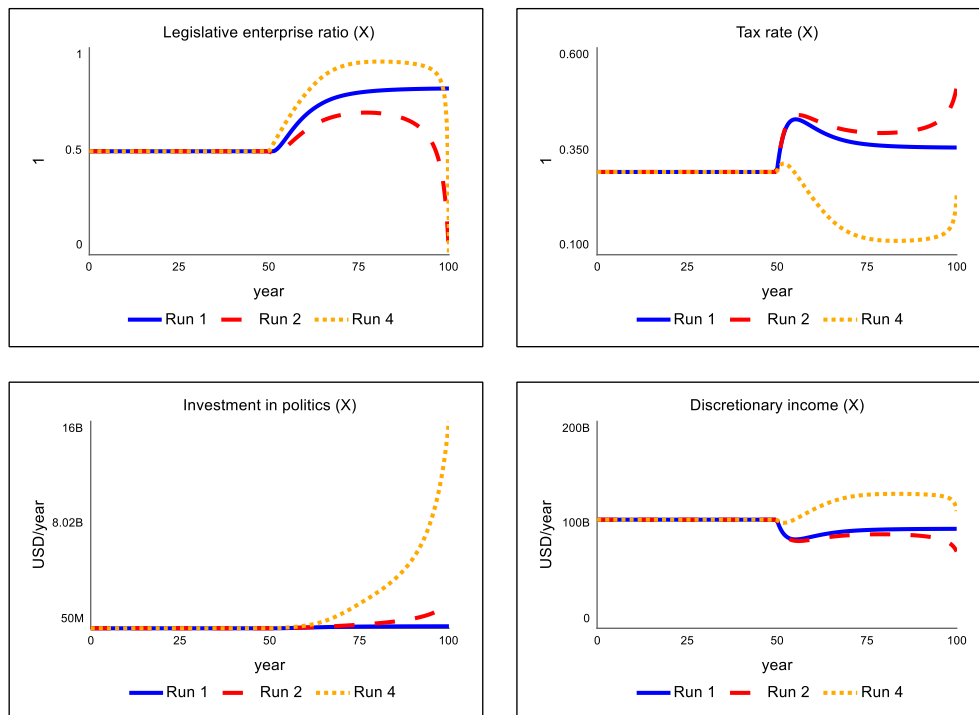
16.3.2. Experiment 2: Effect of reducing campaign contributions (X) on Tax rate (X)

Run1: “(Y) desired tax rate (X)” is increased from 0.3 to 0.6 at $t=50$

Run2: Run1, with “Legislator (X)” is reduced via a RAMP of -1 seat/year starting $t=50$ (since reducing campaign contributions will result in less seats in the legislator).

Run3: Run2, with “Desired tax rate (X)” falling from 0.3 to 0.1 at $t=50$.

Results:



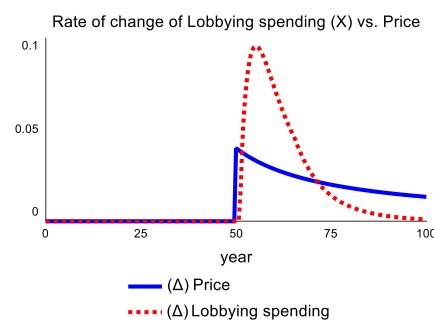
Interpretation of results:

Run1 outlines Agent (Y) taking on Agent (X) by increasing “(Y) desired tax rate (X)” at $t=50$, while Agent (X) is at full force. The different between Run1 and Run2 is that in Run2, As agent (X) reduces campaign contributions to ZERO, the effect is a reduction in number of

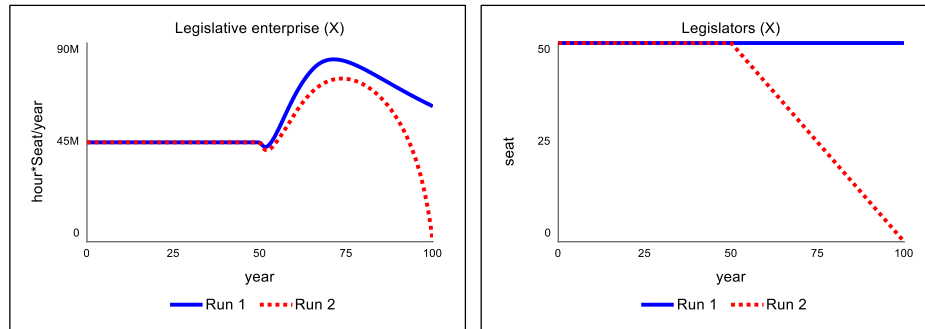
“Legislators (X)” gradually (see section 1.3 for more details on how “Legislators (X)” respond to “Campaign contributions (X)”. The decline in “Legislators (X)” and the concurrent increase in “Legislators (Y)” causes an increase in “Legislative enterprise (Y)”.

This change in legislators is simplified as linear in this experiment via a RAMP function, yet in the model it is goal seeking behaviour. Thus if the outcome, as is seen in Results above, is non-linear when the change is linear, then it is expected that the shape of “L.E. ratio (X)” will be different to the results obtained above.

Comparing “Legislative enterprise (X)” across Run1 and Run2 shows a decreasing “Legislative enterprise (X)” between $t=50$ and around $t=51.6$. This is because of the rates of change of Lobbying spending versus those of price of lobbyist hour. As is observed in the graph to the right, (Δ) Price (as a % of price) is higher than that of (Δ) Lobbying spending (as a % of Lobbying spending) between $t=50$ to $t=51.6$, which makes the numerator of “Legislative enterprise (X)” increasing at a rate below that of the denominator for 1.6 years. Beyond that “Lobbying spending (X)” increases at a rate higher than that of price. This phenomenon can occur if “ $\varepsilon(a)$ Labor ratio elasticity (effect on price)” is higher than 1 (Please refer to section 1.2.7 Experiment 7 for details).

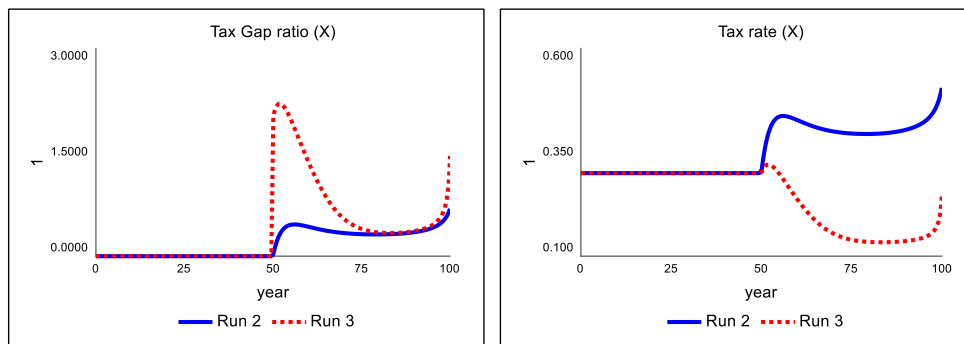


The graph then rises in an S-shaped growth from $t=51.6$ until around $t=71$ in Run1, and $t=74$ in Run2. This is because it follows the shape of “Lobbying spending (X)” which is equal to “Investment portion of political spending (X)”. The latter has a goal, “Indicated investment portion” that has a goal-seeking shape. A goal-seeking shaped goal produces S-shaped growth, because as “Indicated investment portion” is increasing, the gap between it and the stock is increasing, and for balancing loop (B4.3) this means an increasing inflow which produces exponential growth from $t=50$ to $t=59$. As the goal starts increasing decreasingly (stabilizes) due to the dominance of (B3.3) which reduces “Tax rate (X)” according to the shape of “Effect of L.E. ratio on tax rate (X)”, the investment portion and thus “Lobbying spending (X)” increases decreasingly. As “Lobbying spending slows down to almost stabilize, “Price of lobbyist-hour” continues increasing (could be due to supply constraints or price elasticity) which is why Legislative enterprise begin to fall. Another added reason in Run2 for this decline is the decline in Legislator seats for Agent (X).

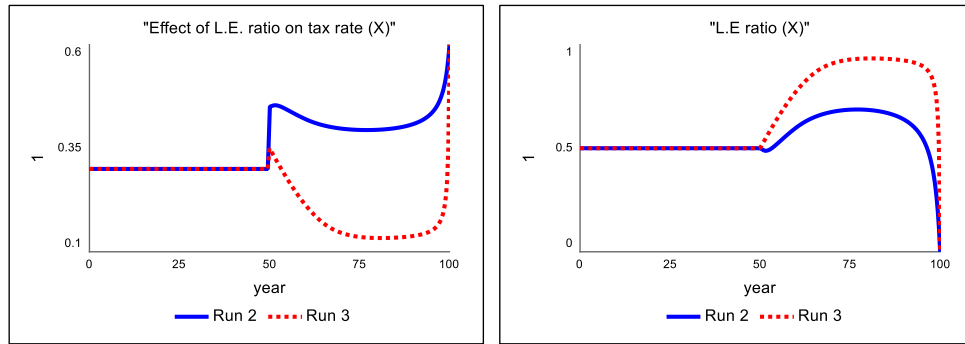


That decline causes Agent (X) to spend more for longer, because its loss in Legislative enterprise reflects a higher tax rate, which increase “Tax gap ratio (X)” resulting in a stronger (B3.3). Spending more for longer causes the peak of the curve “Legislative enterprise (X)” to peak at a later point in time ($t=74$), but the decline in Legislator seats is too steep, which is why in Run2, legislative enterprise dives rapidly in a negative exponential growth curve because a positive exponential growth “Lobbying spending (X)” is multiplied by a sharply decreasing “Legislators (X)”. That effect is not present in Run1, as “Legislators (X)” is constant.

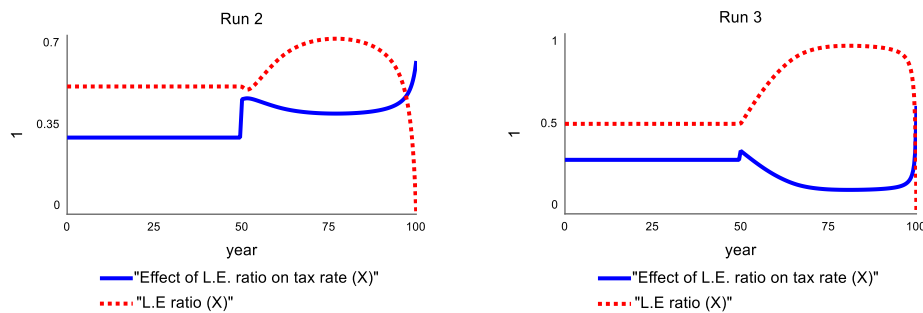
Run3 is an exaggerated version of Run2, where the rate of decline of “Legislators (X)” is the same as that in Run2, but the “Tax gap ratio” is much larger than in Run2 due to the drop in “Desired tax rate (X)” at $t=50$.



“Tax rate (X)” initially increases from $t=50$ to $t=52$, because “Legislative enterprise (Y)” is more than that of Agent (X), which is overturned due to exponentially increasing “Lobbying spending (X)”. The increase lobbying spending increases “L.E. ratio (X)” which reduces “Tax rate goal (outcome of legislative process)” as shown in the graph below:



The graph below clarifies more the inversely proportional relationship between “L.E ratio (X)” and “Effect of L.E. ratio on tax rate (X)” because the larger the effect, the more weight is added to “Desired tax rate (X)” which is always lower than that of Agent (Y). A loss in “Legislative enterprise (X)” translates to a lower “Effect of L.E. ratio on tax rate (X)”, resulting in an increased tax rate goal and thus a higher “Tax rate (X)”.

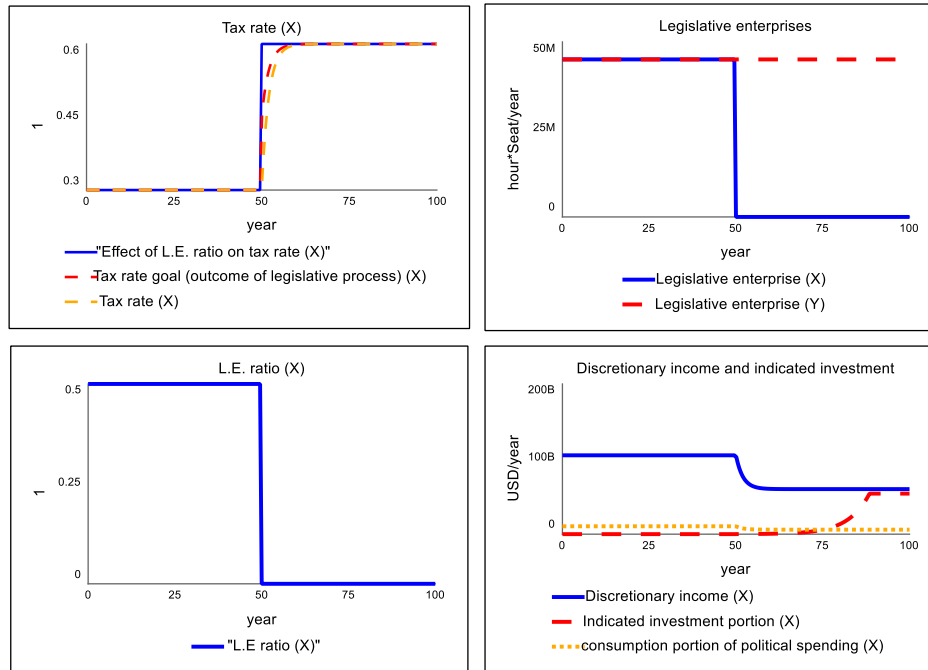


Note that in the real model the number of legislators will not reach zero, because of the uncertainty accounted for in “Probability of outspending resulting in seat win” variable, which is theoretically not going to be equal to 1 in realistic runs of the model, yet for the purpose of exploring the behaviour of this sector under extreme conditions, “Legislators (X)” was allowed to go to zero.

16.3.3. Experiment 3: Effect of zero lobbying spending on Tax rate (X)

“Lobbying spending (X)” is reduced to zero at $t=50$.

Results:



Interpretation of results:

In this experiment, loop (B3.3) was essentially eliminated. This denied Agent (X) the chance to exert counter-pressure against the legislative enterprise of Agent (Y), which means that “(Y) desired tax rate (X)” would’ve become the goal of loop (B4.5), if it weren’t for loop (R4.4), which as “Tax rate (X)” increases, increases the “Tax rate goal (outcome of legislative process) (X)”. The resulting behaviour is a smooth-like shape for the goal of loop (B4.5), to which “Tax rate (X)” catches up.

For Agent (X), despite spending nothing on lobbying the tax rate increase has an effect on “Indicated investment portion (X)”, as shown in the graph above, it continues to increase until it reaches its limit, i.e. “Discretionary income (X)” – “Consumption portion of political spending (X)”.

16.3.4. Experiment 4: Effect of diverging tax goals of Agents (X) and (Y) on Tax rate (X)

3 Runs:

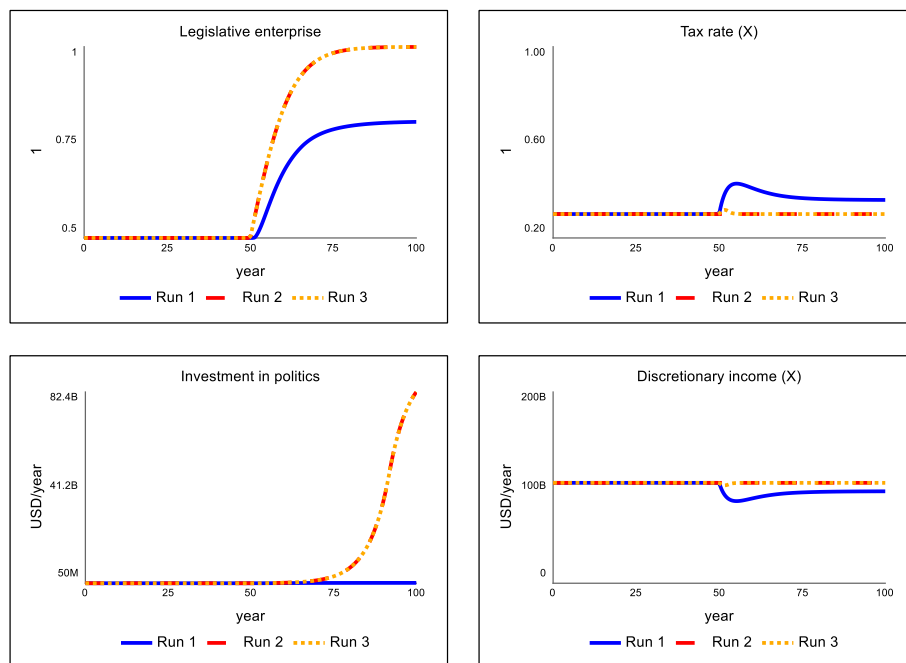
Run 1: “(Y) Desired tax rate (X)” increased to 0.6 at $t=50$, “Desired tax rate (X)” is constant.

Run 2: “(Y) Desired tax rate (X)” is constant, “Desired tax rate (X)” is reduced to 0.1 at $t=50$.

Run 3: “(Y) Desired tax rate (X)” is increased to 0.6 at $t=50$, “Desired tax rate (X)” is decreased to 0.1 at $t=50$.

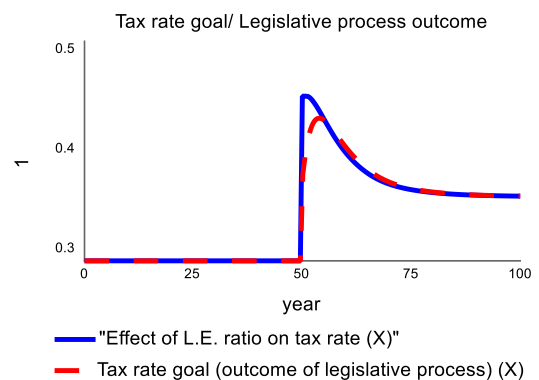
Price of lobbyist hour” is initialized at 50 USD/hour, with a RAMP function of 2 USD/year.

Results:



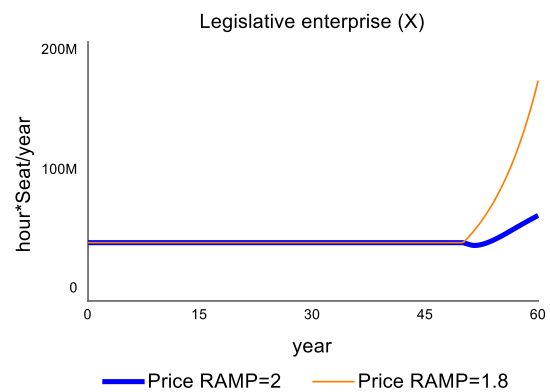
Interpretation of results:

Run 1: “Legislators (X)” and “Legislators (Y)” have been kept constant in this experiment, thus for legislative enterprise to increase only “Lobbying spending (X)” has to increase. At $t=50$, “(Y) Desired tax rate (X)” increased to 0.6 in, which increases in turn the “Effect of L.E. ratio on tax rate (X)”. This increases “Tax rate goal (outcome of legislative process)” to 0.45. Due to public outcry being fixed at 0.5, the tax rate goal is the weighted average of “Tax rate (X)” and



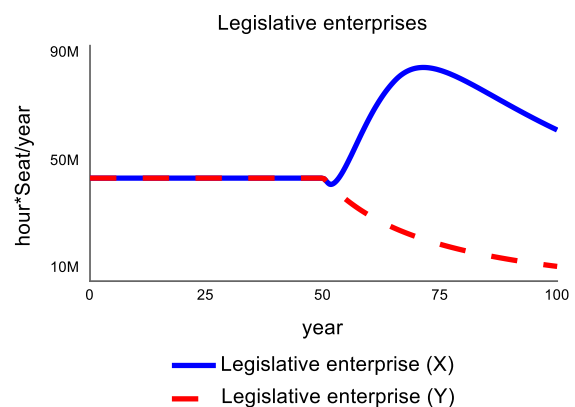
“Effect of L.E. ratio on tax rate (X)”. The equation can be expressed as $[(0.5 \cdot 0.45) + (0.5 \cdot 0.3)]$, which is then compared to “Tax rate (Y)” to make sure that the “Tax rate goal (X)” is not less than the poor, Agent (Y). This goal triggers (B4.5) to close the gap between “Tax rate (X)” stock and itself. “Outcome uncertainty” also has an effect on “Tax rate AT (X)” which is fixed at 11.7 years. This causes “Tax rate (X)” to increase. (R4.4) causes “Tax rate goal (outcome of legislative process)” to increase further after $t=50$, to around $t=54.1$. “Tax rate (X)” follows because it may be conceptualized as a smooth of “Tax rate goal”.

An increase in “Tax rate (X)” increases “Tax gap ratio (X)” which increases “Indicated investment portion (X)”, the goal for loop (B4.3), which adjusts the stock “Investment portion of political spending (X)” over “Investment decision (AT)”. This results in an increase in “Lobbying spending” to counter the tax increase on Agent (X). In the first 1.8 years after the shock is introduced, due to the delays in “Tax rate AT (X)” and “Investment decision AT” the increase in “Lobbying spending” is less than the increase in “Price of lobbyist hour”, which is why “Legislative enterprise (X)” seems to drop until $t = 51.5$, as is shown in the figure to the right.



When compared to a scenario where price ramp was lower, i.e. rate of increase of “Investment portion of political spending” was higher than the rate of increase in price, that drop in “Legislative enterprise (X)” did not occur.

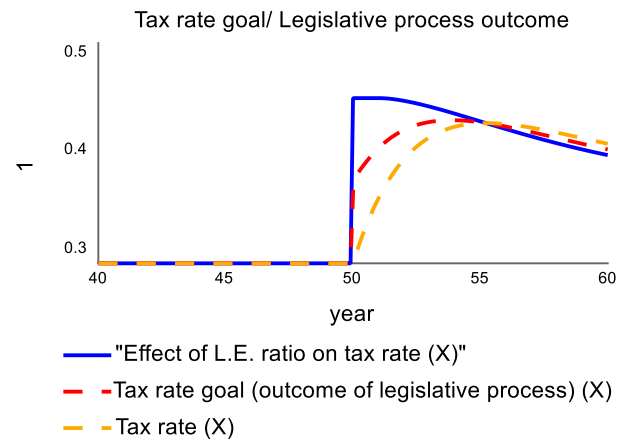
As “Investment portion of political spending (X)” catches on, “Legislative enterprise (X)” begins to rise. The increase in “Price of lobbyist hour” also results in a decline in “Legislative enterprise (Y)”, because “Lobbying spending (Y)” is constant, as is shown in the figure to the right.



The peak of “Effect of L.E. ratio on tax rate (X)” was at $t=50$, because then the L.E ratio was 0.5, giving equal weights to the goals of both agents, and $t=50$ was also the instant when “(Y) desired tax rate (X)” surged from 0.3 to 0.6. Beyond that point in time, “L.E. ratio (X)” is

increasing and thus giving an increasing weight to “Desired tax rate (X)” which is lower than “(Y) desired tax rate (X)” through loop (B3.3).

Since “Tax rate (X)” is a smooth of “Tax rate goal (outcome of legislative process)”, which is itself a function of “Tax rate (X)” through loop (R4.4), the graph to the right shows that “Tax rate goal (outcome of legislative process)”, represented by the red dashed line, lies in between the blue line and the yellow line which make sense because it is a weighted average of “Effect of L.E ratio on tax rate (X)” and “Tax rate (X)” using “Outcome uncertainty (X)” as the weight. It peaks at $t=54$, where the weighted average of the blue line and the yellow line maxes out. Because of this weighing, the peak of “Tax rate goal (outcome of legislative process)” is not at $t=50$.



Note that (R3.7) is disabled by keeping “Legislative enterprise (Y)” as constant, and at $t=100$, “Tax rate (X)” is stable at 0.36. This is because “L.E. ratio (X)” = 0.804 which means that 80.4% of “Desired tax rate (X)” is added to 19.6% of “(Y) desired tax rate (X)” (weighted average). The logical interpretation of this is that Agent (Y) still has some say in determining tax rate, because Agent (X)’s Legislative enterprise did not thwart Agent (Y) completely.

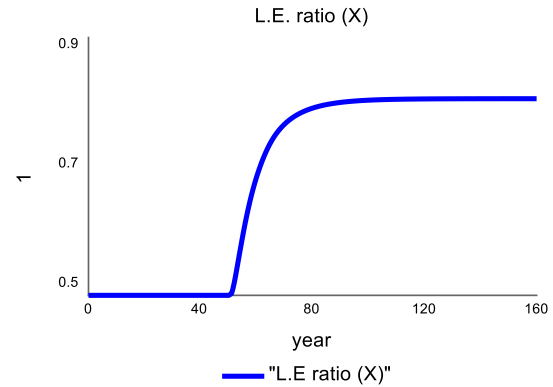
First, to get of “Effect of L.E. ratio on tax rate (X)”, we substitute in equation (Effect of L. E. ratio on tax goal (X)) to get the following:

$$0.804 * (0.3) + (1 - 0.804) * (0.6) = 0.588$$

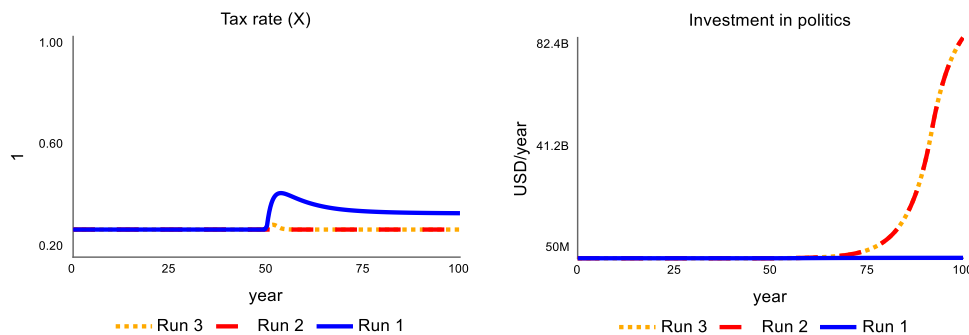
Then substituting in equation Tax rate goal (Outcome of legislative process (X))” we get:

$$0.5 * (0.588) + (1 - 0.5) * (0.36) = 0.359$$

The system stabilizes because at this tax rate for Agent (X), the “Effect of tax gap ratio on investment spending (X)” is equal to 1, which stabilizes (B3.3) and thus Legislative enterprises for both agents will be falling (due to a ramping price) but the ratio between them is constant.



Run2 & 3:



These runs indicate a very important dynamic related to “Realistic tax goal (X)”, the condition placed in this sector, to prevent Agent (X) from paying lower tax rates than Agent (Y).

Although “Investment portion of political spending (X)” escalates to reach 82.4 Billion USD/year, “Tax rate (X)” never reaches the “Desired tax rate (X)” because “Realistic tax goal (X)” is equal to 0.3, the effect of loop (B4.6).

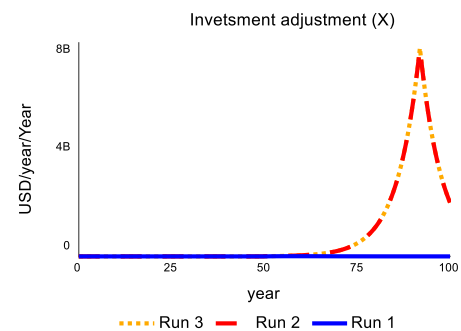
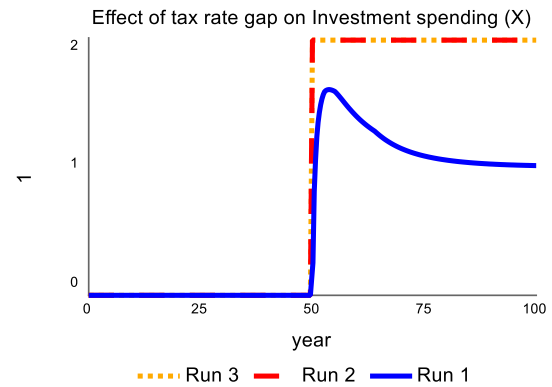
“Tax rate (X)” differs between Run2, and Run3. There is a small bulge in Run 3, because “(Y) desired tax rate (X)” is increased at $t=50$. This causes the increase in the tax rate because at $t=50$, “L.E. ratio (X)” is 0.5 and Agent (X)’s lobbying spending did not increase yet to overtake Agent (Y)’s efforts. That is why that bulge disappears at around $t=54$ as a result of loop (B3.3) increasing “Lobbying spending (X)” in an attempt to eliminate “Tax gap ratio (X)”.

“Investment portion of political spending (X)” has an S-shaped curve. This is because (R4.1) is dominant from $t=50$ to $t=91.8$. Note that “Legislative enterprise” is the same for Run2 & Run3 because the tax gap in both runs maxes out the “Effect of tax gap ratio on investment spending. As “Tax gap ratio” is never closed (reduced to zero). This causes “Effect of tax gap on investment spending (X)” to reach its highest value of 2 immediately at $t=50$. This constant value multiplied by the stock “Investment portion of political spending (X)” produces exponential growth. At $t=91.6$, (B4.4) dominates imposing a limit on “Indicated investment portion (X)” as Agent (X) will not spend more than what they receive, “Maximum investment (X)” as indicated by the equation below:

Maximum investment (X)

$$\begin{aligned}
 &= [(\text{"Discretionary income"}) \\
 &\quad - \text{"Consumption portion of political spending"})] \\
 &\quad * \text{"Maximum \% of remaining income (X)"}
 \end{aligned}$$

Reaching this limit causes goal of loop (B4.3) to become fixed, and as (B4.3) closes the gap “Investment adjustment” decreases (typical goal seeking behaviour). That is why the graph of “Investment portion of political spending” expresses goal-seeking behaviour from $t=91.8$ to $t=100$. To the right is the graph of “Investment adjustment”, the flow adjusting the stock of “Investment portion of political spending”. It suddenly drops at $t=91.8$ since the goal stopped increasing and the closer the stock is to the gap, the lower the adjustment is. Had the goal limit not been reached, the behaviour of the stock would’ve continued as exponential growth.



16.3.5. Experiment 5: Experiment (4) repeated while eliminating the constraint of (B4.6)

3 Runs:

Run 1: “(Y) Desired tax rate (X)” increased to 0.6 at $t=50$, “Desired tax rate (X)” is constant.

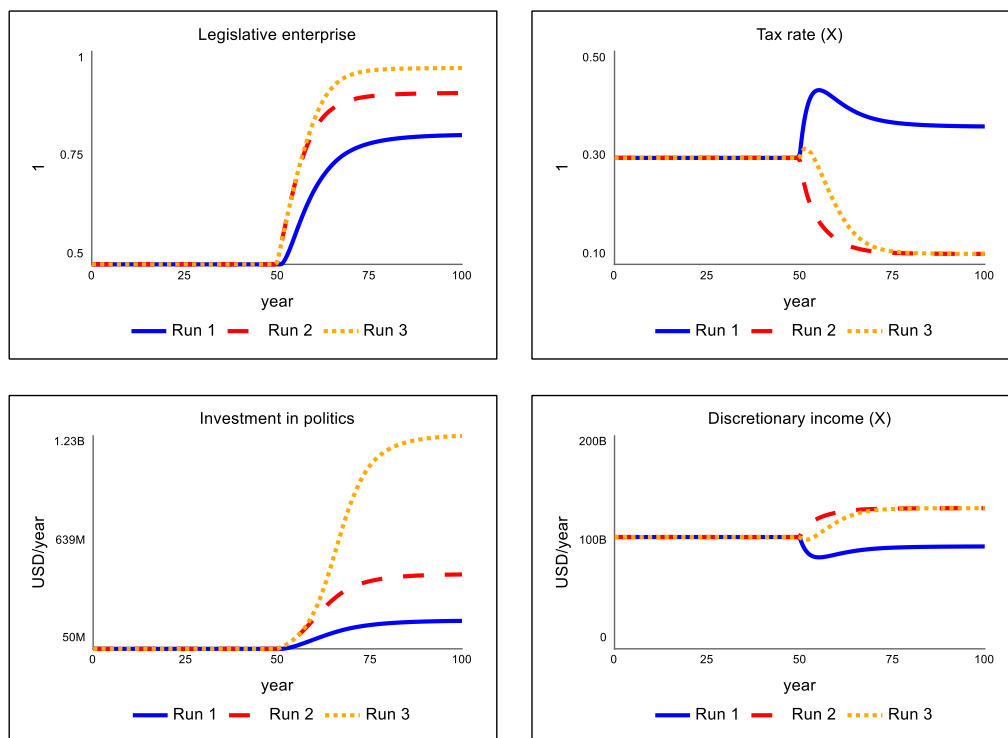
Run 2: “(Y) Desired tax rate (X)” is constant, “Desired tax rate (X)” is reduced to 0.1 at $t=50$.

Run 3: “(Y) Desired tax rate (X)” is increased to 0.6 at $t=50$, “Desired tax rate (X)” is decreased to 0.1 at $t=50$.

Price of lobbyist hour” is initialized at 50 USD/hour, with a RAMP function of 2 USD/year.

“Tax rate (Y)” = 0.05 (*less than the goal of Agent (X), “Desired tax rate (X)”*)

Results:



Interpretation of results:

Note that Run1 has the same results as those explained in Experiment 3.

The results of this experiment are more realistic than those of Experiment 3. First of all the tax rate changes with changes in investment, unlike Run2 & Run3 in Experiment 3, thus a larger “Tax gap ratio” in Run3 corresponds to higher investment.

Moreover, in Run3, Tax rate rises slightly because Agent (Y) has an initially strong legislative enterprise, that is soon overpowered by Agent (X)

The equilibrium “Tax rate (X)” is 0.12, higher than “Desired tax rate (X)”, because of the equilibrium “L.E. ratio (X)”, demonstrated by substituting in the equation for tax goal:

Run 2:

$$0.902 * (0.1) + (1 - 0.902) * (0.3) = 0.1196 \approx 0.12$$

Run 3:

$$0.961 * (0.1) + (1 - 0.961) * (0.6) = 0.1195 \approx 0.12$$

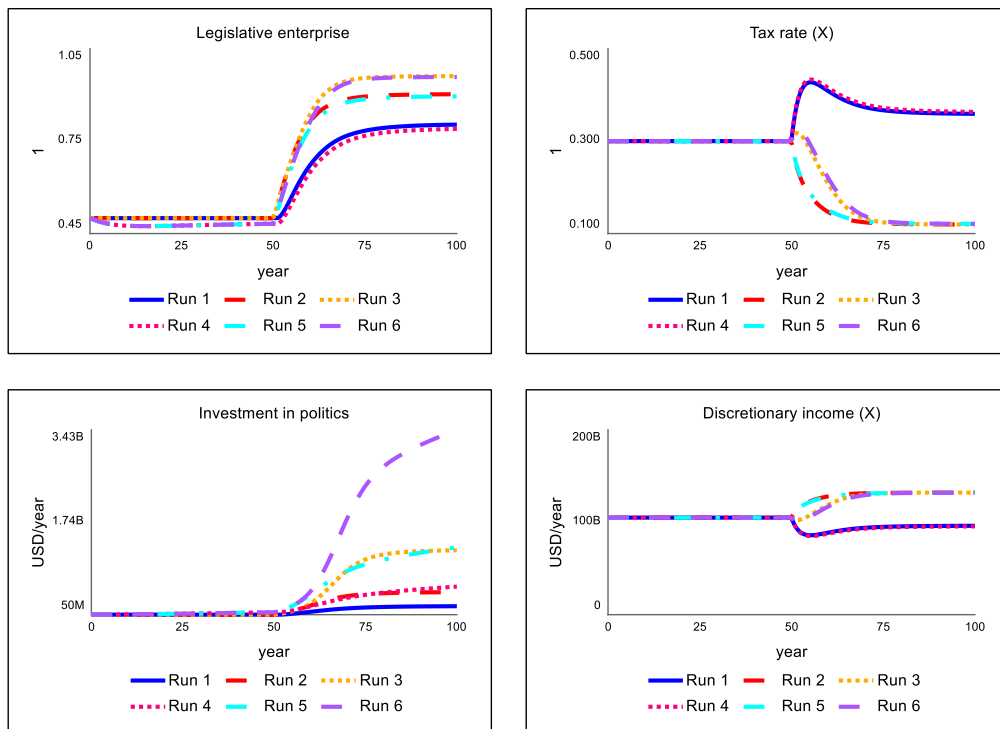
“L.E. ratio (X)” stabilized at 0.12 because that was the tax rate at which “Tax gap ratio (X)” caused “Effect of tax gap on investment spending (X)” to be just a little over 1 (Run 2: 1.0031 and Run 3: 1.0037). Thus loop (R4.1) was gravely slowed down and the escalation of “Investment portion of political spending (X)” is close to equilibrium.

1.1.1.1. Experiment 6: Effect of activating (R3.7) on results of Experiment 5

Runs 1,2,3: are the runs of experiment 4.

Runs 4,5,6: Are the runs of Experiment 4, while adding a RAMP of 1 Million USD/ year to “Investment portion of political spending (Y)”, and a RAMP to “Price of lobbyist-hour” of 0.5 USD/year starting t=0. This is because spending in this experiment is increasing starting t=0.

Results:



Interpretation of results:

An increasing “Investment portion of political spending (Y)” has an effect, especially before the goal-change shock introduced at $t=50$.

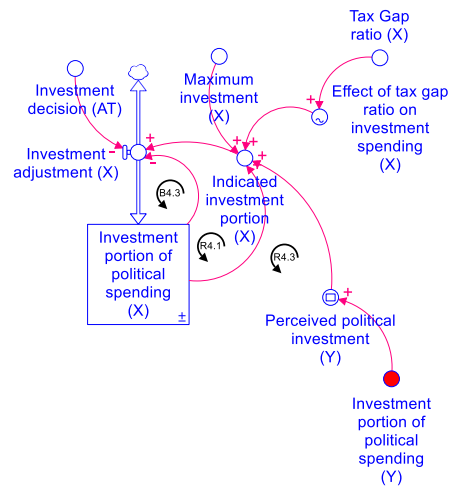
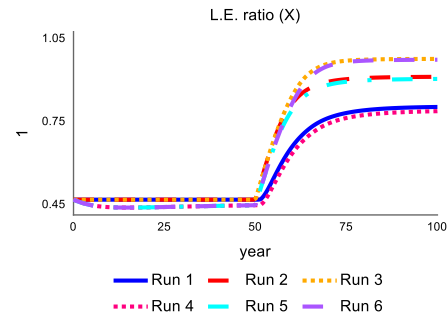
The graph to the right shows that comparing each run of experiment 4 to its counterpart in experiment 5, Run1 with Run4, Run 2 with Run5, and Run3 with Run6, “L.E. ratio (X)” is less in experiment 5 runs.

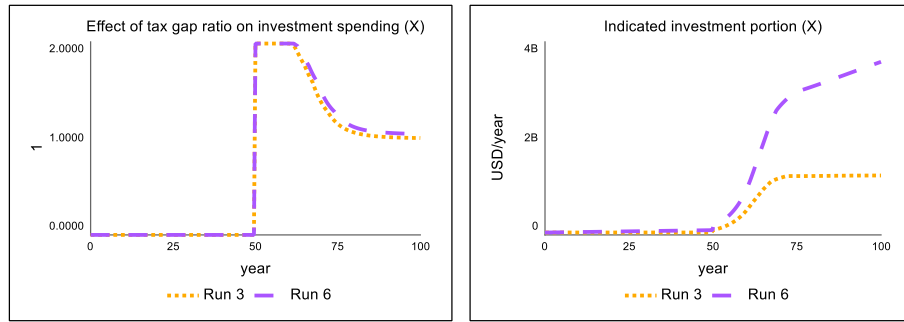
This is because before $t=50$, Agent (X) is benchmarking with Agent (Y) at a delay. Thus when “Investment portion of political spending (Y)” is increasing, that of (X) follows at a delay and thus “Legislative enterprise (Y)” would be more than that of (X), given constant Legislator seats for both. Thus when loop (B3.3) is inactive (since tax goals are met for both agents), an increased political investment by Agent (Y) reduces “L.E. ratio (X)”.

This is caused by the structure shown to the right. There are 2 delays, a perception delay in “Perceived political investment (Y)”, and the second is in “Investment adjustment” which reacts to the “Indicated investment portion” goal over an Adjustment time, “Investment decision AT”.

The exceptionally high spending in Run6 after $t=50$ in comparison to the 5 other runs, especially Run3, may be attributed to the “Effect of tax gap ratio on investment spending (X)”. Because of Agent (Y)’s slightly stronger “Legislative enterprise (Y)” in Run6, “Tax rate (X)” is slightly higher at every point in time, which causes “Tax gap ratio (X)” to be higher, resulting in a slightly higher effect on investment, as is shown in the graph below.

But due to the presence of (R4.1), a persistently higher “Effect of tax gap ratio on investment spending (X)” escalates to a huge disparity in spending as this effect (which is more than 1) is multiplied by the stock value of “Investment portion of political spending” which hence escalates the goal in a reinforcing loop.



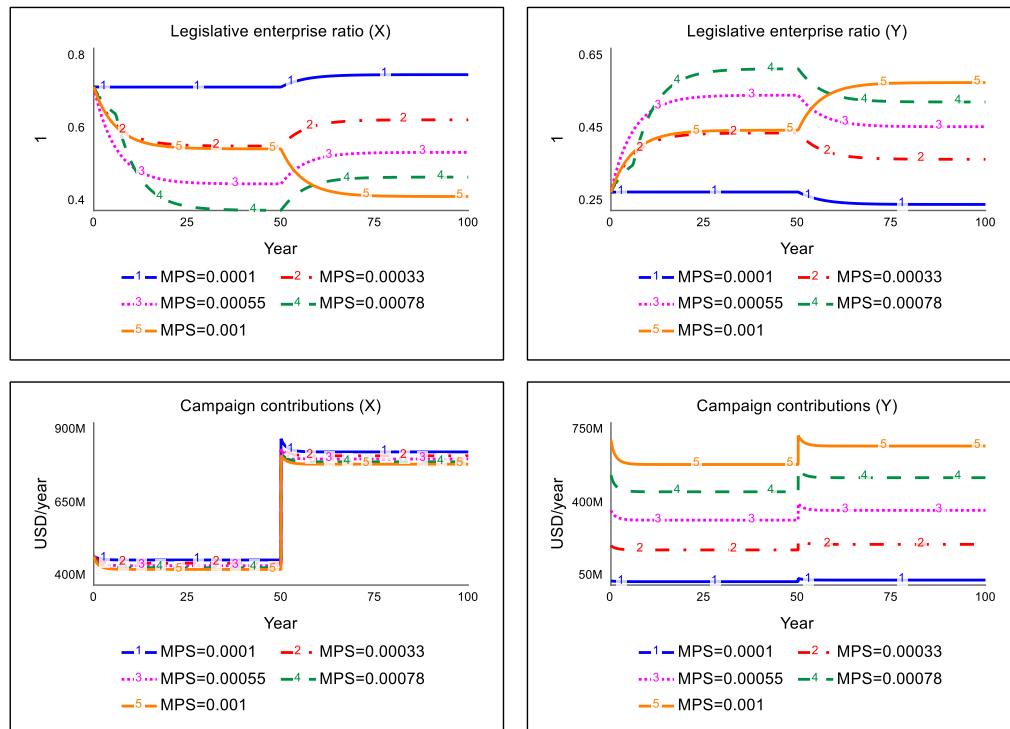


Note that between $t=50$, to $t=60$, the effect cannot exceed 2.0 (as in doubling of the stock value when determining the goal for investment), which is why the graph of “Effect of tax gap ratio on investment spending (X)” is horizontal during that period, but this is not because of any equilibrium reach, in fact it is responsible for the exponential growth seen in the graph of “Indicated investment portion (X)” during that very same period

16.4. Base case

16.4.1. Experiment 1: Income shock for Agent (X) and different “Marginal propensity to spend (Y)”

Results:



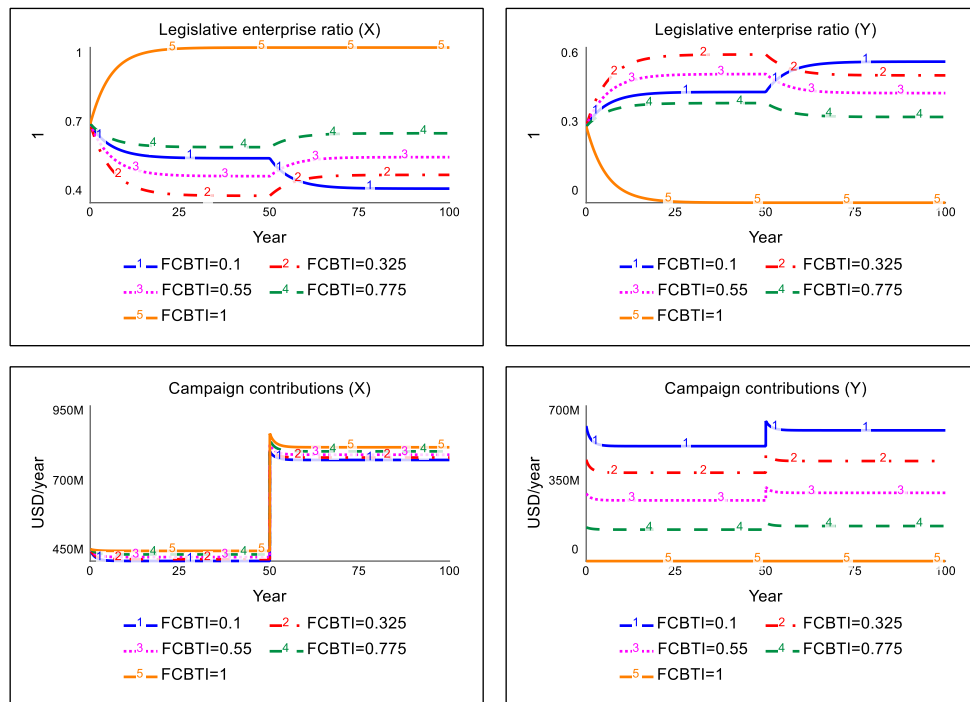
Interpretation of results:

Since income of Y is more than that of X, varying marginal propensity leads to Y getting more legislators since the beginning of the run, and lose as soon as X gets double the income.

In the beginning X is spending less on campaigns because price is rising due to the increased spending of Y, which (B4.2) and (B5.2) makes both agents spend less in campaigns.

16.4.2. Experiment 2: Income shock for Agent (X) and different “Fraction consumption from before-tax income (Y)”

Results:

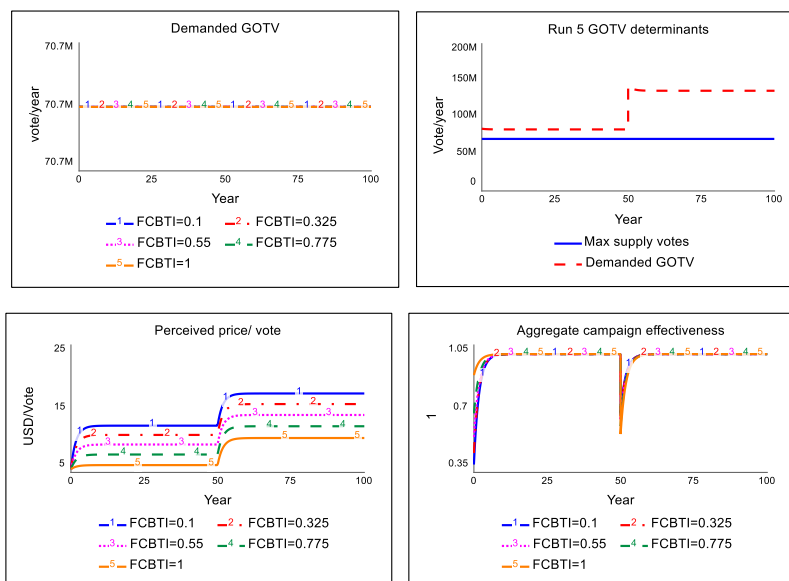


Interpretation of results:

Only run1 stands out from the pattern of the remaining runs because “Legislative enterprise (Y)” overtakes (X). It is not because of pure outspending campaign contributions, but a combination of high campaign contributions and voting uncertainty via “Probability of outspending resulting in seat win”. Given that lobbying spending is equal for both, seats are the only determinant of “Legislative enterprise”. In each of the runs, the higher “Campaign contributions (Y)” due to lower consumption and thus higher “Discretionary income” results in more seats for Agent (Y) as well as a higher “Perceived price/ vote”, since Demand is

initially higher than supply. It takes some time, around 14 years, for price to stabilize until the income shock is introduced at $t=50$ (B1.3). (B1.4) is inactive because despite its attempts to increase demand, due to the constant “Eligible voters”, the demand and the “Effect of GOTV innovation” exceed the eligible voters limit and thus the supply is maxed out. This places all the burden of balancing “Aggregate campaign effectiveness” on (B1.3). Proof of this is shown below, as GOTV is constant and equal to “Max GOTV supply” in all the runs:

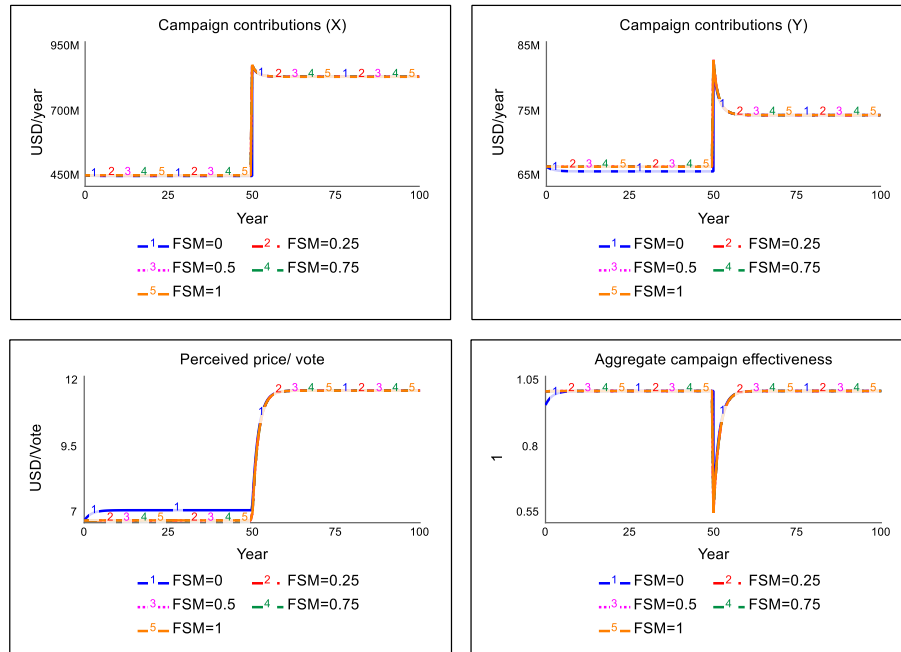
Run5 was chosen as it has the lowest “Campaign contributions (Y)”, thus if the lowest “Total campaign contributions” of all 5 runs caused a “Demanded GOTV” higher than the “Max GOTV supply” then all the other runs which had more demand upward pressure on price resulted, through (B1.4) in more “Demanded GOTV”. This proves that (B1.4) was inactive through the 5 runs.



The below graphs show the upward pressure on price as a result of a low Supply/Demand balance or “Aggregate campaign effectiveness”.

16.4.3. Experiment 3: Income shock for Agent (X) and different “Fraction self-motivated” voters

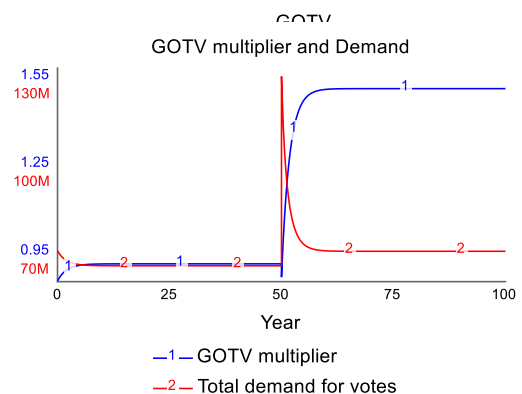
Results:



Interpretation of results:

Runs 2-5 are identical, because of the high demand for votes, exceeding the “Eligible votes” divided by “Election cycle period” i.e. votes/ year available, the more self-motivated voters increase, the less GOTV gets due to the “Max GOTV supply” limitation. Supply is again maxed out, and thus this discrepancy between supply and demand pushes price up, adjusting “Total demand for votes” (B1.3). It is worth noting that as “Self-motivated voters” becomes, there is no effect of campaign spending, because the money is modelled to keep flowing regardless of campaign outcomes. It may be conceptualized as campaigning for convincing the voters to vote for your politician, rather than to GOTV and increase participation rate.

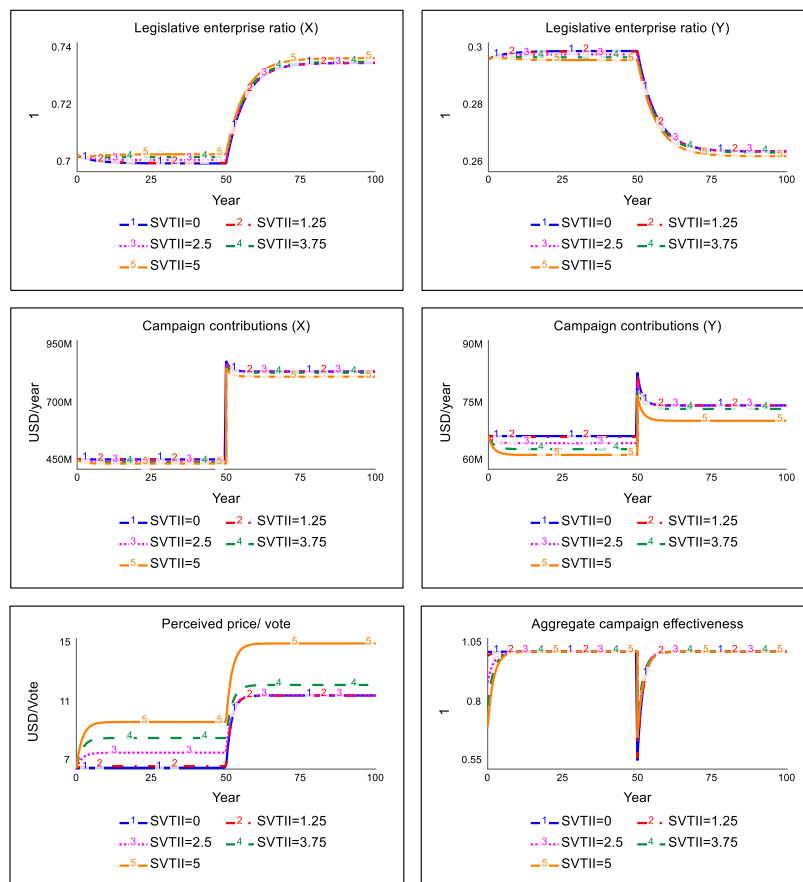
In Run1, however, “Self-motivated voters”=0. This causes “Total supply (per year)” to be equal to “GOTV”. Since (B1.4) and (B/RX) interact to determine how much of the demand is translated to GOTV, in the beginning the effect of inequality reduces GOTV. (B1.4) increases to counter that effect, which is why GOTV is equal to 74.5 million votes, less than the 78.5 million. It is because (B1.4) counters the effect of inequality, when price increases to equilibriate demand to supply. Note that (B1.4) increases to reach 1, while demand decreased as a result of (B1.3), until at



$t=50$ when the demand by Agent (X) spiked causing a surge in price and thus “GOTV multiplier” reached 1.49. Of course due to the constant “Eligible votes” this increased multiplier will have no effect on supply unless an inequality shock was introduced to counter (B1.4).

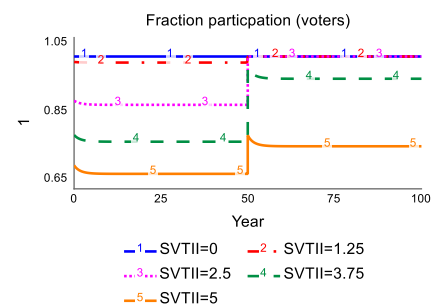
16.4.4. Experiment 4: Income shock for Agent (X) and different “sensitivity of voter turnout to income inequality”

Results:



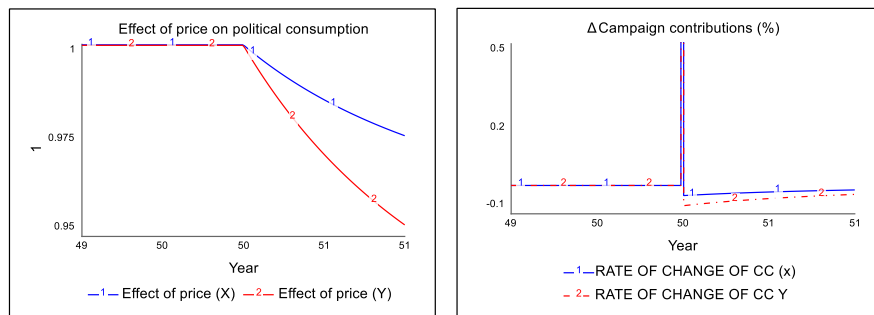
Interpretation of results:

Higher sensitivity of voter turnout to income inequality means that for a given level of inequality, “Net inequality GINI”, there will be less voter turnout as is shown in the figure to the right.



“Fraction participation” is the “Total vote supply” divided by “Eligible voters” over “Election cycle period” to make sure comparison is valid and the denominator has units of “Vote/ year”. Lower supply means lower “Aggregate campaign effectiveness” which raises price. A higher price leads to lower demand (vote per given USD of campaign contributions).

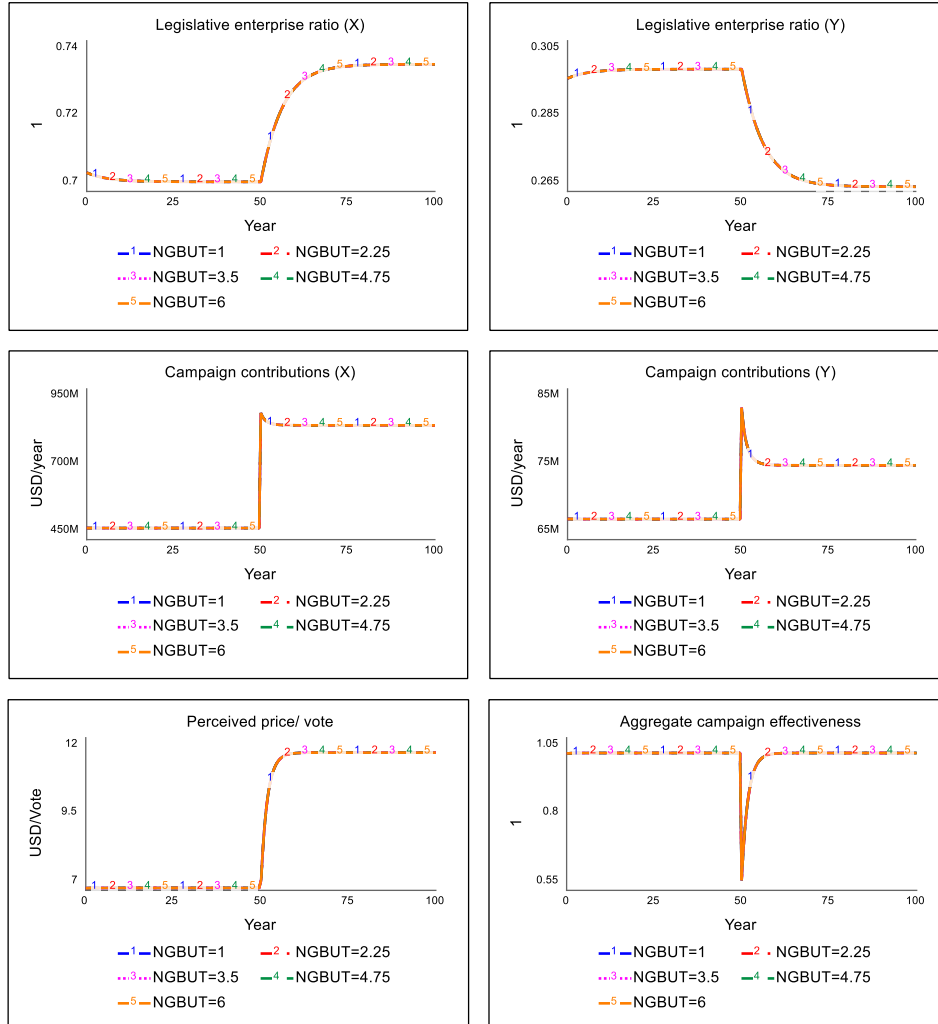
It would be expected for the vote ratio to be constant, since the price/ vote is a common denominator to translate Campaign contributions into votes, yet due to loops (B4.2) and (B5.2), the increasing price has a negative effect on political consumption. Due to the different character traits of the two agents, the price effect is different as “Price elasticity of political spending (Y)” > “Price elasticity of political spending (X)”. This is demonstrated in the following graphs that compare “Effect of price (X)” with that of Agent (Y), as well as shows the rate of change of campaign contributions for both agents.



This is why “L.E. ratio (X)” increases with higher “Sensitivity of voter turnout to income inequality”, while “L.E. ratio (Y)” decreases slightly. It because at higher prices “Effect of price (X)” doesn’t lower “Campaign contributions (X)” as much as “Effect of price (Y)” does on “Campaign contributions (Y)”.

16.4.5. Experiment 5: Income shock for Agent (X) and different “Normal GOTV build-up time”

Results:



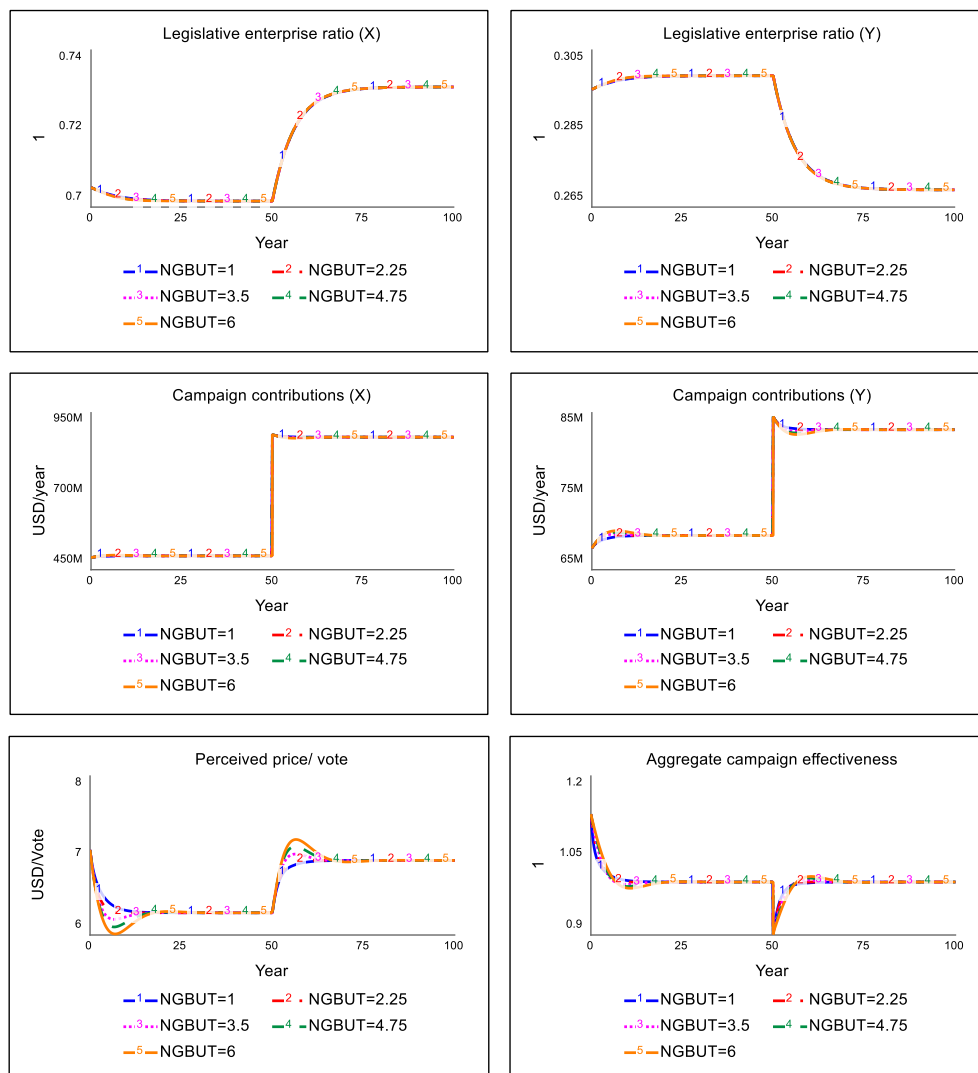
Interpretation of results:

We see no effect because loop (B1.4) is inactive. The limiting factor for GOTV is “Max GOTV supply” rather than the “Demanded GOTV” affected by (B1.4). Thus running sensitivity analysis on an inactive loop will have no effect. The next experiment will remedy this by activating loop (B1.4).

16.4.6. Experiment 6: Income shock for Agent (X) and different “Normal GOTV build-up time” (Eligible voters are increased such that (B1.4) is activated)

“Eligible voters” is increased by 120 million people. Although this is unrealistic, by trial and error it is the value that activates loop (B1.4). The alternative would be to increase “Initial price” per vote to reduce “Total demand for votes” to less than “Max GOTV supply”, at equilibrium.

Results:

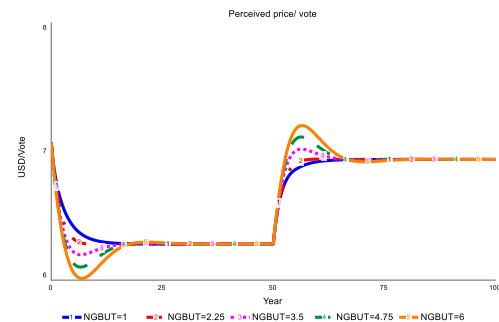


Interpretation of results:

In this case, “Eligible voters” was much higher than in experiment 3, which resulted in a supply exceeding demand for votes. This is why “Aggregate campaign effectiveness” is initially

higher than 1. This leads to “Effect of campaign effectiveness on price” initially being less than 1 which pushes “Price/ vote” down. The 2 loops that correct for discrepancy in “Aggregate campaign effectiveness” are (B1.3) and (B1.4). Only in Run1 is (B1.4) faster than (B1.3) given that the adjustment time of (B1.1), which determines the speed of (B1.3) is equal to 2 years. In Run2, (B1.4) is only slightly slower than (B1.3) with an AT of 2.25 years. Higher Adjustment times for (B1.4) means that an overshoot is bound to happen because Price is perceived at a long delay in (B1.4) while (B1.3) is more agile in correcting the price. This means that at some point price will have been adjusted by loop (B1.3) while (B1.4) is still active based on an old price signal (either underestimated if price is rising, or overestimated if price is falling). This is why the graph of “Perceived price/ vote” shows an overshoot rather than a smooth-goal seeking behaviour, as shown below:

The larger the delay is in loop (B1.4), the larger the overshoot in price. This overshoot does not turn to a sustained oscillation because it gets damped due to the interaction between (B1.3) and (B1.4), two balancing loops one of which (B1.3) short-circuits the other (B1.4) driving stability in the stock “Perceived price/ vote”.



17. Appendix 8: Gini Index calculation

Although Gini coefficient has a complicated equation, because this model considers only 2 agents (the top 10% - Agent (X), and the bottom 90% - Agent (Y)) the calculation becomes much easier. Gini coefficient is based on the Lorenz curve shown in the below figure. It is equal to Area A divided by the Total area under the 45 degree line.

$$\therefore G = A/(A+B) \text{ -----(1)}$$

Given that it is a cumulative curve, then the total area $A+B=0.5*1*1$

$$\therefore A+B=0.5 \text{ -----(2)}$$

In our case with 2 agents, B=area of triangle + area of trapezium

$$\therefore B = (0.5*W*V) + (0.5*(V+1)*(1-W))$$

$$= 0.5*[(W*V) + V - (V*W)+1-W]$$

$$\therefore B = 0.5*[V + 1 - W] \text{ -----(3)}$$

From (2):

$$A = 0.5 - 0.5*[V + 1 - W]$$

$$= 0.5*[1 - V + 1 + W]$$

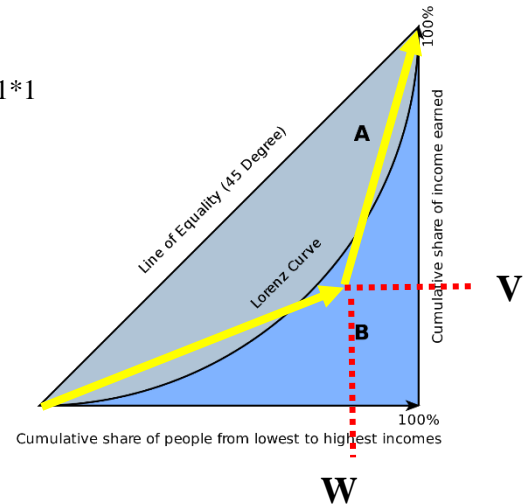
$$\therefore A = 0.5*[W - V] \text{ -----(4)}$$

Substituting (2) and (4) in (1):

$$G = 0.5*(W-V)/(0.5)$$



$$\therefore G = W - V \text{ -----}$$



Source: Wikipedia (GINI Coefficient)

http://en.wikipedia.org/wiki/File:Economics_Gini_coefficient.svg

Thus for 2 agents (top 10% and bottom 90%) whose incomes (average income/ capita * population) are known, it is possible to calculate G through the bottom 90% or (W)'s income share of total income (V).

For example if 90% of the population received 50% of the total income, then $G = 0.9 - 0.5 = 0.4$

*This is an approximation based on uniform incomes for each group of the population (the average). **It always underestimates G.** The more variation there is, which can be introduced later on through a probabilistic distribution, the more complex the calculation will get, and the higher G will be.*

Market incomes are based on employer-labour relations and government regulation over industries which are outside the scope of this model, thus market incomes are taken to be exogenous. Market inequality may be measured using the method above. Government, however, taxes and redistributes. After these processes, net income for each group could improve Gini index, or make it worse. We may calculate it via the same procedure described above substituting net income for market income.

18. Appendix 9: Model documentation

```

r_ratio_=_1" = 1
UNITS: 1
Probability_of_outspending_resulting_in_seat_win = 0.8
UNITS: 1
Zero_line = 0

*****
ADDITIONAL_CALCULATIONS:
*****
"%_population_(X)" = 0.1
UNITS: 1
Budget_for_campaigns = Total_Grant+Total_Franklin
UNITS: USD/year
"Consumption_share_(X)" =
"consumption_portion_of_political_spending_(X)"/("consumption_portion_of_political_spending_(Y)"+"consumption_portion_of_political_spending_(X)")
UNITS: 1
Fraction_participation = "Total_vote_supply_(per_year)"/("Eligible_voters/Elections_cycle_period")
UNITS: Vote/person
"Initial_seats_(X)" = 100-"Initial_seats_(Y)"
UNITS: Seat
"Investment_share_(X)" =
"Investment_portion_of_political_spending_(X)"/("Investment_portion_of_political_spending_(Y)"+"Investment_portion_of_political_spending_(X)")
UNITS: 1
"Population_(X)_earners" = "%_population_(X)"*Taxable_population
UNITS: person
"Population_(Y)_earners" = (1-"%_population_(X)")*Taxable_population
UNITS: person
"Redistribution_(X)" = "Population_(X)_earners"*"Redistribution/_capita"
UNITS: USD/year
"Redistribution_(Y)" = "Redistribution/_capita"*"Population_(Y)_earners"
UNITS: USD/year
"Redistribution/_capita" = Redistribution/Taxable_population
UNITS: USD/year/person
Taxable_population = Eligible_voters
UNITS: person
Total_Franklin = "Franklin_(X)"+"Franklin_(Y)"
UNITS: USD/year
Total_Grant = "Grant_(X)"+"Grant_(Y)"
UNITS: USD/year
Total_independent_expenditures = "Independent_expenditures_(X)"+"Independent_expenditures_(Y)"
UNITS: USD/year
Total_population = Underage+Taxable_population
UNITS: person
"Total_population_(X)" = "%_population_(X)"*Total_population
UNITS: person
"Total_population_(Y)" = (1-"%_population_(X)")*Total_population
UNITS: person

*****
"AGENT_(X)":
*****

```

"Effect_of_L.E._ratio_on_tax_goal_(X)" = "L.E_ratio_(X)"*"Desired_tax_rate_(X)" + (1-"L.E_ratio_(X)")*"Y_Desired_tax_rate_(X)"

UNITS: 1

"(Y)_Desired_tax_rate_(X)" = 1

UNITS: 1

"Campaign_contributions_(X)" = ("consumption_portion_of_political_spending_(X)" - "reduction_(X)")*(1-Grant_&Franklin_policy)

UNITS: USD/year

DOCUMENT: Besides the logical difficulty of explaining such small contributions as an investment, their very size is also a puzzle in this context: if so much is at stake in terms of the value of government policies, why are contributions so small?

Campante 2011

"Cash_(X)"(t) = "Cash_(X)"(t - dt) + ("Income_(X)" + "Redistribution_income_(X)" - "Political_spending_(X)" - "Taxes_(X)" - "Consumption_(X)") * dt

INIT "Cash_(X)" = 0

UNITS: USD

INFLOWS:

"Income_(X)" = "Total_income_(top_10%)"*1 + 1000*1000*1000*3500*0 {UNIFLOW}

UNITS: USD/year

"Redistribution_income_(X)" = "Redistribution_(X)" {UNIFLOW}

UNITS: USD/year

OUTFLOWS:

"Political_spending_(X)" = "consumption_portion_of_political_spending_(X)" + "Lobbying_spending_(X)" {UNIFLOW}

UNITS: USD/YEAR

"Taxes_(X)" = "Tax_rate_(X)"*"Income_(X)" {UNIFLOW}

UNITS: USD/YEAR

"Consumption_(X)" = "Disposable_income_(X)"*"Fraction_consumption_from_disposable_income_(X)" {UNIFLOW}

UNITS: USD/YEAR

"consumption_portion_of_political_spending_(X)" =

"Discretionary_income_(X)"*"Marginal_propensity_to_spend_on_political_campaigns_(X)"*"Effect_of_price_(X)"

UNITS: USD/year

DOCUMENT: They concluded that money was largely directed at ideological consumption rather than buying political benefifits; for an opposite view, see Gordon, Hafer, and Landa (2007).

Bonica et al 2013

Converter_14 = DERIVN("Discretionary_income_(X)", 1)/"Discretionary_income_(X)"

"Desired_tax_rate_(X)" = 0.25

UNITS: 1

"Discretionary_income_(X)" = "Disposable_income_(X)" - "Consumption_(X)"

UNITS: USD/year

"Disposable_income_(X)" = "Income_(X)" - "Taxes_(X)" + "Redistribution_income_(X)"

UNITS: USD/year

"Effect_of_price_(Lobbying)_(X)" = 1/("Perceived_market_price_of_lobbyist-hour"/"Initial_price_of_lobbyist-hour")^"Price_elasticity_of_lobbying_spending_(X)"

UNITS: 1

"Effect_of_price_(X)" = IF(Grant_&Franklin_policy=1) THEN(1)

ELSE(1/("Perceived_price/_vote"/Initial_price)^"Price_elasticity_of_political_spending_(Campaigns)_(X)")

UNITS: 1

"Effect_of_tax_gap_on_investment_spending_(X)" = GRAPH("Tax_Gap_ratio_(X)")

(0.000, 0.000), (0.100, 0.944), (0.200, 1.468), (0.300, 1.682), (0.400, 1.828), (0.500, 1.923), (0.600, 1.955), (0.700, 1.983), (0.800, 1.983), (0.900, 1.983), (1.000, 1.983)

UNITS: 1

DOCUMENT: this should be calibrated through the maximum possible change in the period of doubling time of this stock (thus if the maximum was 3 times it should be reflected in the graph function)

"Fraction_consumption_from_disposable_income_(X)" = 0.84

UNITS: 1

DOCUMENT: Based on

top 1% save from 20-25% of disposable income

"Independent_expenditures_(X)" = ("consumption_portion_of_political_spending_(X)" -

"Campaign_contributions_(X)") * (1 - "SWITCH: Independent_expenditure_policy_0=OFF_1=ON") * (1 - Grant_& Franklin_policy)

UNITS: USD/year

"Indicated_investment_portion_(X)" = MIN(MAX(MAX("Perceived_political_investment_(Y)",

"Investment_portion_of_political_spending_(X)") * "Effect_of_tax_gap_on_investment_spending_(X)" * "Effect_of_price_(Lobbying)_(X)", "Minimum_investment_(X)", Maximum_investment)

UNITS: USD/year

"Initial_tax_rate_(X)" = 0.35

UNITS: 1

"Investment_decision_(AT)" = 6

UNITS: year

"Investment_portion_of_political_spending_(X)"(t) = "Investment_portion_of_political_spending_(X)"(t - dt) + ("Investment_adjustment_(X)") * dt

INIT "Investment_portion_of_political_spending_(X)" = "Minimum_investment_(X)"

UNITS: USD/year

INFLOWS:

"Investment_adjustment_(X)" = ("Indicated_investment_portion_(X)" -

"Investment_portion_of_political_spending_(X)") / "Investment_decision_(AT)"

UNITS: USD/year/Year

"Lobbying_spending_(X)" = ("Total_political_spending_(X)" - "Campaign_contributions_(X)" -

"Independent_expenditures_(X)") * "B3.3_SHUT-DOWN"

UNITS: USD/year

"Marginal_propensity_to_spend_on_political_campaigns_(X)" = 0.001

UNITS: 1

DOCUMENT: Column (1) shows that richer individuals

have a higher probability to contribute, in a probit regression (marginal effects reported). Moving up one discrete income category (which corresponds to an increase of roughly \$10,000) increases the probability of contributing by 2.5 percentage points—quite important if we keep in mind that around 30% of the sample donate money.

campante 2011

"Maximum_fraction_of_remaining_income_after_political_consumption_(X)" = 0.002

UNITS: 1

Maximum_investment = ("Discretionary_income_(X)" -

"consumption_portion_of_political_spending_(X)") * "Maximum_fraction_of_remaining_income_after_political_consumption_(X)"

UNITS: USD/year

"Minimum_investment_(X)" = 1000 * 1000 * 8

UNITS: USD/year

"Outcome_uncertainty_(X)" = Public_outcry

UNITS: 1

"Perceived_political_investment_(Y)" = SMTH1("Investment_portion_of_political_spending_(Y)", 1,

"Investment_portion_of_political_spending_(Y)")

UNITS: USD/year

"Price_elasticity_of_lobbying_spending_(X)" = 0.1

UNITS: 1

"Price_elasticity_of_political_spending_(Campaigns)_(X)" = 0.1

UNITS: 1

"Realistic_tax_goal_(X)" = MAX("Tax_rate_goal_(outcome_of_legislative_process)_(X)", "Tax_rate_(Y)")

UNITS: 1

"Tax_Gap_ratio_(X)" = ("Tax_rate_(X)" / "Desired_tax_rate_(X)") - 1

UNITS: 1

"Tax_rate_(X)"(t) = "Tax_rate_(X)"(t - dt) + ("Tax_rate_adjustment_(X)") * dt {NON-NEGATIVE}

INIT "Tax_rate_(X)" = "Initial_tax_rate_(X)"

UNITS: 1

INFLOWS:

"Tax_rate_adjustment_(X)" = ("Realistic_tax_goal_(X)" - "Tax_rate_(X)") / ("Tax_rate_AT_(X)")

UNITS: 1/year

"Tax_rate_AT_(X)" = GRAPH("Outcome_uncertainty_(X)")
(0.000, 6.00), (0.100, 6.85), (0.200, 8.01), (0.300, 9.09), (0.400, 10.33), (0.500, 11.72), (0.600, 13.34), (0.700, 15.12), (0.800, 17.28), (0.900, 20.52), (1.000, 24.00)

UNITS: year

"Tax_rate_goal_(outcome_of_legislative_process)_(X)" = "Effect_of_L.E._ratio_on_tax_goal_(X)"*(1-"Outcome_uncertainty_(X)") + "Tax_rate_(X)"*"Outcome_uncertainty_(X)"

UNITS: 1

"Total_political_spending_(X)" =

"consumption_portion_of_political_spending_(X)"+"Investment_portion_of_political_spending_(X)"

UNITS: USD/year

"AGENT_(Y)":

"Effect_of_L.E._ratio_on_tax_goal_(Y)" = ("L.E._ratio_(Y)"*"Desired_tax_rate_(Y)")+(1-"L.E._ratio_(Y)"*MIN("X)_Desired_rate_(Y)", "Desired_tax_rate_(X)"*0+1)

UNITS: 1

"(X)_Desired_rate_(Y)" = 0.25

UNITS: 1

"Campaign_contributions_(Y)" = ("consumption_portion_of_political_spending_(Y)"-"reduction_(Y)")*(1-Grant_&_Franklin_policy)

UNITS: USD/year

"Cash_(Y)"(t) = "Cash_(Y)"(t - dt) + ("Income_(Y)" + "Redistribution_income_(Y)" - "Political_spending_(Y)" - "Taxes_(Y)" - "Consumption_(Y)") * dt

INIT "Cash_(Y)" = 0

UNITS: USD

INFLOWS:

"Income_(Y)" = 6000*0 + "Total_income_(bottom_90%)"*1 + 1000*1000*1000*5400*0 {UNIFLOW}

UNITS: USD/year

"Redistribution_income_(Y)" = "Redistribution_(Y)" {UNIFLOW}

UNITS: USD/year

OUTFLOWS:

"Political_spending_(Y)" = "consumption_portion_of_political_spending_(Y)"+"Lobbying_spending_(Y)" {UNIFLOW}

UNITS: USD/YEAR

"Taxes_(Y)" = "Income_(Y)"*"Tax_rate_(Y)" {UNIFLOW}

UNITS: USD/YEAR

"Consumption_(Y)" = "Disposable_income_(Y)"*"Fraction_consumption_from_disposable_income_(Y)" {UNIFLOW}

UNITS: USD/YEAR

"consumption_portion_of_political_spending_(Y)" =

"Discretionary_income_(Y)"*"Marginal_propensity_to_spend_on_political_campaigns_(Y)"*"Effect_of_price_(Campaigns)_(Y)"

UNITS: USD/year

"Desired_tax_rate_(Y)" = 0.25

UNITS: 1

"Discretionary_income_(Y)" = "Disposable_income_(Y)"-"Consumption_(Y)"

UNITS: USD/year

"Disposable_income_(Y)" = "Income_(Y)"-"Taxes_(Y)"+"Redistribution_income_(Y)"

UNITS: USD/year

"Effect_of_(X)'s_tax_gap_on_investment_spending_(Y)" = GRAPH("Tax_ratio_(Y)_from_(X)'s_taxes")
(1.000, 0.000), (1.14285714286, 0.935), (1.28571428571, 1.244), (1.42857142857, 1.406), (1.57142857143, 1.453), (1.71428571429, 1.466), (1.85714285714, 1.480), (2.000, 1.500)

UNITS: 1

"Effect_of_price_(Campaigns)_(Y)" = IF(Grant_&_Franklin_policy=1) THEN(1)

ELSE(1/("Perceived_price/_vote"/Initial_price)^"Price_elasticity_of_political_spending_(Campaigns)_(Y)")

UNITS: 1

"Effect_of_price_(Lobbying)_(Y)" = 1/("Perceived_market_price_of_lobbyist-hour"/"Initial_price_of_lobbyist-hour")^"Price_elasticity_of_lobbying_spending_(Y)"

UNITS: 1

"Effect_of_tax_gap_on_investment_spending_(Y)" = GRAPH("Tax_gap_ratio_(Y)"
(0.000, 0.000), (0.100, 0.944), (0.200, 1.468), (0.300, 1.682), (0.400, 1.828), (0.500, 1.923), (0.600, 1.955),
(0.700, 1.983), (0.800, 1.983), (0.900, 1.983), (1.000, 1.983))

UNITS: 1

"Fraction_consumption_from_disposable_income_(Y)" = 0.92

UNITS: 1

"Independent_expenditures_(Y)" = ("consumption_portion_of_political_spending_(Y)"-
"Campaign_contributions_(Y)")(1-"SWITCH:_Independent_expenditure_policy_0=OFF_1=ON")*(1-
Grant_&_Franklin_policy)

UNITS: USD/year

"Indicated_investment_portion_(Y)" = MIN(MAX(MAX("Investment_portion_of_political_spending_(Y)",
"Minimum_investment_(Y)"), ("Effect_of_(X)'s_tax_gap_on_investment_spending_(Y)"*
"SWITCH:_Redistri
bution_0=OFF_1=ON")+"Effect_of_tax_gap_on_investment_spending_(Y)"), "Effect_of_price_(Lobbying)_(Y)
"), "Minimum_investment_(Y)"), "Maximum_investment_(Y)")

UNITS: USD/year

"Initial_tax_rate_(Y)" = 0.25

UNITS: 1

"Investment_AT_(Y)" = 6+STEP(-3, 38)*0

UNITS: year

"Investment_portion_of_political_spending_(Y)"(t) = "Investment_portion_of_political_spending_(Y)"(t - dt) +
("Investment_adjustment_(Y)") * dt

INIT "Investment_portion_of_political_spending_(Y)" = "Minimum_investment_(Y)"

UNITS: USD/year

INFLOWS:

"Investment_adjustment_(Y)" = ("Indicated_investment_portion_(Y)"-
"Investment_portion_of_political_spending_(Y)"/"Investment_AT_(Y)")

UNITS: USD/year/Year

"Lobbying_spending_(Y)" = "Total_political_spending_(Y)"-"Campaign_contributions_(Y)"

"Independent_expenditures_(Y)"

UNITS: USD/year

"Marginal_propensity_to_spend_on_political_campaigns_(Y)" = 0.0005+STEP(0.0005, 38)*0

UNITS: 1

"Maximum_fraction_of_remaining_income_after_political_consumption_(Y)" = 0.001

UNITS: 1

"Maximum_investment_(Y)" = ("Discretionary_income_(Y)"

"consumption_portion_of_political_spending_(Y)*)"Maximum_fraction_of_remaining_income_after_political
consumption_(Y)"

UNITS: USD/year

"Minimum_investment_(Y)" = 4*1000*1000

UNITS: USD/YEAR

"Outcome_uncertainty_(Y)" = 0.1

UNITS: 1

"Price_elasticity_of_lobbying_spending_(Y)" = 0.3+STEP(-0.2, 38)*0

UNITS: 1

"Price_elasticity_of_political_spending_(Campaigns)_(Y)" = 0.2+STEP(-0.1, 38)*0

UNITS: 1

"Tax_gap_ratio_(Y)" = ("Tax_rate_(Y)"/"Desired_tax_rate_(Y)")-1

UNITS: 1

"Tax_rate_(Y)"(t) = "Tax_rate_(Y)"(t - dt) + ("Tax_rate_adjustment_(Y)") * dt {NON-NEGATIVE}

INIT "Tax_rate_(Y)" = "Initial_tax_rate_(Y)"

UNITS: 1

INFLOWS:

"Tax_rate_adjustment_(Y)" = ("Tax_rate_goal_(outcome_of_legislative_process_(Y))"-

"Tax_rate_(Y)"/"Tax_rate_AT_(Y)")

UNITS: 1/year

"Tax_rate_AT_(Y)" = GRAPH("Outcome_uncertainty_(Y)")

(0.000, 6.00), (0.100, 7.17), (0.200, 8.77), (0.300, 11.11), (0.400, 13.73), (0.500, 16.51), (0.600, 19.13), (0.700,
22.93), (0.800, 26.43), (0.900, 31.54), (1.000, 40.00)

UNITS: year

"Tax_rate_goal_(outcome_of_legislative_process_(Y))" = "Effect_of_L.E._ratio_on_tax_goal_(Y)"*(1-
 "Outcome_uncertainty_(Y)") + "Tax_rate_(Y)"* "Outcome_uncertainty_(Y)"

UNITS: 1

"Tax_ratio_(Y)_from_(X)'s_taxes" = "(Y)_Desired_tax_rate_(X)"/"Tax_rate_(X)"

UNITS: 1

"Total_political_spending_(Y)" =

"consumption_portion_of_political_spending_(Y)"+"Investment_portion_of_political_spending_(Y)"

UNITS: USD/year

CAMPAIGNS_PRICE_MECHANISM:

"%_change_of_supply" = DERIVN("Total_vote_supply_(per_year)", 1)

Aggregate_campaign_effectiveness = SAFEDIV("Total_vote_supply_(per_year)", Total_demand_for_votes)

UNITS: 1

Campaign_cost_shocks = 0+STEP(10, 50)*0

UNITS: USD/vote

Effect_of_campaign_effectiveness_on_price = SAFEDIV(1,

Aggregate_campaign_effectiveness)^"ε(b)_Price_sensitivity_to_campaign_effectiveness"

UNITS: 1

Effect_of_costs_on_price =

1+("ε(c)_Price_sensitivity_to_cost")*(((Campaign_cost_shocks+"Perceived_price/_vote")/"Perceived_price/_v
 ote")-1)

UNITS: 1

Effectiveness_of_independent_expenditure = 0.8

UNITS: 1

Initial_price = 22.7

UNITS: USD/vote

"Perceived_price/_vote"(t) = "Perceived_price/_vote"(t - dt) + (Price_adjustment) * dt

INIT "Perceived_price/_vote" = Initial_price

UNITS: USD/Vote

INFLOWS:

Price_adjustment = ("Price/_vote"- "Perceived_price/_vote")/Price_AT

UNITS: USD/Vote/Year

Price_AT = 2

UNITS: year

"Price/_vote" =

MAX("Perceived_price/_vote"*Effect_of_campaign_effectiveness_on_price*Effect_of_costs_on_price, 0.1)

UNITS: USD/vote

Total_demand_for_votes =

SAFEDIV("Total_spending_by_candidates_(elections)" + (Total_independent_expenditures)*Effectiveness_of_i
 ndependent_expenditure, "Perceived_price/_vote")*1

UNITS: Vote/year

"Total_spending_by_candidates_(elections)" =

("Campaign_contributions_(X)" + "Campaign_contributions_(Y)")*(1-Grant_&_Franklin_policy) +
 ((Grant_&_Franklin_policy)*Budget_for_campaigns)

UNITS: USD/year

"Total_vote_supply_(per_year)" = Self_motivated_voters+GOTV

UNITS: Vote/year

"ε(b)_Price_sensitivity_to_campaign_effectiveness" = 1

UNITS: 1

"ε(c)_Price_sensitivity_to_cost" = 1

UNITS: 1

CONTROL_PANEL:

"Initial_seats_(Y)" = 29.7*0+50

UNITS: Seat

GINI_INDEX_&_PUBLIC_OUTCRY:

"%_population_(Y)" = 1 - "%_population_(X)"

UNITS: 1

Anticipation_horizon = 6

UNITS: year

DOCUMENT: "But it is important to remember that Americans accept economic inequalities only when they are sure that everyone has an equal chance to get ahead — to make the best of life for the individual and his or her family."

democracy in the age of rising inequality

<https://www.apsanet.org/portals/54/Files/Task%20Force%20Reports/taskforcereport.pdf>

Averaging_time = 6

UNITS: year

Initial_public_outcry = HISTORY(Net_inequality_GINI, 0)

UNITS: 1

"Market_income_share_(Y)" = "Income_(Y)" / Total_market_income

UNITS: 1

Market_inequality_GINI = "%_population_(Y)" - "Market_income_share_(Y)"

UNITS: 1

"Net_income_(X)" = "Income_(X)" + "Redistribution_income_(X)" - "Taxes_(X)"

UNITS: USD/year

"Net_income_(Y)" = "Income_(Y)" + "Redistribution_income_(Y)" - "Taxes_(Y)"

UNITS: USD/year

"Net_income_share_(Y)" = "Net_income_(Y)" / Total_net_income

UNITS: 1

Net_inequality_GINI = "%_population_(Y)" - "Net_income_share_(Y)"

UNITS: 1

Public_outcry(t) = Public_outcry(t - dt) + (Change_in_public_outcry_due_to_inequality) * dt

INIT Public_outcry = Initial_public_outcry

UNITS: 1

INFLOWS:

Change_in_public_outcry_due_to_inequality = (Public's_perception_of_future_inequality - Public_outcry) / Averaging_time

UNITS: USD/USD/year

Public's_perception_of_future_inequality = FORCST(Net_inequality_GINI, Averaging_time, Anticipation_horizon)

UNITS: 1

Total_market_income = "Income_(X)" + "Income_(Y)"

UNITS: USD/year

Total_net_income = "Net_income_(X)" + "Net_income_(Y)"

UNITS: USD/year

GOVERNMENT_REDISTRIBUTION:

Fraction_redistribution = 0.5 + STEP(0.25, 38) * 0

UNITS: 1

Redistribution = "SWITCH:_Redistribution_0=OFF_1=ON" * Total_income_tax * Fraction_redistribution

UNITS: USD/year

"SWITCH:_Redistribution_0=OFF_1=ON" = 1 + STEP(-1, 50) * 0

UNITS: 1

Total_income_tax = "Taxes_(X)" + "Taxes_(Y)" - (Budget_for_campaigns * Grant_&_Franklin_policy)

UNITS: USD/year

"INCOME_(DATA)":

AAA = "actuals_in_2017_USD_(bottom_90%)" * "Population_(Y)_earners"

UNITS: USD/year

$$\text{"actuals_in_2017_USD_(\text{bottom_50\%})"}(t) = \text{"actuals_in_2017_USD_(\text{bottom_50\%})"}(t - dt) +$$

$$(\text{"Change_in_income_(\text{bottom_50\%})"}) * dt$$
 INIT "actuals_in_2017_USD_(bottom_50%)" = 20*1000
 UNITS: USD/person/year
 INFLOWS:

$$\text{"Change_in_income_(\text{bottom_50\%})"} = -16/1000*1000$$
 UNITS: USD/year/person/Year

$$\text{"actuals_in_2017_USD_(\text{bottom_90\%})"}(t) = \text{"actuals_in_2017_USD_(\text{bottom_90\%})"}(t - dt) +$$

$$(\text{"Change_in_income_(\text{bottom_90\%})"}) * dt$$
 INIT "actuals_in_2017_USD_(bottom_90%)" = 90.3*1000
 UNITS: USD/person/year
 INFLOWS:

$$\text{"Change_in_income_(\text{bottom_90\%})"} = 0.514*1000$$
 UNITS: USD/year/person/Year

$$\text{"actuals_in_2017_USD_(\text{middle_40\%})"}(t) = \text{"actuals_in_2017_USD_(\text{middle_40\%})"}(t - dt) +$$

$$(\text{"Change_in_income_(\text{middle_40\%})"}) * dt$$
 INIT "actuals_in_2017_USD_(middle_40%)" = 70.1*1000
 UNITS: USD/person/year
 INFLOWS:

$$\text{"Change_in_income_(\text{middle_40\%})"} = 0.53*1000$$
 UNITS: USD/year/person/Year

$$\text{"actuals_in_2017_USD_(\text{Top_10\%})"}(t) = \text{"actuals_in_2017_USD_(\text{Top_10\%})"}(t - dt) +$$

$$(\text{"Change_in_income_(\text{Top_10\%})"}) * dt$$
 INIT "actuals_in_2017_USD_(Top_10%)" = 220*1000
 UNITS: USD/person/year
 INFLOWS:

$$\text{"Change_in_income_(\text{Top_10\%})"} = 6.371*1000$$
 UNITS: USD/year/person/Year

$$\text{"aggregate_change_in_income_(\text{bottom_90\%})"} =$$

$$\text{"actuals_in_2017_USD_(\text{middle_40\%})"} + \text{"actuals_in_2017_USD_(\text{bottom_50\%})"}$$
 UNITS: USD/person/year

$$\text{"Fraction_population_(\text{bottom_50\%})"} = 0.5$$
 UNITS: 1

$$\text{"Fraction_population_(\text{middle_40\%})"} = 0.4$$
 UNITS: 1

$$\text{"Total_income_(\text{bottom_90\%})"} =$$

$$((\text{"Population_(\text{Y})_earners"} * \text{"actuals_in_2017_USD_(\text{middle_40\%})"} * \text{"Fraction_population_(\text{middle_40\%})"}) +$$

$$(\text{"Population_(\text{Y})_earners"} * \text{"actuals_in_2017_USD_(\text{bottom_50\%})"} * \text{"Fraction_population_(\text{bottom_50\%})"})) * 1$$
 UNITS: USD/year

$$\text{"Total_income_(\text{top_10\%})"} = \text{"Population_(\text{X})_earners"} * \text{"actuals_in_2017_USD_(\text{Top_10\%})"}$$
 UNITS: USD/year

LEGISLATOR:

$$\text{"L.E_ratio_(\text{X})"} =$$

$$\text{"Legislative_enterprise_(\text{X})"} / (\text{"Legislative_enterprise_(\text{X})"} + \text{"Legislative_enterprise_(\text{Y})"} * (1 - 0))$$
 UNITS: 1

$$\text{"L.E_ratio_(\text{Y})"} = \text{"Legislative_enterprise_(\text{Y})"} / (\text{"Legislative_enterprise_(\text{X})"} + \text{"Legislative_enterprise_(\text{Y})"})$$
 UNITS: 1

$$\text{"Expected_votes_(\text{X})"} = \text{IF}(\text{"Price_/_vote"} = 0) \text{ THEN } (\text{"Total_vote_supply_(\text{per_year})"} / 2)$$

$$\text{ELSE}(\text{MIN}(\text{SAFEDIV}(\text{"Campaign_contributions_(\text{X})"},$$

$$\text{"Price_/_vote"}), \text{SAFEDIV}(\text{"Campaign_contributions_(\text{X})"},$$

$$(\text{"Campaign_contributions_(\text{X})"} + \text{"Campaign_contributions_(\text{Y})"})) * \text{"Total_vote_supply_(\text{per_year})"}))$$
 UNITS: Vote/year
 DOCUMENT: https://www.ineteconomics.org/uploads/papers/WP_48_Ferguson_et_al.pdf

$$\text{"Expected_votes_(\text{Y})"} = \text{IF}(\text{"Price_/_vote"} = 0) \text{ THEN } (\text{"Total_vote_supply_(\text{per_year})"} / 2)$$

$$\text{ELSE}(\text{MIN}(\text{SAFEDIV}(\text{"Campaign_contributions_(\text{Y})"},$$

$$\text{"Price_/_vote"}), \text{SAFEDIV}(\text{"Campaign_contributions_(\text{Y})"},$$

$$(\text{"Campaign_contributions_(\text{Y})"} + \text{"Campaign_contributions_(\text{X})"})) * \text{"Total_vote_supply_(\text{per_year})"}))$$

UNITS: Vote/year

"Influence_uncertainty_(X)" = 0.1

UNITS: 1

"Influence_uncertainty_(Y)" = 0.1

UNITS: 1

"Legislative_enterprise_(X)" = "Legislators_(X)"*MAX("Lobbying_spending_(X)"/"Price_of_lobbyist-hour", 0.1)*(1-"Influence_uncertainty_(X)")

UNITS: hour*Seat/year

"Legislative_enterprise_(Y)" = "Legislators_(Y)"*MAX("Lobbying_spending_(Y)"/"Price_of_lobbyist-hour", 0.1)*(1-"Influence_uncertainty_(Y)")

UNITS: hour*Seat/year

"Legislators_(X)"(t) = "Legislators_(X)"(t - dt) + ("Winning_elections_(X)" - "Leaving_office_(X)") * dt

INIT "Legislators_(X)" = "Initial_seats_(X)"

UNITS: Seat

INFLOWS:

"Winning_elections_(X)" = "Vote_ratio_(X)"*Seats_available {UNIFLOW}

UNITS: Seat/year

OUTFLOWS:

"Leaving_office_(X)" = "Legislators_(X)"/Term_of_legislator {UNIFLOW}

UNITS: Seat/year

"Legislators_(Y)"(t) = "Legislators_(Y)"(t - dt) + ("Winning_elections_(Y)" - "Leaving_office_(Y)") * dt

INIT "Legislators_(Y)" = "Initial_seats_(Y)"

UNITS: Seat

INFLOWS:

"Winning_elections_(Y)" = ((1-"Vote_ratio_(X)")*Seats_available) {UNIFLOW}

UNITS: Seat/year

OUTFLOWS:

"Leaving_office_(Y)" = "Legislators_(Y)"/Term_of_legislator {UNIFLOW}

UNITS: Seat/year

Seats_available = ("Leaving_office_(X)"+"Leaving_office_(Y)")

UNITS: Seat/year

DOCUMENT: 30% of the senate gets elected every 2 years.

This means that half of the 33 seats may be modelled continuously as elected every year.

Term_of_legislator = 6

UNITS: year

"Vote_ratio_(X)" = SAFEDIV("Votes_(X)", "Votes_(X)"+"Votes_(Y)")*(1-Grant_&_Franklin_policy) +

"Vote_ratio_(X)"_allocation*Grant_&_Franklin_policy

UNITS: 1

DOCUMENT: What we're saying here is that when "Probability of outspending resulting in seat win" falls, the highest spending agent will get less seats per vote.

The probability is multiplied here, since the votes are cast, and they are cast based on campaign spending, and this assumes a deterministic certain relationship between

"Votes_(X)" = IF("Expected_votes_(X)">"Expected_votes_(Y)")

THEN("Expected_votes_(X)"*Probability_of_outspending_resulting_in_seat_win)

ELSE("Expected_votes_(X)"*(1-Probability_of_outspending_resulting_in_seat_win)*"Expected_votes_(Y)")

UNITS: vote/year

"Votes_(Y)" = IF("Expected_votes_(X)">"Expected_votes_(Y)") THEN("Expected_votes_(Y)"*(1-

Probability_of_outspending_resulting_in_seat_win)*"Expected_votes_(X)")

ELSE("Expected_votes_(Y)"*Probability_of_outspending_resulting_in_seat_win)

UNITS: vote/year

LOBBYING_PRICE_MECHANISM:

Active_lobbyists(t) = Active_lobbyists(t - dt) + (lobbyist_adjustment - Lobbyist_attrition_rate) * dt {NON-NEGATIVE}

INIT Active_lobbyists = Initial_number_of_active_lobbyists

UNITS: lobbyist

INFLOWS:

lobbyist_adjustment = (Indicated_labor-Active_lobbyists)/Lobbying_supply_AT + Lobbyist_attrition_rate

UNITS: lobbyist/Year
 OUTFLOWS:
 Lobbyist_attrition_rate = Active_lobbyists/Average_career_duration {UNIFLOW}
 UNITS: lobbyist/Year
 Average_career_duration = 20
 UNITS: year
 "Average_manhours/_lobbyist/_year" = 45*40
 UNITS: hour/lobbyist/year
 Converter_11 = Indicated_labor-Active_lobbyists
 Effect_of_labor_ratio_on_price = SAFEDIV(1,
 "Labor_ratio_(lobbyists)"))^"ε(a)_Labor_ratio_elasticity_(effect_on_price)"
 UNITS: 1
 Effect_of_price_on_supply_of_lobbyists = ("Lobbyists_long-run_expected_price"/"Initial_price_of_lobbyist-hour")*Lobbyist_supply_sensitivity_to_price
 UNITS: 1
 Indicated_labor = MIN(Indicated_manhours_needed/"Average_manhours/_lobbyist/_year",
 Maximum_active_lobbyists)
 UNITS: lobbyist
 Indicated_manhours_needed = (Perceived_demand_for_lobbying)*Effect_of_price_on_supply_of_lobbyists
 UNITS: hour/year
 "Indicated_price_(L)" = MAX("Price_of_lobbyist-hour", Minimum_price)
 UNITS: USD/hour
 Initial_number_of_active_lobbyists = 1335
 UNITS: lobbyist
 "Initial_price_of_lobbyist-hour" = 5
 UNITS: USD/hour
 "Labor_ratio_(lobbyists)" = SAFEDIV(Active_lobbyists, Total_demand_of_lobbyists, 1000*1000*1000)
 UNITS: 1
 Lobbying_price_AT = 1
 UNITS: year
 Lobbying_supply_AT = 2
 UNITS: year
 Lobbyist_supply_sensitivity_to_price = 1
 UNITS: 1
 Lobbyists_AT = 6
 UNITS: year
 "Lobbyists_long-run_expected_price" = SMTH1("Price_of_lobbyist-hour", Lobbyists_AT, "Price_of_lobbyist-hour")
 UNITS: USD/hour
 Maximum_active_lobbyists = 10000
 UNITS: lobbyist
 Minimum_price = 5
 UNITS: USD/hour
 Perceived_demand_for_lobbying = SMTH1(Total_demand_for_lobbying, 2, Total_demand_for_lobbying)
 UNITS: hour/year
 "Perceived_market_price_of_lobbyist-hour"(t) = "Perceived_market_price_of_lobbyist-hour"(t - dt) +
 (Change_in_perceived_price_of_legislative_subsidy) * dt
 INIT "Perceived_market_price_of_lobbyist-hour" = "Initial_price_of_lobbyist-hour"
 UNITS: USD/hour
 INFLOWS:
 Change_in_perceived_price_of_legislative_subsidy = ("Indicated_price_(L)" -
 "Perceived_market_price_of_lobbyist-hour")/Lobbying_price_AT
 UNITS: USD/hour/Year
 "Price_of_lobbyist-hour" = Effect_of_labor_ratio_on_price*"Perceived_market_price_of_lobbyist-hour"
 UNITS: USD/hour
 Rate_of_change_in_demand = DERIVN(Total_demand_of_lobbyists, 1)
 UNITS: lobbyist/year
 Rate_of_change_in_supply = DERIVN(Active_lobbyists, 1)
 UNITS: Lobbyist/year
 Total_demand_for_lobbying = Total_lobbying_spending/("Perceived_market_price_of_lobbyist-hour")

UNITS: hour/year

Total_demand_of_lobbyists = Total_demand_for_lobbying/"Average_manhours/_lobbyist/_year"

UNITS: lobbyist

Total_lobbying_spending = ("Lobbying_spending_(X)"+"Lobbying_spending_(Y))*1

UNITS: USD/year

"ε(a)_Labor_ratio_elasticity_(effect_on_price)" = 1

UNITS: 1

"POLICY_1:_CAMPAIGN_FINANCE_REFORM_(LIMIT_CONTRIBUTIONS)":

"Campaign_contribution_limit_(Total)" =

Seats_available*(1+Challenger_factor)*"Campaign_contribution_limit/_candidate"

UNITS: USD/year

"Campaign_contribution_limit/_candidate" = 2000*1000*1

UNITS: USD/Seat

Challenger_factor = 1.5

UNITS: 1

Contribution_ratio = ("Total_spending_by_candidates_(elections)"/"Campaign_contribution_limit_(Total)")

UNITS: 1

Indicated_reduction = Required_reduction*(Contribution_ratio)

UNITS: USD/year

Policy_Adjustment_Time = 0.5

UNITS: year

"reduction_(X)" =

Required_reduction*"consumption_portion_of_political_spending_(X)"/("consumption_portion_of_political_spending_(X)"+"consumption_portion_of_political_spending_(Y))*"SWITCH:_Contribution_limit_policy_0=OFF_1=ON"

UNITS: USD/year

"reduction_(Y)" =

Required_reduction*"consumption_portion_of_political_spending_(Y)"/("consumption_portion_of_political_spending_(Y)"+"consumption_portion_of_political_spending_(X))*"SWITCH:_Contribution_limit_policy_0=OFF_1=ON"

UNITS: USD/year

Required_reduction(t) = Required_reduction(t - dt) + (reduction_in_contributions) * dt

INIT Required_reduction = 1000*1000

UNITS: USD/year

INFLOWS:

reduction_in_contributions = (Indicated_reduction-Required_reduction)/Policy_Adjustment_Time*(0+STEP("SWITCH:_Contribution_limit_policy_0=OFF_1=ON", Time_of_policy_implementation))

UNITS: USD/year/Year

"SWITCH:_Contribution_limit_policy_0=OFF_1=ON" = 0

UNITS: 1

"SWITCH:_Independent_expenditure_policy_0=OFF_1=ON" = 0

UNITS: 1

Time_of_policy_implementation = 38

UNITS: year

"POLICY_2:_CAMPAIGN_FINANCE_REFORM_(GRANT_&_FRANKLIN_PROJECT)":

"Allocation_(X)" = (("Expected_allocation_(X))* (1-

"Uncertainty_of_allocation_(X)") + ("Expected_allocation_(Y))*"Uncertainty_of_allocation_(Y)") * Grant_&_Franklin_policy

UNITS: USD/year

"Allocation_(Y)" = (("Expected_allocation_(Y))* (1-

"Uncertainty_of_allocation_(Y)") + ("Expected_allocation_(X))*"Uncertainty_of_allocation_(X)") * Grant_&_Franklin_policy

UNITS: USD/year

"Average_candidate_top-up/_citizen_(X)" = 2.5
 UNITS: candidate
 "Average_candidate_top-up/_citizen_(Y)" = 1.25
 UNITS: candidate
 "Expected_allocation_(X)" = "Grant_(X)"+"Franklin_(X)"
 UNITS: USD/year
 "Expected_allocation_(Y)" = "Grant_(Y)"+"Franklin_(Y)"
 UNITS: USD/year
 "Expected_votes_(X)_-_allocation" = MIN("Allocation_(X)"/"Price/_vote",
 "Allocation_(X)"*Total_vote_supply_(per_year)/("Allocation_(X)"+"Allocation_(Y)"))
 UNITS: Vote/year
 "Expected_votes_(Y)_-_allocation" = MIN("Allocation_(Y)"/"Price/_vote",
 "Allocation_(Y)"*Total_vote_supply_(per_year)/("Allocation_(Y)"+"Allocation_(X)"))
 UNITS: Vote/year
 "Franklin_(X)" = "Franklin/_earner"*"Population_(X)_earners"*"Franklin_factor_(X)"
 UNITS: USD/year
 "Franklin_(Y)" = "Franklin/_earner"*"Population_(Y)_earners"*"Franklin_factor_(Y)"
 UNITS: USD/year
 "Franklin_factor_(X)" = "Probability_of_Franklin_top-up_(X)"*Average_candidate_top-up/_citizen_(X)"
 UNITS: candidate
 "Franklin_factor_(Y)" = "Probability_of_Franklin_top-up_(Y)"*Average_candidate_top-up/_citizen_(Y)"
 UNITS: candidate
 "Franklin/_earner" = "Franklin/earner/_election_cycle"/Elections_cycle_period
 UNITS: USD/person/candidate/year
 "Franklin/earner/_election_cycle" = 100
 UNITS: USD/person/candidate
 Grant_&_Franklin_policy = STEP(1,
 Time_for_G&F_policy_implementation)*"SWITCH:_Grant_&_Franklin_project_0=OFF_1=ON"
 UNITS: 1
 "Grant_(X)" = "Grant/_earner/year"*"Population_(X)_earners"
 UNITS: USD/year
 "Grant_(Y)" = "Grant/_earner/year"*"Population_(Y)_earners"
 UNITS: USD/year
 "Grant/_earner/year" = "Grant/earner/_election_cycle"/Elections_cycle_period
 UNITS: USD/person/year
 "Grant/earner/_election_cycle" = 50
 UNITS: USD/person
 "Probability_of_Franklin_top-up_(X)" = 0.8
 UNITS: 1
 "Probability_of_Franklin_top-up_(Y)" = 0.2
 UNITS: 1
 "SWITCH:_Grant_&_Franklin_project_0=OFF_1=ON" = 0
 UNITS: 1
 Time_for_G&F_policy_implementation = 38
 UNITS: year
 "Uncertainty_of_allocation_(X)" = 0.1
 UNITS: 1
 "Uncertainty_of_allocation_(Y)" = 0.3
 UNITS: 1
 "Vote_ratio_(X)_-_allocation" = "Votes_(X)_-_allocation"/("Votes_(X)_-_allocation"+"Votes_(Y)_-_allocation")
 UNITS: 1
 "Votes_(X)_-_allocation" = "Expected_votes_(X)_-_allocation"*(Probability_of_outspending_resulting_in_seat_win)+"Expected_votes_(Y)_-_allocation"*(1-Probability_of_outspending_resulting_in_seat_win)
 UNITS: Vote/year
 "Votes_(Y)_-_allocation" = "Expected_votes_(Y)_-_allocation"*(Probability_of_outspending_resulting_in_seat_win)+"Expected_votes_(X)_-_allocation"*(1-Probability_of_outspending_resulting_in_seat_win)
 UNITS: Vote/year

SCENARIOS:

VOTERS:

Converter_6 = DERIVN(Eligible_voters, 1)/Eligible_voters

Demanded_GOTV = GOTV_multiplier*Total_demand_for_votes

UNITS: Vote/year

Effect_of_GOTV_innovation_on_mobilization =

GRAPH(Effect_of_price_on_GOTV_innovation/HISTORY(Effect_of_price_on_GOTV_innovation, 0))
(0.000, 0.000), (0.166666666667, 0.326), (0.333333333333, 0.541), (0.500, 0.700), (0.666666666667, 0.833),
(0.833333333333, 0.931), (1.000, 1.000)

UNITS: 1

Effect_of_income_inequality_on_voter_turnout = (1-

Net_inequality_GINI)^Sensitivity_of_voter_turnout_to_income_inequality-STEP((1-

Net_inequality_GINI)^Sensitivity_of_voter_turnout_to_income_inequality, 38)*0+STEP(1, 38)*0

UNITS: 1

DOCUMENT: https://www.unwe.bg/uploads/Alternatives/3_Guvercin_EAlternativi_en_1_2018.pdf

Actually this is much better:

<https://link.springer.com/article/10.1007/s11109-010-9106-0>

greater inequality leads to less likelihood to vote

It appears that greater inequality is

adequately modeled as reducing the importance of elections for all citizens

regardless of their incomes, at least in the gubernatorial races examined here.

"— citizen voice, government decision-making, and public policy — may be coming together to amplify the influence of the few and promote government unresponsive to the values and needs of the many. Such a negative spiral can, in turn, prompt Americans to become increasingly discouraged about the effectiveness of democratic governance, spreading cynicism and withdrawal from elections and other arenas of public life."

reinforcing loop

Effect_of_price_on_GOTV_innovation =

(SMTH1(("Price/_vote"/Initial_price)^Sensitivity_of_GOTV_to_price_changes, "Normal_GOTV_build-up_time", 1))*1

UNITS: 1

Elections_cycle_period = 2

UNITS: year

Eligible_voters(t) = Eligible_voters(t - dt) + (Maturation - Death) * dt

INIT Eligible_voters = 157.060*1000*1000 + 120*1000*1000*0

UNITS: Person

DOCUMENT: Based on US 1980 Census, 157.060 million citizens were above 18 (voting age).

The total population was 226.546 million citizen.

<https://www2.census.gov/programs-surveys/cps/tables/p23/168/tab07.pdf>

There's almost a 30 million gap in voters although the total population is consistent.

INFLOWS:

Maturation = Underage/Maturation_time {UNIFLOW}

UNITS: Person/Year

OUTFLOWS:

Death = Eligible_voters/Life_expectancy {UNIFLOW}

UNITS: Person/Year

DOCUMENT:

Fertility = 1.9557/2/32*1 + 1/58*0

UNITS: 1/year

DOCUMENT: Taken as the average of births per woman over the period from 1980-2016. Data extracted from:

<https://fred.stlouisfed.org/series/SPDYNTFRTINUSA>

Fraction_self_motivated = 0.1

UNITS: vote/person

DOCUMENT: "Only some Americans fully exercise their rights as citizens, and they usually come from the more advantaged segments of society. Those who enjoy higher incomes, more occupational success, and the

highest levels of formal education, are the ones most likely to participate in politics and make their needs and values known to government officials."

the same task force paper.

$GOTV = \min(\text{Max_GOTV_supply}, \text{Demanded_GOTV})$

UNITS: vote/year

$GOTV_multiplier =$

$\text{Effect_of_GOTV_innovation_on_mobilization} * \text{Effect_of_income_inequality_on_voter_turnout}$

UNITS: 1

$\text{Life_expectancy} = 76 - \text{Maturation_time}$

UNITS: year

DOCUMENT: Based on World Bank data:

<https://data.worldbank.org/indicator/SP.DYN.LE00.IN?locations=US>

$\text{Maturation_time} = 18$

UNITS: year

DOCUMENT: Voting age in USA in 1980 was 18 years old.

$\text{Max_GOTV_supply} = \text{Eligible_voters} * \text{Maximum_GOTV_}\% / \text{Elections_cycle_period}$

UNITS: Vote/year

$\text{Maximum_GOTV_}\% = \text{Maximum_participation_rate} - \text{Fraction_self_motivated}$

UNITS: vote/person

$\text{Maximum_participation_rate} = 1$

UNITS: vote/person

DOCUMENT: If political awareness was 100%, no campaigns will be needed.

"Normal_GOTV_build-up_time" = 2

UNITS: year

$\text{Self_motivated_voters} = \text{Eligible_voters} * \text{Fraction_self_motivated} / \text{Elections_cycle_period}$

UNITS: vote/year

$\text{Sensitivity_of_GOTV_to_price_changes} = 1$

UNITS: 1

$\text{Sensitivity_of_voter_turnout_to_income_inequality} = 1.5$

UNITS: 1

$\text{Underage}(t) = \text{Underage}(t - dt) + (\text{Birth} - \text{Maturation}) * dt$

$\text{INIT Underage} = 69.784 * 1000 * 1000 * 0 + \text{Eligible_voters} * \text{Maturation_time} / \text{Life_expectancy} * 1$

UNITS: Person

DOCUMENT: Based on US 1980 Census, 69.784 million citizens were below 18 (voting age).

The total population was 226.546 million citizen.

<https://www2.census.gov/programs-surveys/cps/tables/p23/168/tab07.pdf>

INFLOWS:

$\text{Birth} = \text{Eligible_voters} * \text{Fertility} \{ \text{UNIFLOW} \}$

UNITS: Person/Year

OUTFLOWS:

$\text{Maturation} = \text{Underage} / \text{Maturation_time} \{ \text{UNIFLOW} \}$

UNITS: Person/Year

{ The model has 265 (265) variables (array expansion in parens).

In root model and 0 additional modules with 14 sectors.

Stocks: 19 (19) Flows: 31 (31) Converters: 215 (215)

Constants: 80 (80) Equations: 166 (166) Graphicals: 6 (6)

There are also 43 expanded macro variables

Thank you