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NOTE: This is a print version of the journal with no appendices. All appendices will be available in the online version of the journal found on the website

UCL Journal of Economics

Editorial Board

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Foreword

Welcome to the inaugural issue of the UCL Journal of Economics - the first undergraduate run peer reviewed journal at the UCL Department of Economics. We're incredibly pleased to present a series of research papers penned from highly driven and curious minds from around the world. The journey here was a natural result of an increasing interest in undergraduate research, and a manifestation of UCL's research-led teaching philosophy. The UJE emerged from the research division of the Economic Tribune - the flagship magazine of the Department of Economics - in an attempt to meet demand from an audience that was interested in more comprehensive academic research. Over the course of the last year, our team conceptualised what this journal would look like - finally arriving at a model we would like to describe as inclusive.

We are open to submissions from any undergraduate student around the world for research pieces which employ elements of economics in them. From full length papers to selected literature reviews, the piece need not be something written specifically for the journal and we actively encourage students to submit something that was originally intended for a university course. Further, we employ a system where papers submitted after an intake deadline or have room for improvement are "conditionally accepted" for the next issue.

This journal is a celebration of the hard work of budding academics in the field of Economics and we are pleased to present fourteen thought provoking papers. Some of these have been chosen from UCL Economics' annual research symposium "Explore Econ", others are the work of research correspondents from the Economic Tribune, and others are submitted from students around the world.

Firstly, Jakub Terlikowski - who won Explore Econ - examines how vaccines could be optimally distributed as he employs a model based on population interaction and administrative constraints. Then, the Runner-Up of Explore Econ Guillaume Marder explores what the potential impact of a uniform VAT rate implemented in Spain would look like. We then take a detour into the realm of developmental economics and the impact of migration on the labour market in Gaurav Khatri's paper titled "The Effects of Rohingya Refugees from Myanmar on Low-Skilled Wages in the Chittagong Division of Bangladesh".

With the pandemic (seemingly) drawing to a close, we must cast an eye over the past three years to see what we must do better. This year's popular vote winners from Explore Econ are a team of four: Xingzuo Zhou, Yiang Li, Tianning Zhu, and Xiaoyu Guo. They show us that we must combat more than just the virus in order to emerge successfully. Their paper on the relationship between racial hate crime and Covid-19 explores the ways in which the pandemic bred not only sickness, but prejudice as well.

We are proud to present articles by two of our own research correspondents. Combining fascinating subject area with fascinating methodology, Suraj Sridhar builds an Agent Based Model to capture the complex system of income-based segregation in urban areas. In another very relevant paper, John Korngold assesses how climate change affects economic outcomes by linking growing income inequality and climate disruption to demonstrate that policy makers might benefit from taking this interaction into consideration.

We now move onto papers submitted from students at UCL and universities from across the Atlantic such as Vanderbilt, UC Berkeley and UChicago.

Alessandro Guarnieri makes the case that loose monetary policy increases wealth inequality along education in a paper aptly titled "Monetary Policy, Portfolio Heterogeneity, and the College Wealth Gap".

On the microeconomics side, Yiyang Li's paper offers insight into consumer belief – more specifically how perceptions about quality are shaped by online reviews.

There's a market for everything, and in Thomas Adler's paper titled "Insects on our plates?" we explore the potential of the edible insect market. This paper is a must read for any budding entomologists!

In case you feel fatigued, you can take a pitstop and read a policy brief on American Right-to-Work legislation by Nicholas Whitaker. The paper covers how unions have been losing power in the United States since the 1950s, but that there is potential for a revival - leaving us to mull over how policymakers across the world might counteract a loss in worker bargaining power.

In the aftermath of China's One Child Policy, we see the spectre of a population ageing crisis. Tianyi Zhang's paper examines expansionary population policies and alternate solutions to this problem.

As many countries around the world become more and more undemocratic, we must ask ourselves what impact institutional change would have on economic growth. Haneeboy Barlis uses a Difference-in-Differences technique to assess the impact of France's constitutional change to GDP.

Abhishek Roy attempts to establish a causal relationship between per capita income and renewable energy generated by a state in the United States in paper that offers insight into how policymakers may enable poorer states to reduce their burden on non-renewables.

We wrap up with Nolan Seigel's thesis which outlines research on how substantive representation is in the American institutions of government and how this feeds into policy formulation.

I sincerely hope you enjoy reading this diverse range of papers and are inspired to read further or do your own research. I'd like to offer a well-deserved congratulations to all the authors who contributed to this journal. I hope you're incredibly proud of your achievement and wish you all the best in your future endeavours.

Creating the UJE has truly been a labour of love – it's been a year of planning, outreach, drafting and editing. There's a number of people whom I'd like to thank because without them you wouldn't be holding this journal or reading it online. Firstly, our advisory board who supported us and guided us. Professor Parama Chaudhury, Dr. Silvia dal Bianco and Dr. Ramin Nassehi's enthusiasm for this project gave us the motivation we needed to achieve our goal. Secondly, I'd like to thank our Peer Reviewers Daniel Tseng, Sam Asher, Damian Phelan and James Kinder for lending us their expertise and ensuring our selection process was rigorous.

The team at UCL Press, especially Ian Caswell, also deserve a great deal of thanks as without their advice and infrastructural support the UJE could not have got off the ground.

Lastly, I would like to thank my team for their tireless effort over the last year. Shivam, Phin, Isabelle, Xingzuo and Matty deserve a great deal of appreciation for all the work they've done. I'd also like to give a special note of thanks to Shivam, Phin and Isabelle for being around from the beginning and being an incredible team to work with.

It's been an honour.

Yours Truly
Ananya Ashta
Editor-in-Chief
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Explore Econ

Explore Econ is an annual student-run undergraduate research conference, organised by the Centre for Teaching and Learning Economics (CTaLE) in the UCL's Department of Economics. The conference showcases the research conducted by students both within and outside the curriculum. This section showcases abstracts of all the prize winners (Paper category) of this year's conference held on 8th June, 2022. In addition to the following, a special shoutout also to Neil Majithia and Adam Horne for winning the Best Poster and Runner-up poster award.

Entries of all shortlist and winners for paper and poster categories can be viewed at the Explore Econ 2022 website

Article (Explore Econ Winner)

Optimal Vaccine Allocation: Modelling Population Interaction and Administrative Constraints

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Abstract

The COVID-19 pandemic and associated vaccine shortages in many places have caused immense suffering. This paper proposes a theoretical framework for finding the optimal vaccine allocation among interconnected populations. In particular, the analysis focuses on modelling how interaction and administrative constraints affect the optimal vaccine allocation. The proposed framework suggests that both factors affect the optimal vaccine allocation differently, especially when the shortage of vaccines is severe. Four hypotheses are put forward, which should be verified empirically in order to falsify the plausibility of the proposed theoretical framework.

Keywords: COVID-19 Vaccines, Mathematical Modelling, Constrained Optimisation

1. Introduction

The number of deaths worldwide caused by COVID-19 has exceeded 6 million (Ritchie et al., 2020). Scientists developed vaccines several months after the first cases of COVID-19 were confirmed (AJMC Staff, 2021), and many countries have faced vaccine shortages (Feinmann, 2021). Given this reality, in order to limit human suffering, it is imperative to understand how to allocate vaccines optimally. In this paper, I look at how the interaction between populations and constraints on the number of vaccines administered daily affect the optimal vaccine allocation. Using a simple pandemic model and an optimisation algorithm, I show that both factors affect the optimal vaccine allocation differently, especially when the number of vaccines available is small.

2. Literature Review

Major pandemics have had a significant influence on the history of humankind (Piret and Boivin, 2021). To understand them, scholars have developed mathematical models that allow us to describe and predict the flow of a pandemic with a set of equations. The SIR model, developed in the 1920s (Kermack and McKendrick, 1927), is one of the simplest ways of modelling pandemics. Its basic version divides the population into three compartments (Susceptible, Infected, Recovered) but scholars have extended the model to account for quarantines, lockdowns, vaccinations, and deaths (Fosu et al., 2020).

One of the reasons why scholars are interested in modelling pandemics is the need to understand how to fight them effectively. In particular, one of the questions discussed in the literature is how to allocate vaccines optimally between different populations, given the constraints policymakers face. This problem can be formulated as a constrained optimisation problem and has attracted the attention of economists (Kitagawa and Wang, 2021). Dujizer et al. (2017) showed the importance of the herd effect in determining the optimal allocation.

This paper attempts to extend the discussion of the optimal vaccine allocation problem in two ways. Firstly, I look at how administrative constraints (the number of people that can be vaccinated daily) affect the optimum. Secondly, I investigate how different patterns of interaction between populations (allowing for infections in population A to affect population B) affect the optimum.

3. The Model

I use an extended version of the SIR model to understand how administrative constraints and population interconnectedness affect the optimal allocation. I assume that in each population, there are four different compartments: Susceptible, Infected, Recovered, and Dead. At any point in time, each person from every society is in one of them. Once someone is in the Recovered compartment, they can no longer move back to being infected (they are immune). Lastly, I assume it is possible to identify susceptible individuals, and vaccination (which is fully effective and takes no time) transfers people from the Susceptible to the Recovered compartment.

The number of susceptible, infected, recovered, and dead people in population i are denoted by S_i, I_i, R_i, and D_i. Recovery and death rates are denoted by γ_i and α_i, respectively. The number of people vaccinated in each period in population i is denoted by V_i (this is a fixed number for every population). Lastly, β_i and ω_{ij} capture the transmission of the disease. The former coefficient describes the increase in infections resulting from contact inside population i, whereas the latter describes the increase in infections in population i resulting from the contact with population j (note that ω_{ij} is not necessarily equal to ω_{ji}). Ω denotes the matrix containing all possible ω_{ij}. Figure 1 summarises the model.
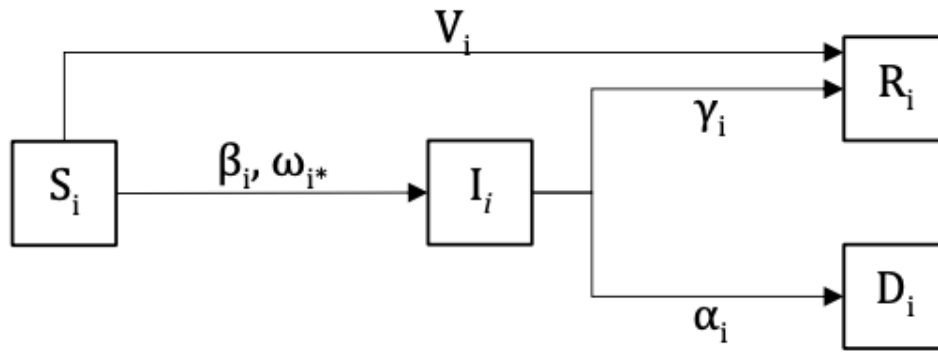
Figure 1: A diagram of a SIR model for population i with four compartments, vaccination, and interaction between populations. ωi* denotes the ith row of matrix Ω.

The pandemic flow for *k* societies can be described as a system of differential equations (*Ni* denotes the size of population *i*):

$$\frac{dS_i}{dt} = -\frac{S_i}{N_i}\left(\beta_i I_i + \Sigma_{j\neq i}^k \omega_{ij} I_j\right) - V_i$$

$$\frac{dI_i}{dt} = \frac{S_i}{N_i}\left(\beta_i I_i + \Sigma_{j\neq i}^k \omega_{ij} I_j\right) - \alpha_i I_i - \gamma_i I_i$$

$$\frac{dR_i}{dt} = \gamma_i I_i + V_i$$

$$\frac{dD_i}{dt} = \alpha_i I_i$$

3.1. Minimisation algorithm

The problem of optimal vaccine allocation can be described as a constrained minimisation problem:

$\min \Sigma_{i=1}^k D_i^T$ subject to $\Sigma_{i=1}^k W_i \leq P$

Where D_i^T denotes the number of deaths in society *i* at the end of the pandemic, *Wi* denotes the number of vaccines allocated to society *i,* and *P* denotes the number of vaccines available.

Instead of solving this problem explicitly, I designed a simple greedy minimization algorithm. It builds on the presumption that marginal gains from adding a small number of vaccines to every population are equal for all populations at the optimum. The algorithm works as follows:

1. **Input:** initial conditions (*Si*, *Ii*, *Ri*, and *Di*), and rates of change (αi, βi, γi, ωi, and Vi) for every society, total vaccine stockpile *P*;
2. **Initialisation**: Start from a random allocation of vaccines such that $\sum_{i=1}^k w_i = P$; **while** the decrease in total deaths > ε:
3. Compute marginal gain (decrease in total deaths from marginally increasing vaccine stockpile) for each society;
4. Transfer 10 vaccines from the society with the lowest marginal gain to the one with the highest; **return W_i** for all *i*

3.2. The four scenarios

The two phenomena I would like to analyse using the model are the presence of administrative constraints and interaction between populations. To understand them better, I look at the optimal vaccine allocation between three populations under four scenarios: the base scenario (with no interaction and no administrative constraint, corresponding to the case discussed by Duijzer et al. (2017)), the administrative constraint scenario (only 1% of the population can be vaccinated daily), the first interaction scenario (all populations interact with each other), and the second interaction scenario (Population 2 is affected by Population 1 and Population 3 is affected by Population 3, but not vice-versa). Table 1 summarises the parameter values used for each scenario.

	Population 1	*Population 2*	*Population 3*
Base scenario			
Population size	10,000	20,000	40,000
Number of people initially infected	150	240	400
β_i	2	2	2
γ_i	1	1	1
α_i	0.035	0.035	0.035
V_i	∞	∞	∞
ω_i*	[0.0, 0.0, 0.0]	[0.0, 0.0, 0.0]	[0.0, 0.0, 0.0]
Administrative constraint scenario*			
V_i	100	200	400
Interaction scenario 1 (network)*			
ω_i*	[0.0, 0.2, 0.2]	[0.2, 0.0, 0.2]	[0.2, 0.2, 0.0]
Interaction scenario 2 (chain)*			
ω_i*	[0.0, 0.0, 0.0]	[0.2, 0.0, 0.0]	[0.0, 0.2, 0.0]
*all other parameters are the same as in the base scenario			

Table 1: Summary of the parameters used for the simulations. ω_i* denotes the ith row of the Ω matrix.

Scenario	Base scenario			Administrative constraint scenario			Interaction scenario 1 (network)			Interaction scenario 2 (chain)		
Population	Pop 1	Pop 2	Pop 3	Pop 1	Pop 2	Pop 3	Pop 1	Pop 2	Pop 3	Pop 1	Pop 2	Pop 3
Vaccine stockpile												
2000	2000	0	0	200	600	1200	0	0	2000	2000	0	0
5000	0	5000	0	700	1400	2900	0	0	5000	3500	1500	0
8000	1200	6800	0	1100	2300	4600	0	0	8000	3600	4400	0
10000	0	0	10000	1400	2800	5800	0	0	10000	3900	6100	0
15000	0	0	15000	2100	4300	8600	0	3000	12000	4200	7400	3400
20000	0	6200	13800	2800	5700	11500	700	5500	13800	4100	7500	8400
25000	3000	7000	15000	3700	7000	14300	2900	6900	15200	4200	8100	12700
30000	4000	8500	17500	5000	9000	16000	4300	8600	17100	4600	9100	16300

Table 2: Optimal Vaccine allocations between three populations under 4 scenarios with different vaccine stockpiles

4. Results

I computed the optimal vaccine allocation for each of the four scenarios with different vaccine stockpiles. Table 2 summarises the results. Optimal vaccine allocations for the base scenario are, to a certain degree, similar to those presented by Duijzer et al. (2017, p. 2). The differences arise because my model incorporates deaths, and my objective is different (minimising the number of deaths rather than people infected). Building on their insights, I interpret my results as consistent with the finding that the herd effect is maximised at the optimum.

Compared to the base scenario, the optimal allocation is more equitable under the administrative constraint scenario. That may be because a more equitable distribution allows for the vaccination of more people in the early days of the pandemic. Hence, under administrative constraints, maximising the number of people vaccinated in the early days of the pandemic may be the optimal strategy.

When we include interaction between all societies (the network scenario), the largest population receives more vaccines. The larger the population size, the more a population can potentially affect the populations interacting with it (since the impact of interaction is proportional to the total number of people infected). Hence, when focusing on larger populations, policymakers can slow the spread of the pandemic by limiting the effects of interaction. Secondly, under the chain interaction scenario, the

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population earlier in the chain receives more vaccines. This should not be a surprise since the earlier a population is in the chain, the more influence it effectively has on other groups, given the interaction structure. That would suggest policymakers should prioritise populations earlier in the chain, other things being equal.

Lastly, the optimal allocation is similar under all four scenarios when the number of vaccines available is high. Moreover, under all four scenarios, we can see the importance of the herd effect. In every case, populations receive vaccines until a certain threshold, after which the marginal gains from adding more vaccines diminish.

The results suggest four main hypotheses about the optimal vaccine allocation: (1) when faced with administrative constraints, policymakers should aim to maximise the total number of people vaccinated in the early days of the pandemic; (2) when several populations are equally interconnected, policymakers should prioritise the largest population; (3) when there is a chain of populations, policymakers should give more weight to those earlier in the chain; (4) given the herd effect, policymakers should not vaccinate whole populations when faced with a vaccine shortage.

5. Conclusion

In this paper, I examined how the interaction between societies and constraints on the number of vaccines administered daily might affect the optimal vaccine allocation. Both of these factors influence the optimum differently. The presented approach and analysis can be easily extended by allowing other parameters (death rates, recovery rates) to vary. Lastly, the hypotheses presented in this paper should be verified empirically.

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Article (Explore Econ Runner-Up)

What is the potential impact of a uniform VAT rate in Spain, if implemented in a revenue neutral way?

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Abstract

This paper analyses a revenue neutral reform of the Spanish tax system. Differentiated VAT rates on all products except alcoholic beverages and tobacco would be eliminated and replaced by a single uniform rate of tax. This could lead to substantial efficiency gains by reducing distortions in consumption and production decisions, as well as administrative and compliance costs. The current system also has the peculiarity of being slightly regressive, meaning that unlike most other similar reforms, this one would also lead to gains in terms of equity.

Keywords: Tax Policy; Spanish Economy; Efficiency Gains

1. Introduction

This paper analyses a simulated revenue neutral reform of VAT in Spain. The country currently has differentiated rates of VAT. Switching to a system with a single uniform rate might be particularly beneficial in terms of efficiency. However, differentiated rates are often used for equity objectives. This paper shows that the current Spanish tax system is slightly regressive and thus analyses why such a reform could have benefits both in terms of efficiency and equity.

2. The Reform: Description and Background

Spain currently has a standard VAT rate of 21%, a reduced rate of 10%, a super reduced rate of 4% and a number of VAT exempt products (European Commission, 2021). This reform would eliminate differentiated rates and replace them by a single uniform rate for all products except alcoholic beverages and tobacco. It would be carried out in this way as differentiated rates on this product category are usually implemented not only to raise revenue but also to reduce externalities and for public health reasons, meaning there is a rationale for not changing them. Currently, Spain is one of the EU countries with the largest share of goods not subject to the standard VAT rate (Figure 1: Bach et al., 2021), meaning there is potentially great scope to reduce the standard rate.
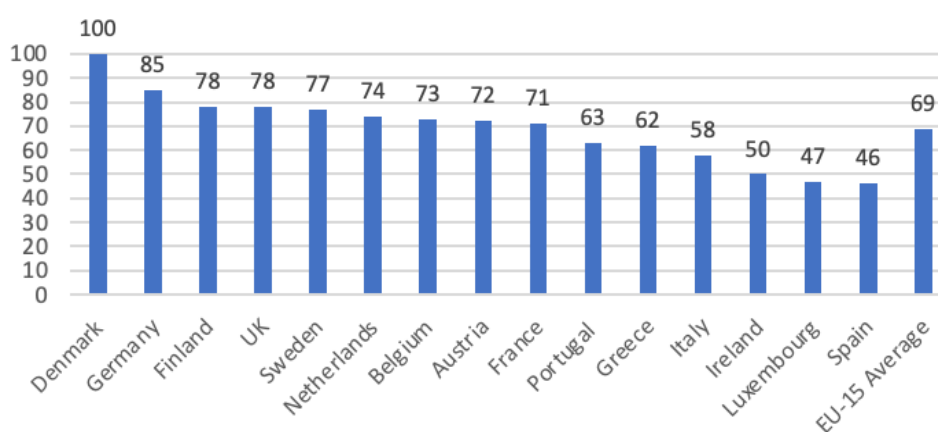
Figure 1: Share of the Standard VAT Rate as a percentage of the whole VAT Taxable Base (Year 2000)
Source: Bach et al (2021)

A tax system's efficiency is typically measured by c-efficiency which decomposes efficiency into two measures: the policy and compliance gaps; it could be improved upon as those measures are not zero (Table 1: Keen, 2013). The policy gap is zero if a uniform rate of VAT is applied to all final consumption and the compliance gap measures how much tax evasion there is.

Country	C-efficiency	Compliance Gap	Policy Gap	Breakdown of the Policy Gap	
				Rate Differentiation	Exemptions
Austria	59	14	31	18	17
Belgium	52	11	42	22	25
Denmark	64	4	33	0	33
Finland	61	5	36	12	27
France	51	7	45	26	26
Germany	57	10	37	12	28
Greece	47	30	33	30	4
Ireland	66	2	33	24	12
Italy	43	22	45	26	26
Luxembourg	87	1	12	30	-26
Netherlands	60	3	38	24	19
Portugal	53	4	45	25	27
Spain	57	2	29	33	-6
Sweden	56	3	42	19	29
United Kingdom	48	17	42	21	27

Table 1: C-Efficiency in 15 European Countries in 2006
Source: Keen (2013)

3. Literature Review

3.1. Advantages of the reform

Such a reform would improve the efficiency of the Spanish tax system. According to optimal tax theory, having a uniform rate is beneficial as Mankiw et al. (2009) argue that only final goods being taxed, and typically at a uniform rate, is one of the main lessons of this literature. This outcome is efficient as it does not distort production decisions by avoiding taxation of intermediate goods and aims at reducing distortions in consumer behaviour when choosing between products.

Rate differentiation is achieved in two ways: reduced rates (potentially even rates of 0%) or having tax exempt products, Spain uses both methods. Exemption is seen as more problematic in the optimal taxation literature: it leads to higher administration and compliance costs and impacts economic efficiency by breaking chains of VAT (Abramovsky et. al, 2017).

A uniform rate of VAT also means that taxpayers need to supply less information to the tax authority which reduces compliance costs. Bach et al. (2021) find a positive correlation between having a higher number of differentiated rates and higher compliance costs.

Less information being supplied by taxpayers also means less scope for tax evasion. According to Keen and Smith (2006), this removes the incentive for taxpayers to misclassify their commodities so that they are taxed at a lower VAT rate than what they should be and reduces the problem of traders abusively claiming refund entitlements when they use inputs taxed at a higher VAT rate than the final products they sell.

A uniform rate also means avoiding litigation and lobbying costs for the tax treatment of goods. With several rates, producers might try to have their product be considered as fitting in the lower tax category (Abramovsky et. al, 2017).

Finally, rate differentiation is often said to be done to reduce inequalities. Often, food is taxed at a reduced rate because its budget share is higher for poorer households. Boeters et al. (2010) argue that sometimes the aim of such policies is not to reduce

inequalities. They study the German tax system and emphasise that rate differentiation acts in part as "industry-specific subsidies", obtained through lobbying efforts. This means that when they test a potential removal of rate differentiation, they find a very small negative impact on equity. However, Abramovsky et. al (2017) highlight that such effects on inequality cannot be assessed generally but are specific to each tax system and therefore remain a largely empirical question.

3.2. Drawbacks of the reform

There is an efficiency argument for having differentiated rates. According to Ramsey (1927), in a model with a single individual and where revenues can only be raised through commodity taxes then there should be multiple rates so that the compensated demand for each product is reduced by the same amount - this can be implemented by using differences in elasticities of demand (Baumol & Bradford, 1970). Diamond (1975) highlights that when such a Ramsey rule is applied, there is a trade-off between efficiency and equity; the goods with the smallest elasticities, which should be taxed the most, tend to be necessities such as food that make up a larger budget share for poorer households. Similarly, Corlett and Hague (1953) and Kleven (2004) advocate differential taxation of goods, but based on whether a good is complementary with leisure or not.

Differentiated rates also allow for lower taxation of goods most prone to tax evasion which reduces the incentive to evade the tax (Abramovsky et. al, 2017).

Finally, equity objectives are often the argument put forward for having differentiated rates. Rate differentiation is often designed to reduce the tax burden on poorer households by having reduced rates on necessities like food. Hossain (1995) studies a reform in Bangladesh that substitutes having multiple differentiated rates for a single uniform rate of taxation and finds that such a reform decreases overall welfare as it raises inequality. However, this result is sensitive to how averse to inequality society is modelled to be.

4. Data Analysis

The proposed reform is tested using 2020 data on consumption expenditures from the Spanish national statistics agency (INE, 2020); individuals are divided into quintiles according to the amount of their consumption. Revenue currently raised is calculated per quintile and then summed across households; a new uniform rate that raises the same amount of revenue is then computed. This allows us to know what share of total spending is devoted to VAT on average per household in each quintile. Moving to a uniform rate of tax would typically be assumed to be regressive. But here, as shown in the graph below, the initial system is slightly regressive while the proposed one has a completely flat distribution.
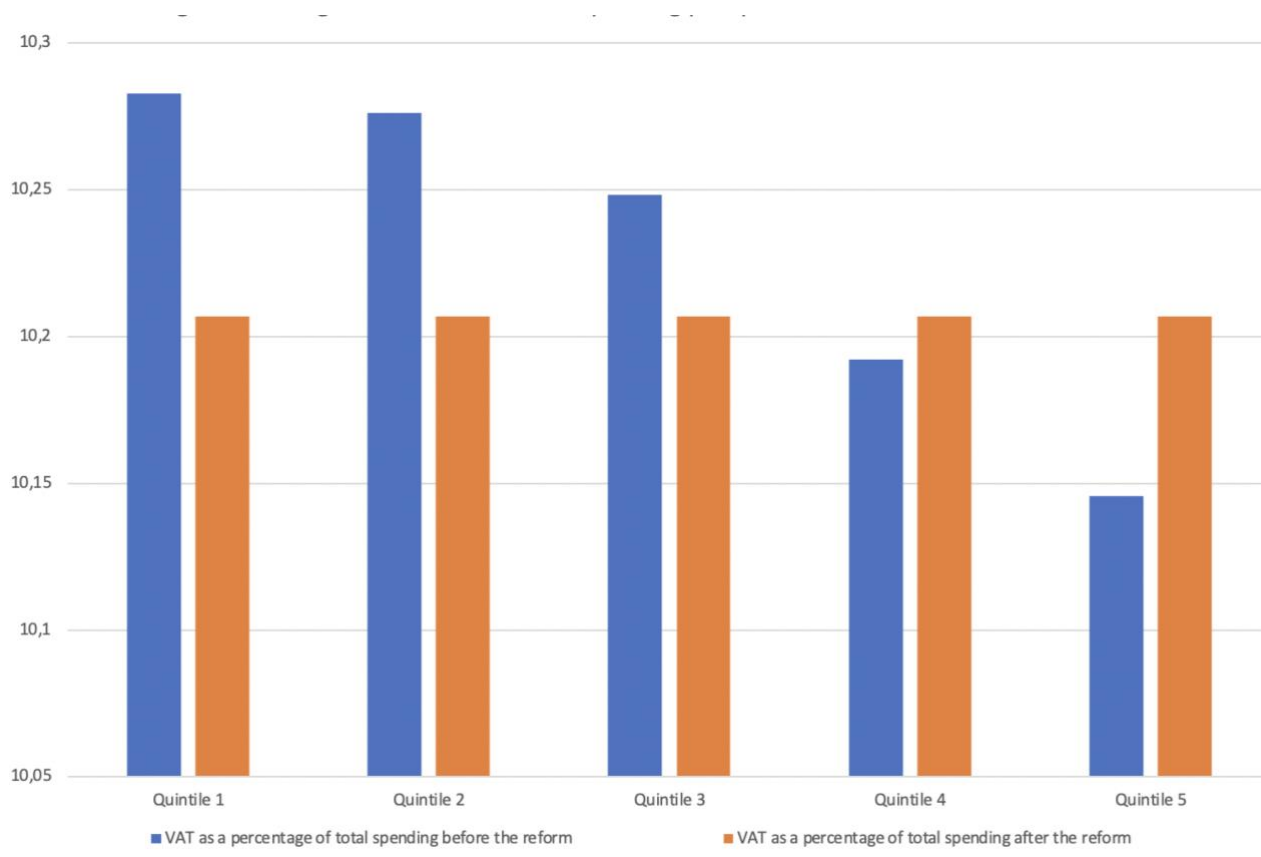
Figure 2: Average Share of VAT in Total Spending per Quintile Before and After the Reform
Source: INE (2020) Based on Expenditure Quintiles

Using expenditure quintiles for those calculations is better than using income quintiles as it captures the fact that individuals tend, to a certain extent, to smooth their consumption over their lifetime so that incomes vary more than consumption (Stiglitz & Rosengard, 2015). Consumption quintiles are then a better representation of an individual's place in a society's wealth distribution. The system is seen as only very slightly regressive, probably in part because of this smoothing effect of consumption data instead of income data. Poterba (1989), for example, observes that taxes on motor fuels are far less regressive when taking into account consumption data instead of income data because of this smoothing effect.

The initial regressivity of the Spanish tax system may seem surprising as rate differentiation is often carried out for equity objectives. Such regressivity can be explained because some necessities like food are subject to a reduced rate, while other goods such as education are tax exempt, even though they can be considered to be luxuries as they are a larger budget share for richer households as shown in the two graphs below.
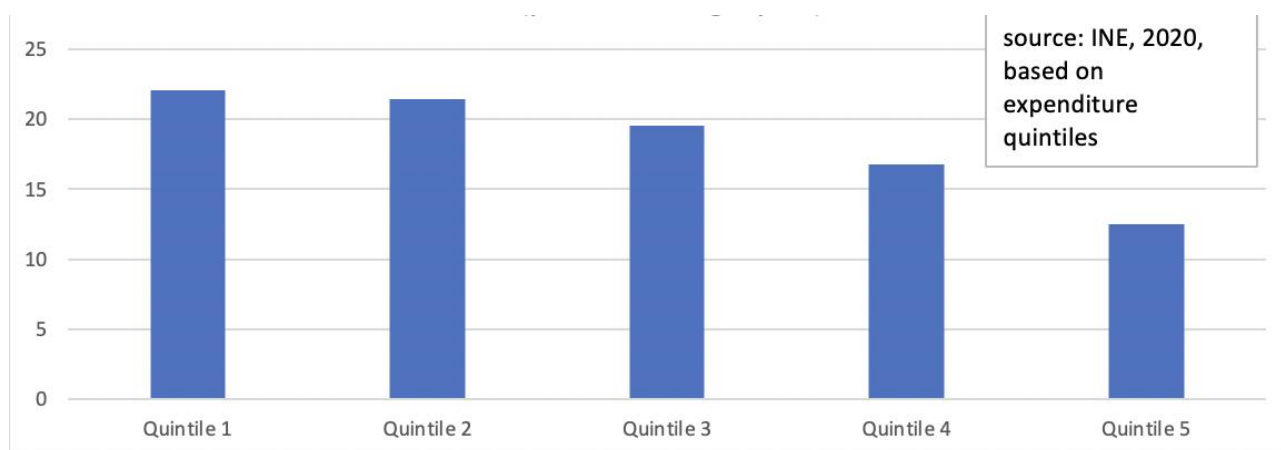
Figure 3: Budget Shares of Food and Non-Alcoholic Beverages per Quintile (Product Category 01)
Source: INE (2020) Based on Expenditure Quintiles
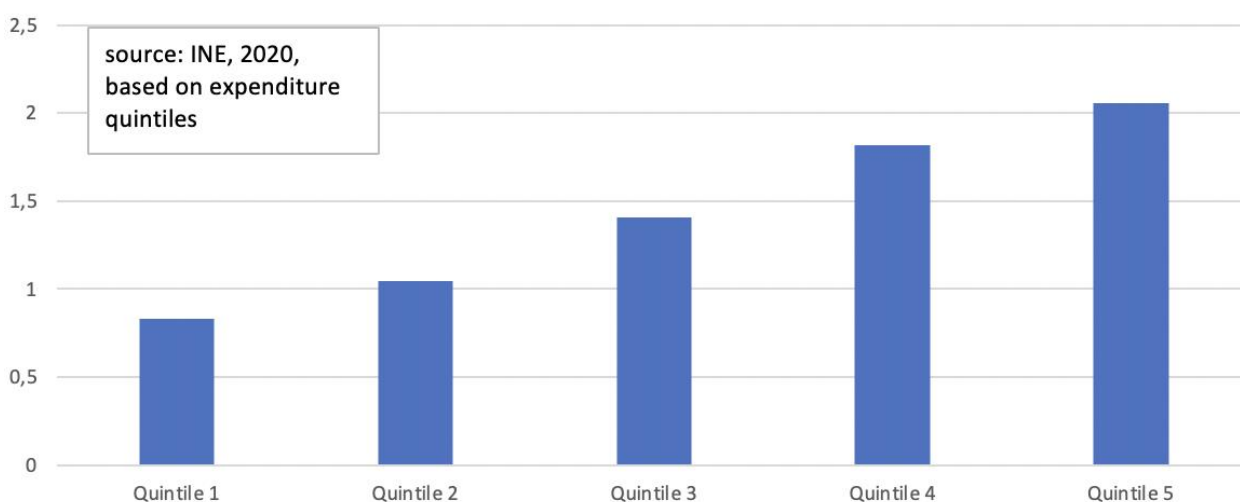
Figure 4: Budget Shares of Education per Quintile (Product Category 10)
Source: INE (2020) Based on Expenditure Quintiles

This analysis is carried out in a revenue neutral way: the initial and the proposed tax systems raise the same amount of revenue meaning that the macroeconomic effects on the government's deficit do not have to be considered. This is done assuming behavioural responses to the tax away. To take them into account would require having data on elasticities of demand for each quintile, which is not available. In reality, consumption patterns are affected by changes in the structure of taxation (Andrikopoulos et al., 1993). Although, it can be assumed that despite changes in behaviour, sufficient revenue should be raised as a result of the lower administrative and compliance costs, and the reduced tax evasion with such a reform. This is reinforced by Hossain (1995) who argues that as total expenditure should not change with such a reform, the tax in theory still manages to raise the required revenue, making such an assumption valid.

5. Conclusion

Eliminating the many different rates of VAT in the Spanish tax system and substituting them with a single uniform rate would potentially have substantial benefits. In terms of efficiency, less information would have to be supplied by taxpayers which would reduce the scope for evasion. Litigation and lobbying costs for the VAT classification of products would also be eliminated. A simpler system also means a reduction in administrative costs. Such efficiency gains can often only be achieved at the cost of higher inequalities, but since, in this case, the current system is slightly regressive, making the tax burden flat could also be beneficial in terms of equity.

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Article (Explore Econ Winner of the Stone Centre Prize)

The Effects of Rohingya Refugees from Myanmar on Low-Skilled Wages in the Chittagong Division of Bangladesh

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Abstract

On the 25th of August 2017, the military of Myanmar initiated a large-scale genocide of Rohingya Muslims living in the country's Rakhine region. Over 650,000 Rohingya fled Myanmar and sought refuge in Southern Bangladesh in August and September of 2017, with over 90% of them settling in the latter nation's Chittagong division (UNHRC, 2021). This constituted an approximately 3% rise in the population of Chittagong, with the figure being over 30% for districts within Chittagong with particularly high refugee populations such as Cox's Bazaar (IFPRI, 2019). This paper employs difference-in-differences regression analysis to investigate how this influx – and the associated increase in labour supply – impacted the wages of low-skilled workers in Chittagong. It is found that the crisis did not depress wages in the region.

Keywords: Inequality, Migration, Refugees, Difference-in-Differences, Trade

1. Introduction

On the 25th of August 2017, the military of Myanmar initiated a large-scale genocide of Rohingya Muslims living in the country's Rakhine region. Over 650,000 Rohingya fled Myanmar and sought refuge in Southern Bangladesh in August and September of 2017, with over 90% of them settling in the latter nation's Chittagong division (UNHRC, 2021). IFPRI (2019) estimates suggest that this constituted an approximately 3% rise in the population of Chittagong, with the figure being over 30% for districts within Chittagong with particularly high refugee populations (Cox's Bazaar, for instance). This paper investigates how this influx – and the associated increase in labour supply – impacted the wages of low-skilled workers in Chittagong.
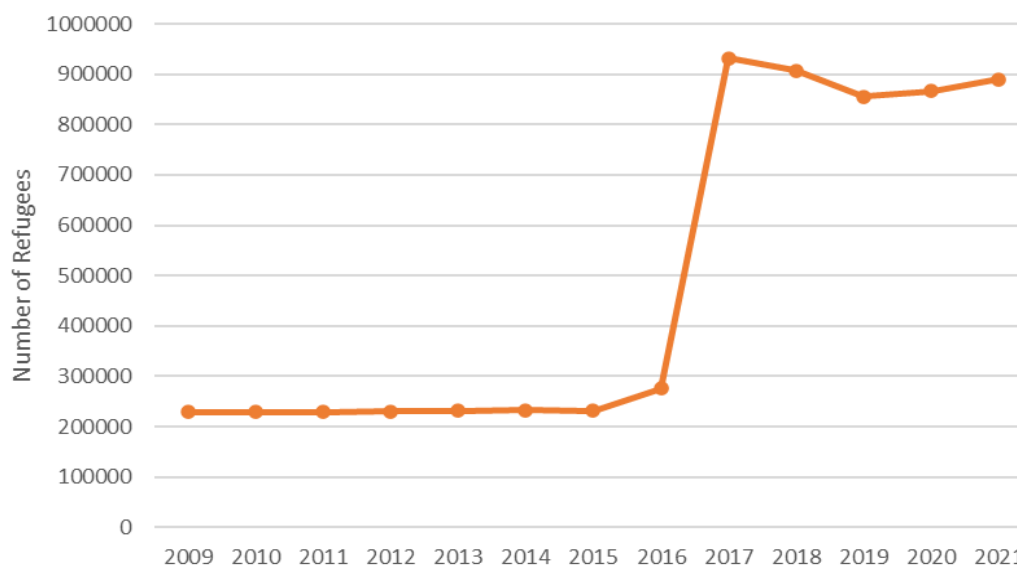
Figure 1: Refugees from Myanmar in Bangladesh (UNHCR Refugee Statistics; The Refugee Project)

2. Literature Review

Famously, Card (1990) found that a 7% increase in Miami's labour force brought about by an influx of 125,000 Cuban immigrants had no negative effect on wages of natives. Dustmann and Glitz (2015) similarly determined that economic effects of a refugee influx in the tradable sector do not manifest through factor price changes. Instead, the main channels are increases in the size of enterprises that intensively use labour of the skill level represented by the refugees, or more intensive use of such labour by these enterprises.

Borjas and Monras (2017) found that wage impacts of refugee crises vary by worker groups: those with skills levels similar to refugees are likely to experience declining wages, while those for whom refugees are not good substitutes tend to benefit.

In the Bangladeshi context, the IFPRI (2019) used a Local Economy-Wide Impact Evaluation (LEWIE) model to simulate the Rohingya influx. Two scenarios were considered: (1) the refugees remain confined to the Cox's Bazaar district of Chittagong where most refugee camps are based, and (2) refugees disperse across Chittagong. In the former case, a 31.01% drop in wages was predicted in Cox's Bazaar, while in the latter, a less severe – but still substantial – 3.86% drop was predicted in wages at the Chittagong level. Notably, this negative estimate was arrived at even after accounting for the fact that almost 55% of Rohingya refugees are children (UNHRC, 2020).

3. Empirical Analysis

I adopt a two-step empirical approach. First, identifying a control group with which to compare Chittagong. And second, comparing the post-influx wage trend in Chittagong with that of the control, ascribing any divergence to the crisis.

3.1. Choice of Control

All divisions of Bangladesh apart from Chittagong form the pool of prospective controls. We are interested in a division wherein wages, (1) followed a similar trend to Chittagong pre-influx, and (2) were unlikely to have been affected by the influx.

Monthly data on each division's Wage Rate Index (WRI) – the Bangladesh Bureau of Statistics' (BBS) preferred measure of low-skilled wages – is leveraged to identify a division that meets (1). Table-1 shows the differences between Chittagong's WRI and each other division's WRI in each month of 2017 before the influx.

Date	Dhaka	Rajshahi	Rangpur	Khulna	Barisal	Sylhet
Jan-17	0.73	1.29	-1.68	0.14	-1.5	-3.09
Feb-17	0.08	1.08	-1.37	-0.39	-1.72	-2.93
Mar-17	0.01	0.82	-1.39	-0.64	-1.78	-3.2
Apr-17	0.09	0.89	-1.26	-0.68	-1.62	-2.98
May-17	-0.16	0.99	-1.42	-0.81	-1.76	-3.06
Jun-17	-0.41	1.05	-1.33	-0.79	-1.76	-2.85
Jul-17	-0.64	0.86	-1.55	-0.91	-1.71	-2.87
Aug-17	-0.68	0.75	-1.8	-0.96	-1.85	-2.88
Standard Deviations	**0.432023**	**0.162245**	**0.173853**	**0.335112**	**0.101088**	**0.116378**

Table 1: Wage Rate Index Differences (Chittagong - Stated Division)

The final row displays the standard deviations of each division's WRI differentials with Chittagong. Evidently, this is lowest in Barisal, indicating that its pre-influx wage-trend was closest to Chittagong's (see Figure-2). Encouraged by the facts that almost none of the 2017 Rohingya refugees settled in Barisal, and Barisal shares no land border with Chittagong - making migration of refugees into Barisal difficult, we adopt Barisal as our control (UNHRC, 2021; Nations Online Project, 2022).
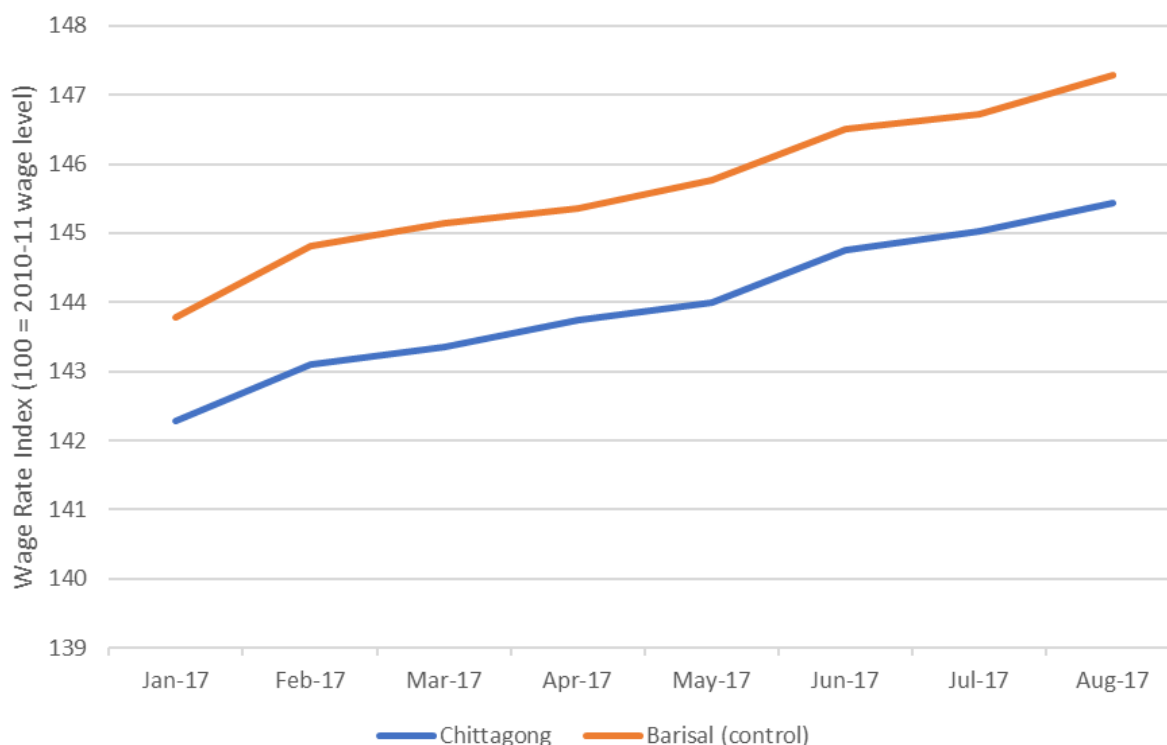
Figure 2: Common Pre-Influx Time Trend

3.2. Comparison

3.2.1. The Easy Answer

Figure-3 shows the evolution of wages in Chittagong and Barisal prior to and following the influx. The lack of WRI divergence post-influx implies – interestingly – that the refugees had no impact on wages. However, this analysis could be misleading.
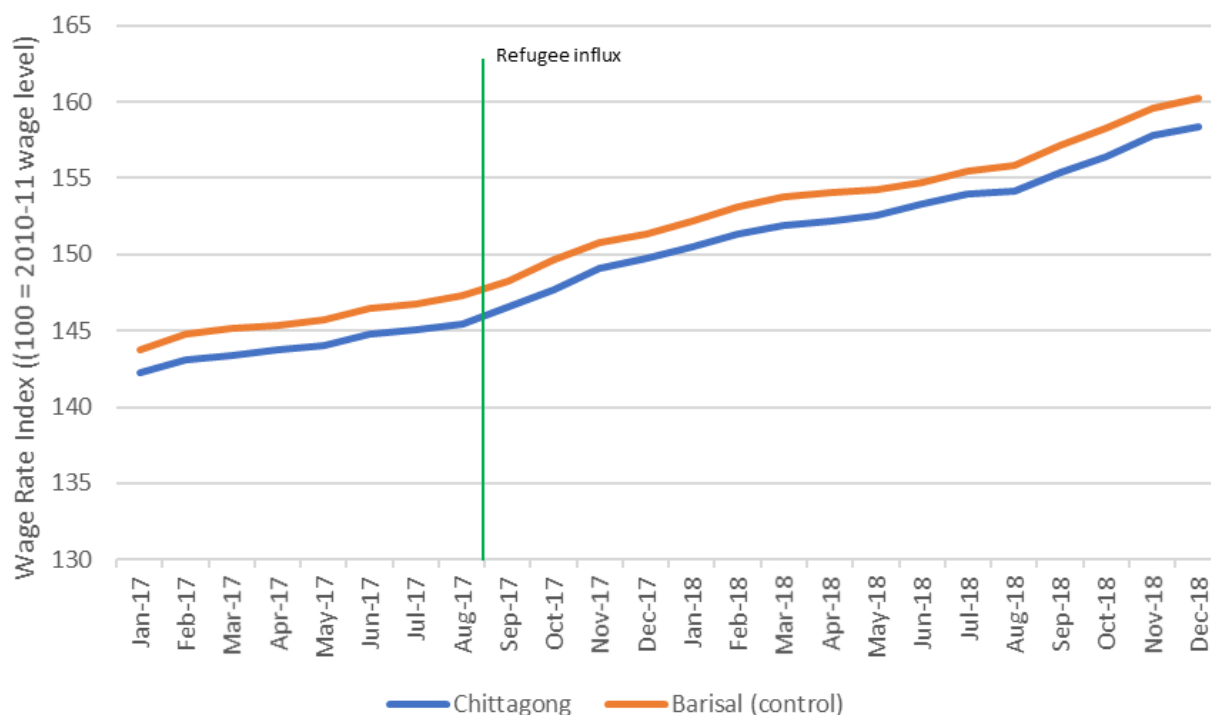
Figure 3: Post-Influx WRI Comparison

3.2.2. The Caveat

Unfortunately, the BBS does not make sufficiently clear what the '100' value in Barisal and Chittagong's respective WRI time-series corresponds to. While the base year (2010-11) is unambiguously specified, it is uncertain whether the base is Bangladesh's national average wage in 2010-11, or respectively, the local average wages in Barisal and Chittagong in 2010-11. The need therefore arises, for analysis that is robust to this potential heterogeneity in indexation to ensure comparability between Barisal and Chittagong's data.

3.2.3. A Robust Solution

The indexation problem is solved by using growth rates of the WRI between consecutive months instead of levels of the WRI. An analogy helps to clarify why: while one would be remiss to compare *levels* of the Consumer Price Index (CPI) across geographies, *growth rates* of the CPI – inflation rates – are indeed perfectly comparable.

Table-2 reproduces the analysis of Table-1, using growth rate differentials instead of level differentials. As indicated by the final row, Barisal remains the relevant control group.

Date	Dhaka	Rajshahi	Rangpur	Khulna	Barisal	Sylhet
Feb-17	-0.46214	-0.15416	0.221981	-0.37343	-0.14707	0.122165
Mar-17	-0.04905	-0.18452	-0.01206	-0.17373	-0.03919	-0.18112
Apr-17	0.055789	0.047584	0.092355	-0.0266	0.113489	0.155897
May-17	-0.17415	0.068877	-0.10877	-0.08916	-0.0943	-0.05085
Jun-17	-0.17284	0.03835	0.066976	0.016725	0.006289	0.153636
Jul-17	-0.15792	-0.13358	-0.1489	-0.08144	0.036368	-0.00995
Aug-17	-0.02619	-0.07803	-0.1675	-0.03246	-0.09204	-0.00114
Standard Deviations	**0.153943**	**0.098474**	**0.133122**	**0.121726**	**0.082875**	**0.115412**

Table 2: WRI Growth Rate Differences

NOTE: Each data-point was obtained as follows: % change in Chittagong WRI from previous month - % change in stated division's WRI from previous month

3.2.4. Difference-in-Differences Estimation

We now use regression analysis to determine how wage patterns in Chittagong were affected by the crisis. The relevant variables are as follows: *growthrate*, measuring %change in WRI from the previous month; time-dummies from *Feb-17 – Dec-18*, taking the value 1 if the observation in question is from that time period; *Treatment*, taking the value 1 if an observation relates to Chittagong and 0 if it relates to Barisal; and finally, time-treatment interaction dummies, defined as the product of a time-dummy and *Treatment*, taking value one if the observation is from Chittagong, in the period stated in the variable name (*TreatMonthYear*), and 0 otherwise.

We regress *growthrate* on all the time-dummies (except *Feb-17* to avoid the dummy-variable trap), *Treatment*, and time-dummy interactions for periods after the influx (*TreatAug17 – TreatDec18*). The exclusion of time-treatment interactions prior to the influx is predicated on the reasonable assumption of a common pre-influx *growthrate* trend in Chittagong and Barisal (supported by Table-2). The interpretation of various coefficients in this regression is explained in Table-3.

Coefficient	Interpretation
Constant term	*growthrate* in Barisal in Feb-17
Time-Dummies	Barisal *growthrate* in stated period minus Barisal *growthrate* in Feb-17
Treatment	Pre-influx average difference between Barisal monthly *growthrate*s and Chittagong monthly *growthrate*s
Time-Treatment Interactions	Difference between Barisal *growthrate* and Chittagong *growthrate* in a given month post-influx that is NOT accounted for by pre-influx average growth rate difference

*Table 3***:** Coefficients and their Interpretation

If a coefficient of a time-treatment interaction is non-zero, we interpret the crisis to have affected Chittagong's wage patterns as the pre-influx growth rate differential does not equal the post-influx growth rate differential.

The regression output, however (see Figure-4 and Appendix), shows that the coefficients of all but one time-treatment interactions (*TreatNov17*) are not statistically different from zero at the 5% significance level. The coefficient of *TreatNov17* is in fact statistically positive, indicating an unusually *high* growth rate in Chittagong relative to Barisal.
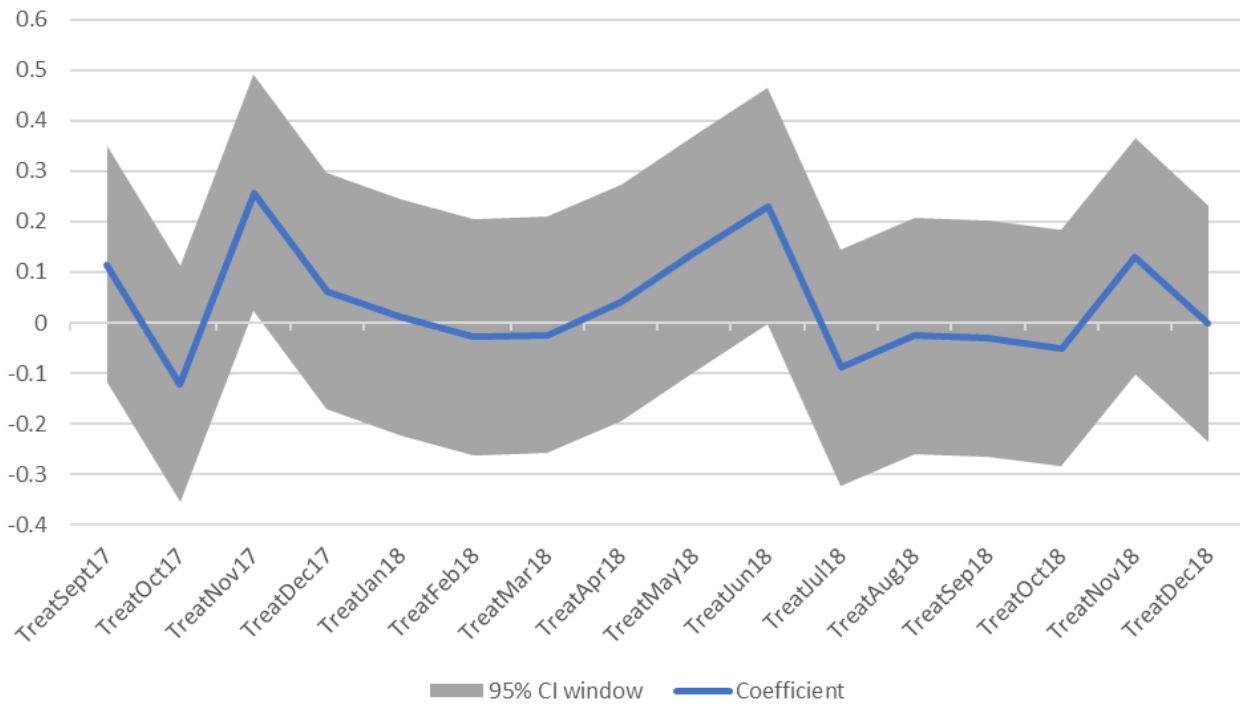
Figure 4: Regression Coefficients

We therefore conclude that the influx did not depress wages in Chittagong. This is supported by Figure-5 which shows no marked divergence in growth rates in Chittagong and Barisal after the influx.
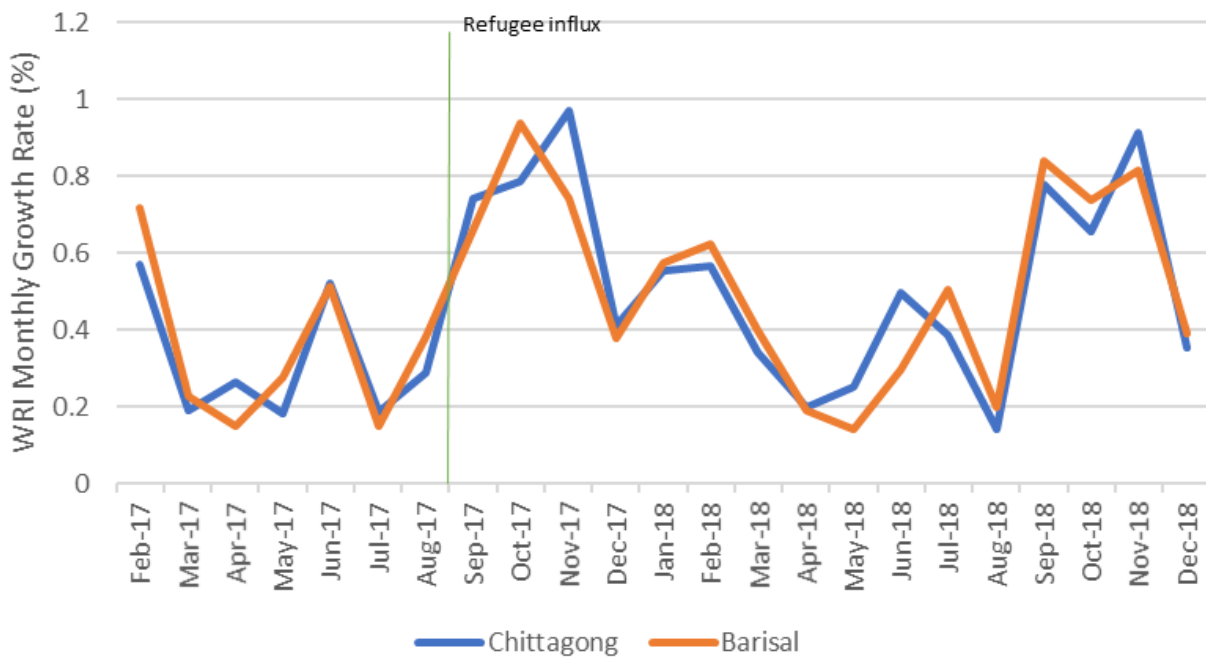
Figure 5: WRI Monthly Growth Rate Trends

4. Hypotheses and Conclusions

An immediately apparent explanation for our results is provided by the fact that, as per prevailing Bangladeshi legislation, the Rohingya are not allowed to work outside of refugee camps (Dempster and Sakib, 2021). Effective implementation of this restriction would mean that the influx constituted an increase in Chittagong's population, sans an increase in labour force. The larger population size would increase aggregate demand, exerting upward pressure on wages. The IFPRI (2019) however, estimates that 47% of Rohingya households were engaged in economic activities regardless, limiting the value of this hypothesis.

Another theory – supported by the UN Development Programme (2018) – suggests that the influx could have reduced wages in specific regions with high refugee populations, but these impacts were too localised to reflect in the aggregate Chittagong trend. However, this is contrary to economic intuition, which suggests that out-migration from low-wage areas in search of less saturated labour markets will depress wages in neighbouring geographies as well (Borjas, 2001). Consequently, localised effects *would* reflect in the aggregate trend.

A more realistic explanation is that most Rohingya worked in farms and fisheries in Myanmar, and thus have limited ability to influence wages in Chittagong, where these sectors are not very large or well-established (Rakhine Commission, 2017). Recall the literature review's allusion to the relation between skill-substitutability and wage-impacts of refugees.

A more worrying prospect is that the wage effects of the crisis were concentrated in the informal sector, as suggested by Altindag et al (2020), and the BBS data-collection did not adequately cover informal sector workers. While this would indeed be a significant caveat to our results, it is less concerning than it seems, for two reasons. Firstly, the BBS survey makes specific efforts to include workers from 44 informal sectors (BBS, 2022), and secondly, wage changes in the informal sector have spill-over effects on formal sector wages (author's reasoning based on Bassier, 2021);: even if refugees entered informal employment, the wages of formal workers were unlikely to have been unaffected.

The final explanation we will consider is provided by the Rybczynski theorem, which posits that an increase in labour supply is accompanied by an expansion of labour-intensive sectors (in Chittagong, garments, textile, footwear, tourism) and contraction of capital-intensive sectors (in Chittagong, shipbuilding, industrial parts, electric and electronic goods) (Chittagong Chamber of Commerce & Industry, 2022; Rybczynski, 1955). If the theorem was operational in Chittagong, the deleterious effects of increased labour supply on wages would thus have been counterweighted by a rise in labour demand.

In conclusion, the influx did not affect wages of low-skilled workers in Chittagong, however, further research is needed to definitively identify why this was the case.

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Article (Explore Econ Popular Paper Winner)

Racial Hate Crime and COVID-19: A Multinomial Choice Study in the US

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Abstract

During the COVID-19 pandemic, a dual shock to the economy and health system, the sentiments of uncertainty and insecurity have exacerbated the racial inequalities in the United States - contributing to the rise of antagonistic racial tension. Using hate crime data published by the Federal Bureau of Investigation (FBI), this study implemented a Multinomial Logistic Regression to analyse the marginal probability of different races committing hate crimes. It is found that all races except for African Americans tend to target African Americans as victims of a racial hate crime. This study reveals the racial inequality and discrimination that existed in the United States, providing policymakers and public activists with evidence and direction to make efforts.

Keywords: COVID-19, Multinomial choice, Racial hate crime, Stigmatisation, Inequalities

1. Introduction

In December 2019, a novel coronavirus disease, COVID-19, was first found in Wuhan, China, and within weeks it swiftly swept over the rest of the world. As people adapt to this unprecedented "twin pandemic" of both economic and public health shock, there are rising fears regarding the uncertainty of COVID-19 (Anand, 2020, p. 5). Studies on similar sentiments of uncertainty in historical shocks such as national wars and terrorism are shown to be reflected in the individual and government responses - which exacerbate the horizontal and vertical power imbalances within the society (Adefuye et al., 2020; Bar-Tal & Labin, 2001). For COVID-19, the suspected geographic origins of the virus were conflated with Asian ethnicity so that all people sharing the race of the people at the geographic origin of the virus were at risk of social exclusion. Multiple studies have also indicated the social exclusion resulting from COVID-19 has punitively obstructed health-seeking behavior for all ethnic minorities including African Americans and led to wider social othering between races (e.g., Tai et al., 2020; Romano et al., 2021; Goldberg, 2020). In this paper, we examine how COVID-19 affects hate crime rates against different ethnic groups in the United States. Using data from FBI Hate Crime Statistics, we apply a multinomial logistic regression aiming to understand the racial bias motivation behind hate crimes.

2. Literature Review

Hate crime is the physical or verbal aggression directed at a group with particular physical or social attributes aiming to dethrone their individual identity and social acceptance (Goffman, 2018). Past studies on hate crimes targeting national, sexual, racial, religious, or other social attributes have found significant stigmatizing perceptions and physical aggression (e.g., Laverick and Joyce, 2019; Walfield et al., 2017; Jones, 2020). These sentiments of stigmatization stem from some form of injustice that is not natural but the combination of toxic social, political, and community arrangements (Marmot et al., 2008, Marmot, 2017).

The present literature has discussed COVID-19 hate crimes widely against infected patients (E.g., Sun et al., 2021) and healthcare workers (E.g., Abdelhafiz & Alorabi, 2020; Villa et al., 2020). Due to racial sensitivity, quantitative studies of racial aggression commonly used indirect evidence without public access to administrative datasets (Goldberg, 2020). For COVID-19, internet search queries, for instance, are an indirect proxy to measure the intensity of Sino-phobia, which has increased dramatically over the period (E.g., Budhwani & Sun, 2020; Li et al., 2020). Using social media data, Williams (2021) studied the racial sentiments on Twitter following Donald Trump's tweet that labeled COVID-19 as the "Chinese Virus". He has not only found a significant increase in the online hate against Asian Americans but also a parallel trend in the physical world, where they experienced significantly more physical harassment since Trump posted the tweet. These practices are significantly associated with victims' perceived stigmatization and a higher incidence of mental distress (Xin et al., 2020). Using data from a large-scale mental health survey, Zhou et al. (2021) have found East Asians and Pacific islanders have faced heavy mental burdens from such heightened racial stigma from the discriminatory public discourses toward Asians. In the UK, Gray and Hansen (2020) used London Metropolitan Police data to carry out a probit regression that has found that COVID-19 is statistically significantly related to a higher probability of Chinese being hate crime victims.

Beyond Asians, previously vulnerable populations also faced social exclusions and racial inequalities during the COVID-19 pandemic in the United States. African Americans have a long history of marginalization, discrimination, and racial trauma resulting from a "hierarchy of citizenship" (Wakeel & Njoku, 2021). The historical and institutional discrimination generally breeds medical mistrust and skepticism of diagnostic and treatment messages among black communities, which has caused a surge in COVID-19 infection, hospitalization, and death rates among African Americans (Romano, 2021). Additionally, the poverty concentration among African American communities makes them less likely than other racial groups to access health insurance (Bogart and Thorburn, 2005; Bailey et al., 2020). The shortage of medical resources and lack of testing further increases the chance of disease transmission within the community, reinforcing the pre-existing stigma of viewing these minority groups as risky and virus-laden (Nydegger and Hill, 2020).

Despite the significant contributions to this field of pandemic stigmatization, a significant lacuna remains in the evidence base. First, the present research has merely focused on the hate crimes and stigmatization of Asians and not on other ethnic minorities. Second, there is a lack of quantitative studies on US hate crimes during COVID-19, which, as a dual economic and health shock, significantly differs from other pandemics or global events (Anand, 2020). Previous literature has treated COVID-19 as a

homogeneous period throughout, without considering the dynamics as the US adapts to it. Third, there is insufficient evidence disentangling the offenders' ethnic background with the racial crime they commit. In this paper, we attempt to fill these gaps.

3. Materials and Methods

We collect our data from the Federal Bureau of Investigation Hate Crime Statistics. The data includes all reported & registered crimes in the US. The selection bias, as usually appeared in surveys, does not exist here as all cases reported to the police are recorded. All the uses of data meet the ethical requirements and there is no potential risk of the exposure of any personal information. Before our analysis, we combine all non-racial crimes together as our baseline (i.e. random-race crimes). Table 1 illustrates the summary statistics of the cleaned data. The outcome measure in this analysis is bias_motivation. It is the motivation of the hate crimes and includes the following categories: baseline (1), White (11), Black (12), Asian (13), Indian (14), and Other (15). The main explanatory variable is o_race (Offender's race). The control variables are SI (COVID-19 stringency index, a proxy of the pandemic), quarter (seasonal factors) and states (demographic factors).

As the dependent categorical variable is polychotomous, Multinomial Logistic Regression (MultiLogit) was adopted and these coefficients provide the effect sizes on the probabilities of category membership. As an extension of binary logistic regression, Multi-Logit uses maximum likelihood estimate probabilities of each category relative to the reference category of the outcome variable. Hence, when the dependent variable has k=6 categories, the model fits k-1=5 logit equations simultaneously and our interesting marginal effects (probability) estimated by β_j differ according to the category relative to the reference category. In theory, our framework is:

$$U(BM_{ij}) = \alpha_j + \beta_j OR_i + \gamma' C_i + \epsilon_{ij}$$

where

- $U(BM_{ij})$ denotes utility of individual i committing crime to race j
- α_j denotes the constants
- C_i denotes the control vector, including SI, quarter and states

We then parameterise it:

$$ln\left(\frac{P(BM_{ij} = j)}{P(BM_{ij} = 1)}\right) = \hat{\alpha_j} + \hat{\beta_j} OR_i + \hat{\gamma}' C_i$$

Herein, the predicted probability that Black is a victim will be discovered through the marginal effect of OR_i when j=12. In our study, we calculate this marginal probability at means (APE).

4. Results

As Table 2 and Figure 1 illustrate, except for our baseline (non-racial crimes, or equivalently, random-race crimes), African Americans suffer from hate crimes the most.

Specifically, all races except for African Americans are most likely to target African Americans when committing hate crimes; and African Americans are most likely to target white Americans when committing hate crimes. Asian, Indian, and other minority races are rarely the target of racial hate crimes (statistically insignificant).

Motivation	Offender Race							Total
	Asian	Black	Indian	Others	Pacific Islander	Unknown	White	
Baseline	38	738	17	87	5	2313	1673	4871
Anti-White	6	448	15	24	12	430	253	1188
Anti-Black	33	120	23	60	8	1647	1639	3530
Anti-Asian	1	14	6	2	0	51	57	131
Anti-Indian	7	45	0	5	1	144	123	325
Anti-Others	2	11	1	3	1	145	91	254
Total	87	1376	62	181	27	4730	3836	10299

Table 1: Summary Statistics

Motivation	Offender Race						
	Asian	Black	Indian	Others	Pacific Islander	Unknown	White
Baseline	0.48 ***	0.63 ***	0.34 ***	0.52 ***	0.33 ***	0.53 ***	0.48 ***
	(8.08)	(26.10)	(4.95)	(12.84)	(2.70)	(31.97)	(33.29)
Anti-White	0.07 ***	0.25 ***	0.19 ***	0.09 ***	0.23 ***	0.07 ***	0.04 ***
	(2.40)	(11.82)	(3.55)	(4.39)	(2.44)	(9.95)	(8.98)
Anti-Black	0.42 ***	0.10 ***	0.45 ***	0.38 ***	0.42 ***	0.37 ***	0.46 ***
	(7.25)	(10.66)	(6.26)	(9.68)	(3.41)	(29.16)	(32.82)
Anti-Asian	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	(0.14)	(0.14)	(0.14)	(0.14)	(0.03)	(0.14)	(0.14)
Anti-Indian	0.02	0.01	0.00	0.01	0.01	0.01	0.01
	(0.72)	(0.73)	(0.03)	(0.69)	(0.56)	(0.74)	(0.74)
Anti-Others	0.01	0.00	0.01	0.01	0.15	0.12	0.01
	(0.52)	(0.55)	(0.48)	(0.53)	(0.48)	(0.56)	(0.56)

Table 2: Marginal Probability of Offender Race to Motivation (t statistics in parentheses)
* significant at 10%, ** significant at 5%, *** significant at 1%;
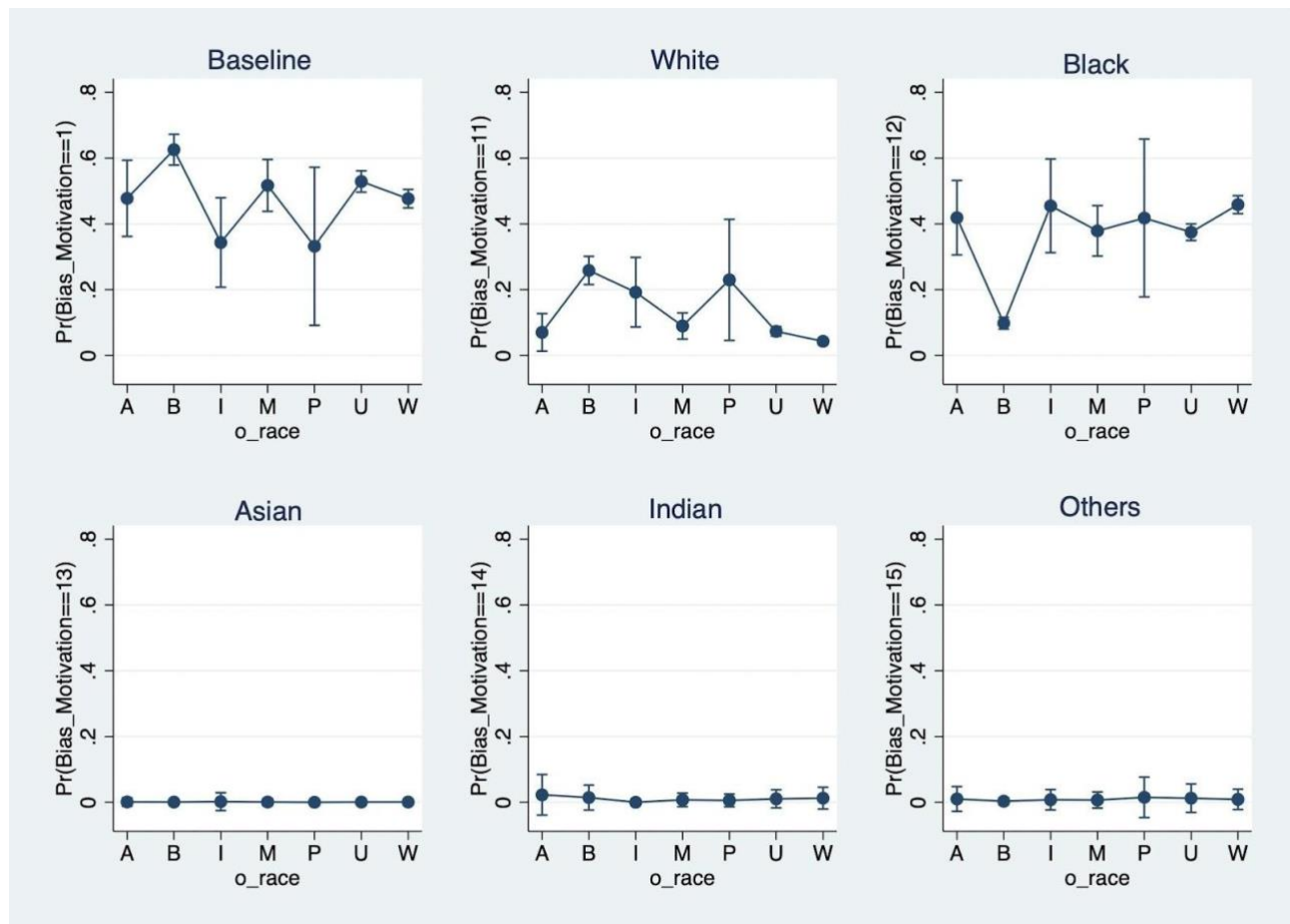
Figure 1: Marginal Probability of Offender Race to Motivation

5. Discussions and Conclusions

The goal of this paper is to further delve into the association between an offender's race and COVID-period hate crimes for various ethnic communities in the US. While a large and growing body of literature on Asian Americans has established that racial stigmatization has a consistent and positive association with Asian targeted hate crimes, few studies have tested this association for other racial/ethnic minorities. This is especially the case for hate crimes targeted at African Americans, which increased over the last few months. Overall, we aim to expand this study by including other racial/ethnic groups neglected in previous pieces of literature to provide some account for why this association might exist.

From the regression results presented above, we draw several main conclusions. First, anti-Black bias was the biggest cause of the racial hate crimes committed in the United States during the COVID-19 pandemic. The offender's race has a positive and statistically significant association with hate crimes against African Americans after controlling for stringency and demographic factors. Specifically, other than fellow African Americans, all other races are roughly equivalently associated with a higher probability of committing anti-Black crimes during the pandemic. The high anti-Black motivation is consistent with the expectations of implicit bias of viewing African Americans as a high-risk group in the US society, as this often means seeing them as potential carriers and spreaders of the virus.

The COVID-19 pandemic has also been a period of racial tension in the United States among not just the ethnic minorities, but White Americans. We find the anti-White hate crime is the second-highest bias motivation, though the ethnicity is the 60% majority in the US population. Moreover, our finding also suggests a positive association between the offender's race and crime motivations during the pandemic for anti-White crimes. Different from the findings on the bias motivation against African Americans, the anti-White hate crimes are associated unequally by the offenders' race. African Americans and Pacific Islanders are much more likely to commit anti-White hate crimes than other races in the United States. This is, we believe, most likely

the effect of the upstream inequalities in racial power dynamics, which have been exacerbated during the pandemic (Dunkan, 2019). Past studies have noted that White Americans have extensive medical resources in comparison to other ethnic groups (Elam-Evans, 2008). During the COVID-19 pandemic, this health inequality may, unfortunately, push other marginalized ethnic groups who lack medical resources to commit unlawful hate crimes.

We find statistically insignificant associations between offenders' race and crime motivations in terms of the anti-Asian, anti-Indian, and anti-other crimes. This contradicts our theoretical predictions on significant Asian hate during COVID-19. We attribute this to one major limitation with the use of administrative FBI Hate Crime Statistics. In Table 1, summary statistics have shown a limited number of hate crimes reported by these three groups (Anti-Asian, 131; AntiIndian, 325; Anti-Others, 254). This might reflect a severe under-reporting issue in anti-Asian crimes. Previous research has revealed language barriers and irresponsibility of the authorities in dealing with anti-Asian crimes, which has led some Asians to avoid reporting their cases out of distrust of the authorities (Gover et al., 2020; Pezzella et al., 2019). Therefore the crime is not documented and leads to an underestimation of the frequency. In other words, selection bias may exist in our studies, which is a potential limitation or contradiction.

In conclusion, this study provides empirical evidence of the hate crime levels during the COVID-19 pandemic and that there is a positive association between COVID-related crime motivation and the offender's ethnicity. The anti-Black and anti-White crime motivation is heavily affected by race after controlling for the governmental stringency index and seasonal and demographic controls using multinomial logistic regression. These results suggest that policymakers should consider long-standing race inequalities to reduce racially targeted crimes in the pandemic. In the future, we aim to use more accurate or representative proxies/instrumental variables for COVID-19, such as vaccination, daily infections, and social media data. (Zhou & Li, 2022).

Acknowledgements

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Article

Income-Based Segregation in Urban Areas: Framework for a Complex-Systems Approach

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Abstract

Income-based segregation is a fundamentally complex phenomenon. Though it can be analytically studied, developing an agent-based model allows us to study segregation at several levels of aggregation – to better understand the interactions that take place in between the micro- and macro- levels that lead to the pattern of segregation observed in modern cities. The spatial agent-based model of the housing market developed in this paper gives a foundation which can be built upon to tackle some of the key problems present in existing literature. We test the model to find that the degree to which households are willing to spend on rent relative to other expenditures and the extremity of variation of this degree in the population give rise to different patterns of segregation observed in the housing market. We assume a rental-only market, and that agents' incomes are locally spent. A section on guidance for further development and extension of the model is then presented.

Keywords: Income Segregation; Agent-Based Model; Housing Market; Urban Segregation; Complex System; Spatial Autocorrelation, Computation

1. Introduction

Any system for the organisation of social beings must inherently describe the networks they can access and influence. In the study of people, whether in an economic, political, or moral context, understanding their "topology" gives a causal notion of how the constituent parts of the system influence their networks: a critical intuition for macro behaviour. Cities lend themselves to this type of disaggregation, owing to the myriad people, interdependencies, and interactions they comprise. Their behaviour is characteristic of a complex economic system, defined here as a model of an economic phenomenon that builds up from constituent parts, is simulated through computation, and perpetually asks how people change their behaviour in reaction to the behaviour of others (Arthur, 2013). Income-based segregation is a commonplace result of the complex interactions that make up a city, with consequences ranging from exacerbated income inequality (Bailey et al., 2020) to the polarisation of ideas (Morales et al., 2019).

Existing research building an agent-based model of income segregation in cities is sparse. Prior to Schelling's dynamic model of racial segregation (1971), income segregation models used equilibrium analysis. Schelling's work, which sets out a grid-based model for residential racial segregation, has set standards in the field that spawned much further research in racial segregation. These standards have been applied to models of income segregation with some success, but gaps still exist in terms of minimising the number of assumptions made and ensuring model design factors such as intrinsic attractiveness of locations are determined endogenously and not chosen arbitrarily by the modeller.

By building a simple grid model of the rental housing market in one city, we can adapt the model to understand the specific factors that contribute to the spatial segregation of citizens by income. As a test, we vary the degree of homogeneity of the marginal rate of substitution (MRS) between housing and non-housing expenditure of agents to study how the spatial distribution of agents changes, finding that the greater the extremity of variation of the MRS, the lower the observed segregation effect as measured by both quantitative and qualitative factors.

In the interest of disclosure, this paper is not complete. It does not intend to cement the notions of utility, maximisation, or constrained choice such that they can stand up to the same well-established ideas in analytical models in economics. Regarding the critical issues outlined by those analysing existing literature on agent-based models of segregation (Crooks et al., 2008), neither does this paper constitute a solution to them. Rather, this paper seeks to be a beginning point for the study of simulated housing markets – a framework using which the reader can conduct their own experiments as suits their interest. In that respect, a full replication of the code used to build the model presented can be found on GitHub via the link provided in the Appendix.

2. Literature Review

Patterns of segregation in cities are well documented, with much of the literature focusing on race and income. Income-based segregation is defined here as the grouping of households with similar income levels into the same geographical or social space (Reardon and Bischoff, 2011). This review attempts to organise the key ideas employed in modelling the emergence of segregation, analyse how these learnings are applied to income-based segregation, and identify areas that require further, or different, thinking.

It is worth mentioning that the analysis of income-based segregation is fairly unorganised in the field. While modern researchers follow well-trodden paths, their approaches are always novel and highly variable. Crooks et al. (2008) aptly summarise this phenomenon, declaring that "there are as many models as modellers".

Despite that, common themes arise.

2.1. Traditional Models of Income-based Segregation

Analytical models of income-based segregation mainly take root from Tiebout (1956), on the premise that households' location choices are analogous to decisions between bundles of public goods available at each location. While his analysis concerns political affiliation, the principles of the model are nonetheless applicable to income-based segregation. As analytically

demonstrated by Epple and Platt (1998), when heterogeneous households vote within their jurisdiction on taxes and expenditure and are free to move between jurisdictions that offer different tax-expenditure rates, an equilibrium state of partial income segregation arises. New research goes further, highlighting that income inequality – implicitly present in Epple and Platt's model – creates market pressure toward segregation by incomes, since houses are chosen based on the attributes of the neighbourhoods they are in and the physical characteristics of the housing stock (Watson, 2006). Reardon and Bischoff (2011) verify this empirically, showing a positive correlation between income inequality and income-based segregation.

2.2. The Benefits of an Agent-based Approach

There are two reasons why we may favour a computational ABM approach. First, income-based segregation perpetuates its own cause: increased segregation can isolate social networks and increase inequalities between regions, leading to further pressure toward segregation (Schelling, 1969) and positive and negative feedback loops. While analytical approaches deal well with stationary points that arise from these loops, their usefulness is limited to these cases only, and falls short in describing the journey to these points and the timescales on which they may arise. Second, analytical models have to encode most of the "processing" work into the same space as the result they are depicting. Their graphs have to be incredibly information-dense, yet still show only a slice of the dynamics taking place.

In order to observe the feedback loops and document the interactions that individuals have within their city, agent-based models (ABMs) can be used. ABMs build a bottom-up model of the market, ensuring the micro-level interaction between individual actors is well-defined, allowing macro behaviour to emerge naturally, preserving heterogeneity, and removing the need for aggregation that masks the complexity in the transition from the micro to the macro level. Households are represented by singular agents with heterogeneous incomes, preferences, and behaviours. Their interactions are governed by common rules. Through simulation, segregation emerges endogenously and without any assumption of equilibrium. Arthur (2013) asserts that such thinking is of profound use to modelling systems with a multitude of interactions since the model takes equilibrium to be a special case of a more general non-equilibrium state that the system is in.

2.3. The Schelling Model and its Derivatives

The first such ABM applied to segregation in Schelling's seminal work (Schelling, 1971) details racial segregation, but in principle, his model can act as a guide for desirable characteristics in ABMs of any kind of segregation. Schelling constructs a grid of houses that he populates with Black or White households, leaving some vacant. An individual household dissatisfied with the ethnic ratio in their local neighbourhood can move to the nearest vacant house. The model can be run by hand until a stable equilibrium is reached, where every actor is satisfied with their current position and no more moves can be made. For example, complete segregation would be a stable equilibrium, since a move to the opposite neighbourhood will cause dissatisfaction. Schelling demonstrates that even a small preference for a local majority in terms of race can lead to total segregation over time. Many authors have since developed Schelling's model, remaining in the context of racial segregation (Spaiser et al., 2018; Barr and Tassier, 2008; Zhang, 2011; Grauwin et al., 2012). Promising research conducted by Bonakdar (2019) imposes housing, credit, and labour market constraints on Schelling's model, finding that lock-in effects arise for low-income households which are also stuck with negative equity, since the price of favoured houses exceeds the agent's income, especially when access to credit is low, though he does not investigate what lock-in effects imply for segregation. Bonakdar concludes that racial segregation diminishes in comparison to income segregation when such constraints are imposed and socioeconomic factors like income and education are non-zero.

2.4. ABMs of Income-based Segregation

While such market constraints are commonly applied to Schelling's model, the literature on the direct application of ABMs to income-based segregation is comparatively sparse. Of the few papers that document the creation of such ABMs, the models laid out in Pangallo et al. (2019) and Gauvin et al. (2013) are the most developed, with the housing market forming their central context.

Pangallo et al. (2019), though building on the model set out by Gauvin et al. (2013), lay out a more general framework. The city created is grid-based but departs from Schelling's by introducing an external "reservoir" of buyers, with internal movement not explicitly defined. Location attractiveness depends on both a static exogenous intrinsic term and on an endogenously determined term, which varies with the income statistics of the local neighbourhood. In both papers, this intrinsic attractiveness decreases with distance from the centre, therefore accounting for the "monocentric" concentration of amenities and job opportunities observed empirically. Pangallo et al. find their model agrees with empirical data (Reardon and Bischoff, 2011) and that positive feedback results in richer households locating closer to the centre. Gauvin et al. take a further step by adapting the model to Paris house prices in 1994, arranging for each district in Paris to be assigned its own intrinsic attractiveness, and find that their results agree with empirical observation.

However, there exists a critical problem in using intrinsic attractiveness as a basis for agents' decisions. Since it is not endogenously determined, it reflects an assumption of the modeller of a typical city structure and in whatever way it is assigned, it imposes a condition on the model that is not necessary. Central business districts are not inherent characteristics of a city, rather they are creations of the actors within the city itself. That intrinsic attractiveness takes on certain values implicitly holds factors of amenities and opportunities constant in the area, when in fact, we have seen from Tiebout (1956) and Epple and Platt (1998) that consumer-voters choose their level of amenities through location, creating demand for them and boosting their production by picking higher tax-expenditure levels.

Gauvin adds depth to the issue through the introduction of a social influence term that characterises the degree to which incoming transactions at a location put upward pressure on attractiveness due to a higher intensity of demand at that location. When social influence is too low, heterogeneous attractiveness levels alone do not result in segregation. Yet, framing income segregation as a problem of social preferences for neighbours with particular incomes – a notion borrowed from Schelling's model (1971) – and not an issue of the direct effects of incomes on the quality of neighbourhood characteristics in itself cuts out key determinants of house prices, especially in a city, such as the local spending pattern of households. Furthermore, since these incomes are constant in both models, social mobility, defined as agents being able to change their place within the income distribution, is not accounted for.

3. Methodology

3.1. Defining the Objects

We now develop an agent-based computational model of a general city.

3.1.1. Agents

The model contains N agents, with each agent $n = 1, 2, ..., N$ earning a fixed heterogeneous income level $Y = y$ in each period T, where Y is a random variable drawn from a specified distribution common to the entire population that we can vary. Furthermore, each agent faces a trade-off between income spent on housing in period T and income toward non-housing expenditure, represented by the marginal rate of substitution (MRS) α between housing and non-housing expenditure.

Therefore,

$$y = h + d$$

where h is housing expenditure and d is non-housing expenditure.

$$h(y, \alpha) = \frac{y}{1 + \alpha}, \qquad d(y, \alpha) = \frac{\alpha y}{1 + \alpha}, \qquad \alpha > 0.$$

The MRS α is exogenous to the model; similar to the income level, it is a random variable drawn from a specified distribution that is in our control.

3.1.2 Houses

In order to preserve the elegance of Schelling's (1971) model, this paper considers an $M = M_1 \times M_2$ grid of houses (Figure 2), setting $M_1 = M_2$ without loss of generality.

381	69	333
348	**5**	225
166	312	182

Figure 1: The Moore neighbourhood (Gardner, 1970) of the house occupied by agent 5

The utility $u_{(a,b)}$ of a house at position (a, b) is given by the simple mean of the incomes of the K agents occupying its Moore neighbourhood (Figure 1):

$$u_{(a,b)} = \sum_{k=1}^{K} \frac{y}{k}$$

This utility can be interpreted as the availabilities of local amenities (including public services such as schools and hospitals, and private facilities such as commercial areas) in line with Tiebout's (1956) theory that the choice of consumer-voters on the community they reside in is dependent on their preferences for local amenities.

It is important to note that $u_{(a,b)}$ can be easily modified to reflect how we want the incomes of the surrounding neighbourhood to translate into the utility of each house.

3.2. The Market Matching Process

Agents are initially allocated random houses in period $T = 0$, resulting in a grid similar to Figure 2.

171	139	97	73	169	328	221	29	312	263	61	57	116	340	175	79	244	195	65	217
121	245	301	14	98	337	192	99	310	397	161	267	47	141	115	56	202	365	222	39
395	70	26	67	288	64	227	232	194	317	11	109	339	396	82	30	381	106	149	201
302	230	173	219	274	394	130	318	358	140	373	156	315	117	329	200	28	268	74	177
265	7	93	386	382	186	17	314	183	363	167	95	342	212	252	388	137	362	110	290
162	248	66	27	19	258	31	160	205	198	170	58	83	147	251	380	25	111	293	389
319	105	85	352	123	81	126	112	100	273	132	20	62	305	104	2	398	357	75	145
283	220	101	266	118	375	125	238	260	6	239	187	68	12	181	134	182	114	46	338
354	343	34	355	378	119	240	23	253	191	313	285	166	275	131	150	51	190	377	60
231	193	284	286	215	351	96	306	179	180	211	153	21	35	282	103	196	270	87	399
40	323	254	33	204	371	168	127	48	348	350	289	299	164	197	250	393	142	135	38
155	72	59	138	281	259	146	158	88	346	133	279	55	242	151	49	353	347	10	262
264	8	255	22	152	3	53	326	243	159	157	1	90	308	269	272	367	44	189	316
368	13	207	24	276	307	178	309	384	246	41	226	208	344	76	203	84	124	278	294
91	249	185	206	128	224	223	37	297	144	18	32	277	257	15	210	311	387	9	325
391	92	4	233	364	148	122	129	280	236	360	256	379	36	235	291	94	374	229	199
172	361	218	69	345	341	334	369	370	241	300	136	108	143	5	356	216	321	332	385
50	89	390	184	296	247	372	336	383	292	237	324	359	392	349	113	327	320	78	214
43	376	330	213	16	63	228	45	366	154	331	400	295	107	271	225	298	174	54	42
335	176	86	77	209	322	163	165	52	287	261	333	234	304	102	303	188	120	80	71

Figure 2: A grid of size N= 20 X 20. Darker shades indicate agents with lower income

Each next period starts with a round of bidding, where every agent places a bid B on every house in the city, given by:

$$B = \frac{u_{(a,b)}}{u_{(a*,b*)}} \times h(y, \alpha)$$

where $(a*, b*)$ is the location of the house with the highest utility. Therefore, each agent prepares a bid for every house in order of preference based on housing utility $u_{(a,b)}$ so that in the event that they are outbid for their most preferred house, they have a next-best alternative.

All houses are then auctioned in a Dutch-style auction, starting with the highest bidder on each house. Once the new tenants are set, the utilities of all houses are updated with the incomes of new neighbours in preparation for the next round of bidding.

3.3. Key Assumptions of the Model

i.) The market presented is purely rental, with tenancy contracts all lasting one period, after which they expire en masse. There is one common implicit "landlord" for all tenants in the city.

ii.) The city is assumed to be closed, with each agent able to occupy one household such that every house is occupied in every period. The landlord therefore sees demand for city housing only originating from the existing city population. No external reservoir of agents exists.

iii.) That the presence of local amenities is dependent on neighbouring incomes is a strong assumption; the implication is that income is locally spent, either through tax-based distribution, or through consumption of goods and services in local markets. The exact interaction between local incomes and amenities is coded for in $u_{(a,b)}$.

iv.) All actors have perfect information and well-defined choices – hence the market clears.

4. Results

To quantify the degree to which the city is segregated by income, we can use Moran's I (Moran, 1950), a metric of spatial autocorrelation. Moran's I is given by:

$$I = \frac{N}{\Sigma_i \Sigma_j w_{ij}} \frac{\Sigma_i \Sigma_j w_{ij}(y_i - \underline{y})(y_j - \underline{y})}{\Sigma_i (y_i - \underline{y})^2}$$

where i and j index a pair of houses, y_i and y_j are the incomes of the occupants of houses i and j, w_{ij} is a component of a spatial weights matrix that takes on 1 if houses i and j are neighbours and 0 if they are not, and $\underline{y}$ is the average income of the population. Moran's I takes values $-1 < I < +1$, with $I = -1$ indicating perfect dispersal analogous to a checkerboard pattern, $I = 0$ indicating random arrangement, and $I = +1$ implying perfectly segregated clusters.

Below are two typical evolutions of the model under various initial conditions.

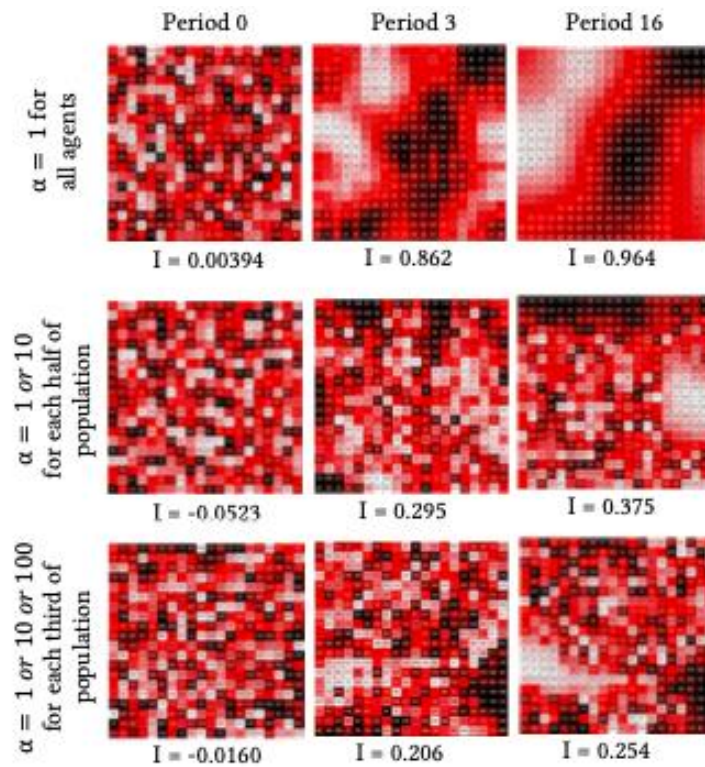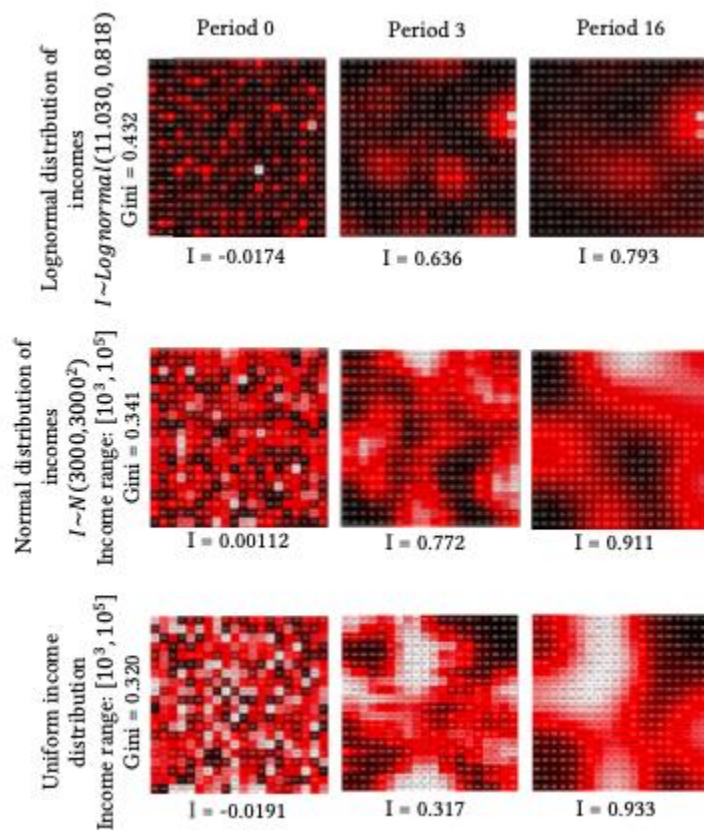*Figure 3:* Varying with a uniform income distribution, N = 400, income range: [1000, 10000]

Figure 4: Varying income distribution with homogeneous α, N=400. Values for μ and σ in the lognormal distribution were obtained based on (Schield, 2018)

From these preliminary results, we can ascertain that when there is a more pronounced difference in willingness to pay for local amenities – as characterised by the presence of individuals with $\alpha = 1, 10$, and 100 in the population – the Moran's I value reached after a number of periods falls, indicating a fall in income-segregation. This is similar to varying the income distribution but allows for more detailed interaction between agents' income and expenditure to be encoded using the MRS in future development.

5. Discussion and Points for Development

5.1. The MRS

What is the intuition behind the MRS and its impact on segregation? An individual agent, despite recognising the superior amenities available at one location over another, will still only allow a certain proportion $h = \frac{y}{1+\alpha}$ of their income to be spent on housing. Therefore, a rich agent with a high value of α places a similar bid on a given house to a poorer agent with a low value of α; the presence of individuals who do not place much importance on rental spending relative to other spending both *delays* and *reduces* the overall segregation effect.

However, the assumptions exclude both wealth effects of home ownership and social mobility. The introduction of social mobility is especially complicated, requiring either assumptions regarding (or the direct generation of) labour markets, education networks, and even technological development.

5.2. On Local Expenditure

Furthermore, these results rely on the implicit assumption that local income is locally spent – if only in part then in a consistent proportion across the whole city. Again, such an assumption cannot be removed without explicitly defining the avenues through which income is generated and spent. Here, a more efficient model structure using multiple mathematical graphs that describe the interdependencies between agents in different capacities can be employed. The spatial weights matrix w, which currently is only used to describe relationships between neighbours, can be replicated to account for other relationships, such as employment contracts, transport links, and goods and services trade, all of which play a prominent role in the housing decision.

5.3. What Do We Want Our Cities to Look Like?

Analysis of ONS (Office of National Statistics) data indicated that urban towns and cities in the UK see a value of Moran's I between -0.15 and 0.7 (ONS, 2021). Research on Facebook data conducted by Bailey et. al (2020) illustrates a link between socio-economic connectedness and social mobility – the networks people have access to can affect their maximum potential earnings in their life, suggesting two-way causality between income inequality and income-based segregation.

Just as income inequality naturally questions the degree of inequality that is tolerable – or even desirable – in society, policymakers here must make a judgement: how much segregation is too much? Adding social mobility to the presented model can allow us to study the origins of the ONS's and Bailey's findings, and the conditions under which they are mitigated, giving modellers the ability to recommend not just methods to achieve a given level of equity and mobility in society, but that level which is consistent with the behaviour of free people itself.

6. Conclusion

This paper has provided a review of the literature on modelling segregation, which was revolutionised by Shelling's (1969) paper that analysed racial segregation, and, upon considering the existing attempts to translate his model into a computational study of income-based segregation, has given a general, accessible framework that can be used for further research.

The grid-based model presented looks at the housing market in a closed city with one landlord and N agents with varying incomes and expenditure preferences occupying N households. By measuring the degree of segregation using the Moran's I

value reached after a given number of periods, we show that the presence of citizens with varying propensities to spend on housing relative to other expenditures has a direct impact on the observed segregation pattern. The more variable and extreme the differences in the proportion of income spent on housing by each agent relative to another agent, the closer the Moran's I value reached was to 0, implying a lower degree of income segregation.

The eradication of certain assumptions, such as that local income is locally spent, and that incomes remain fixed for the whole simulation, can give rise to richer analysis. A model without these assumptions, we recommend, should replicate the spatial weights matrix defined for Moran's I to describe networks pertaining to the labour market, goods and services trade, and transportation to analyse income-based segregation more efficiently and with greater detail.

There are a number of further considerations which could be addressed in future research:

i.) *Challenges in geo-spatial ABMs*
Crooks et al. (2008) outline seven key challenges faced by modellers when creating ABMs. No widely accepted theoretical framework exists as with analytical models concerning utility, rents, rules for interaction, and other modelling standards. In Crooks (2010), he also proposes a non-grid-based model for a city, better capturing the high population densities present in modern metropolises.

ii.) *Matching ABMs with data*
A model is only as useful as it is applicable. New measures such as rank-order segregation proposed by Reardon et al. (2012) and the spatial ordering index proposed by Dawkins (2007) allow model data to be more accurately compared with empirical data so as to isolate the analysis of income segregation from the underlying income distribution.

iii.) *Artificial learning*
Though the discussed models are dynamic, the agents themselves are static beings. Incorporating ideas from Holland and Miller (1991) and Axelrod (1997) on agents adapting to novel circumstances through intelligent learning and genetic selection processes could add a new layer of complexity to the entire model.

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Article

Climate Change and Economic Outcomes: a State-Level Analysis in the US

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Abstract
Growing economic inequality and increasing climate disruption are two major issues that are not always studied in accordance despite their interconnectedness. A better understanding of their relationship can help policy makers address both of these issues. Combining data from a study on city-level climate risk and readiness with data from the 2020 US Census, I run a series of OLS regressions to estimate the size effect of these two variables on 3 different economic outcomes. Although further research is required to establish causality, my findings suggest climate risk and unemployment rates are associated, in turn suggesting that policy-makers consider tackling both issues simultaneously.

Keywords: Climate Change; Inequality; Unemployment; USA

1. Introduction

This paper explores the intersection of two widely researched topics: the economic impacts of climate change and geographic inequality of incomes. By combining the data of a study on variations in climate change risk and preparation across United States cities (Chen et al., 2015) with socio-economic state-level data from the 2020 Census, the paper aims to estimate the contributions of climate change to economic inequality in the US.

2. Literature review

2.1. Income inequality in the US: national and geographic trends

2.1.1. Rising income inequality in the United States

Using data from income tax returns and national accounts, Piketty and Saez (2014) find that income inequality in the United States has followed a U-shaped pattern over the last century. The share of pre-tax income belonging to the highest 10% fell from 45% in 1910 to 35% in the 1960s, and started rising in the early 1970s to reach a record-level of nearly 50% in 2010. In contrast, the same measure of income inequality in Europe, which started the 20th century at higher levels than the US, neighbours 35% nowadays. Panel A of figure 1 illustrates US and Europe trends in income inequality, in particular, it shows how their paths significantly deviated from one another from the 1970s onward.

2.1.2. Geographic pattern to income inequality

The Brookings Institution, an American research group, studied the evolution of various economic indicators over the last century, as part of a paper on "the geography of prosperity" (Nunn, Parsons and Shambaugh, 2018). With regard to income per capita, there are significant differences across regions of the US, with areas such as New England and the Mideast consistently scoring higher than the Southwest and Southeast. Similarly to the evolution of national income inequality, the authors find that geographic inequality has followed a U-shaped pattern since the start of the 20th century. Differences between regions fell between 1930 and 1980 but have gradually risen since the 1980s. Over this latter period, income per capita in New England rose from 105% to 125% of the national average, while that of the Southwest fell from 98% to 90%. Panel B of figure 1 illustrates these regional trends. The parallel with panel A illustrates how both overall inequality and geographic inequality in the US have followed similar time trends.

2.2 Climate change risk and readiness across cities

2.2.1 Around the world

In an increasingly urbanised world, with two-thirds of the global population expected to live in cities by 2050 (Guilyardi et al., 2018), no city is immune to climate risks. The Carbon Disclosure Project, a non-profit organisation, found the five most common climate risks among a sample of 620 studies to be flooding, heat waves, rainstorms, extreme temperatures, and droughts (2019). For every city, they calculate a "hazard score" (HS) which increases with the amount of climate risks and the severity of the threat. For instance, Santiago, Chile (HS=5) has relatively few climate risks while Sydney, Australia (HS=27) is much more vulnerable. In both the short and long-run, the authors find that these risks
threaten to exacerbate pre-existing social and economic challenges such as access to healthcare and social services, prevalence of diseases, and unemployment (CDP, 2019).

2.2.2. Across the United States

The Notre Dame Global Adaptation Initiative (2015) ranked the 270 US cities with a population of 100,000 and above according to climate change vulnerability, and readiness scores. Risk is an index of a city's adaptive capacity (e.g., water quality, insurance coverage), sensitivity (e.g., access to vehicle, housing quality) and exposure (e.g., percentage of high-risk flood zones). Readiness is an index of a city's economic (e.g., debt per inhabitant), governance (e.g., percentage of climate change deniers) and social (e.g., civic engagement) readiness against climate change. Cities such as Seattle (WA) which score high on readiness

and low on vulnerability will be less impacted by climate change than cities such as Newark (NJ) which score low on readiness and high on vulnerability. In addition to highlighting significant differences in climate vulnerability and readiness across US cities, the data also shows a negative correlation between the two indices. In other words, cities with the greatest climate threats are also those that are the least prepared to face them. The composition of the two variables is represented in figure 2.
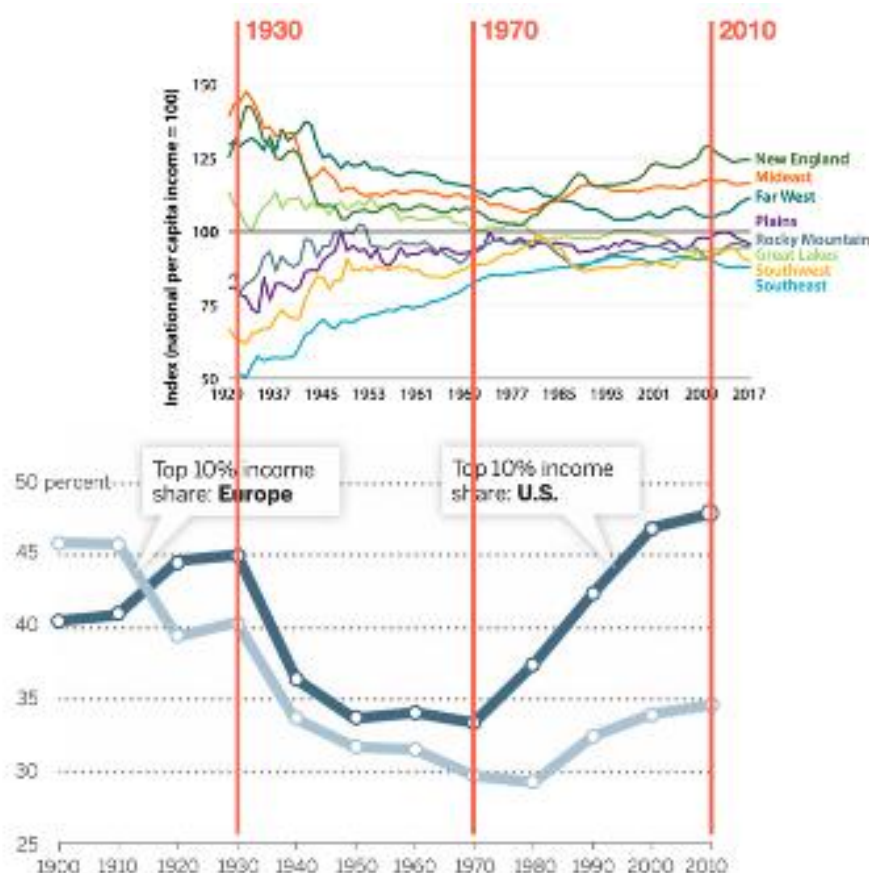
Figure 1(A): US Regional Relative Per Capita Income (Nunn, Parsons and Shambaugh, 2018) (Upper Panel); *Figure 1(B):* Share of Top Income Decile in Total Pretax Income (Piketty and Sae) (Lower Panel)

2.3. Climate change and inequality

2.3.1 Climate change and inequality between countries

Climate change and inequality have traditionally been studied separately, yet they are firmly linked to each other. On the one hand, climate change exacerbates poverty and inequality, both within and between countries. For instance, one channel via which climate change impacts world inequality is through global warming. Diffenbaugh & Burke find that, because growth is highest when temperatures are moderate, global warming boosts the economies of cold and wealthy nations while harming those of tropical, and impoverished ones. They further estimate that around a quarter of between-country inequality today is explained by this dual effect of global warming. On the other hand, inequality and climate change are linked in that countries' historical contributions to climate change are highly unequal, with the US alone having contributed 60% of today's climate change (Evans, 2021).

2.3.2. Climate change and inequality between cities

Through the channels identified by the CDP's study (2019), variations in cities' levels of vulnerability and readiness towards climate change can translate into different economic outcomes at the city level, hence explaining some of the inequality between US cities observed by Nunn, Parsons and Shambaugh (2018). Similarly to Diffenbaugh & Burke's (2019) work on countries,

the aim of this paper is to quantify the respective effects of climate change vulnerability and readiness on cities' economic outcomes, and subsequently estimate how much geographic inequality has resulted, and might result, from these factors. One obstacle to this analysis is the possible existence of reverse causality (i.e., economic outcomes might affect cities' levels of vulnerability and readiness).

3. Data

3.1. Variables

This paper seeks to evaluate the overall effect of climate change on economic outcomes. Climate change is a complex phenomenon whose effects, both direct and indirect, happen at various levels. For this reason, it is difficult to quantify such a concept. As mentioned in section 2.2, the Urban Adaptation Assessment, led by the Notre Dame Global Adaptation Initiative by Chen et al. (2015) ranks the 270 largest US cities according to climate change risk (*Risk*) and readiness (*Readiness*).
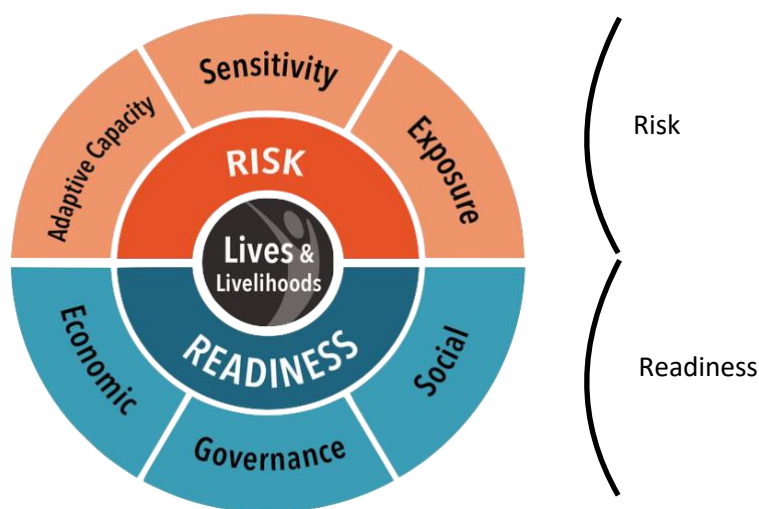
Figure 2: The components of Risk and Readiness (Nunn, Parsons and Shambaugh, 2018)

The rest of the data comes from the 2020 United States Census [census.gov] which was collected during the Covid-19 pandemic and marked the 24th census in US history. The census provides state-level data (including Washington DC) on a range of economic, social, housing and demographic factors, from which I was able to construct new variables better suited for my analysis. I will be looking at state median household incomes, unemployment rates and poverty rates. Other variables from the Census serve as controls. Table 1 lists the variables included in my study, alongside their label and source. Additionally, the variable *State_Code* denotes individual observations.

Variable	Label	Source
Climate Change		
Risk	Average climate change risk score for cities belonging to state	Nunn, Parsons and Shambaugh, 2018
Readiness	Average climate change readiness score for cities belonging to state	Nunn, Parsons and Shambaugh, 2018
Economic		
Median_Fam_Inc	Median family income in the past 12 months (in 2020 inflation-adjusted dollars)	US Census 2020

Variable	Label	Source
Unemployment	Ratio of unemployed civilian labour force to civilian labour force in state	Constructed from US Census 2020
Poverty_rate	Share of population with income below poverty line in state	Constructed from US Census 2020
Private_HU	Share of the population with private health insurance in state	Constructed from US Census 2020
Social		
High_School	Share of the population over 25 that has at least graduated from high school in state	Constructed from US Census 2020
College	Share of the population over 25 that has graduated from college in state	Constructed from US Census 2020
Spanish_HH	Share of Spanish speaking HH, with or without limited English speaking in state	Constructed from US Census 2020
Limited_English_HH	Share of HH with limited English speaking in state	Constructed from US Census 2020
Computer_access	Share of households with access to a computer in state	Constructed from US Census 2020
Demographic		
Population	Population in state	US Census 2020
Sex_ratio	Male to female ratio in state	Constructed from US Census 2020
Married_Couple_Fam	Share of own children under 18 living in married-couple families	Constructed from US Census 2020
Share_pop_under_18	Ratio of population under 18 years of age to total population in state	Constructed from US Census 2020
Race_1 to Race_7	7 variables corresponding to the share of population identifying as (1) White alone, (2) Black or African American alone, (3) American Indian and Alaska native alone, (4) Asian, (5) native Hawaiian and other Pacific Islander alone, (6) some other race alone and (7) two or more races, in state	Constructed from US Census 2020
Occupation_1 to Occupation_5	5 variables corresponding to the share of civilian employed population 16 years and over working in (1) management, business, science, and arts occupations, (2) service occupations, (3) sales and office occupations, (4) natural resources, construction, and maintenance occupations and (5) production, transportation, and material moving occupations, in state	Constructed from US Census 2020

Table 1: List of variables with label and source

3.2. Discussion on Data

My original idea for socio-economic outcomes was to look at city-level data by Nunn, Parsons and Shambaugh (2018) who constructed a "prosperity index" for a large sample of cities based off 6 socio-economic factors (median household income, poverty rate, unemployment rate, adult employment rate, house vacancy rate and life expectancy). However, the study by Nunn, Parsons and Shambaugh (2018) is at the county level, while the work of Chen et al. (2015) defined cities as a metropolitan area which could correspond to a part of a county or encompass multiple counties. This caused two problems: firstly, it made it impossible to have STATA append the data, secondly it made comparisons inaccurate. After an attempt to manually append the two datasets, I decided to use state-level data from the 2020 Census. In turn, this meant transforming the data on climate change from the city-level to the state-level as an average of cities included in the dataset belonging to each state. Transposing data from the city level to the state level requires strong assumptions (developed in a section 5.3). A future project could directly include state-level data, so far I was not able to find a study assessing both risk and readiness for each state.

Furthermore, I have dropped data from Puerto Rico as it is not a part of the 2020 Census, as well as DC because it is an outlier with regard to many factors (e.g., GDP per capita much higher than any state). Using the software STATA, I used ordinary least squares (OLS) regression to analyse the potential climate predictors of three economic outcomes (median household incomes, unemployment rates, and poverty rates).

4. Model

Using the software STATA, I ran 3 sets of ordinary least squares (OLS) regressions to analyse the potential climate predictors of the 3 economic outcomes I considered. OLS minimises the sum of squared residuals between the true data and their linear estimation.

For each of the three explanatory variables, I ran a first regression without any controls, and a second with controls, as follows:

$$y = \beta_1 \cdot Risk + \beta_2 \cdot Readiness \qquad (1)$$
$$y = \beta_1 \cdot Risk + \beta_2 \cdot Readiness + X \cdot \beta_X + \epsilon \qquad (2)$$

Where:
- y consecutively corresponds to *Median_Fam_Inc*, *Unemployment* and *Poverty_rate*, the explained variables
- *Risk* and *Readiness* are the explanatory variables
- X is a matrix containing all the remaining variables from Table 1
- β_1, β_2 and β_X are the respective estimated coefficients for *Risk*, *Readiness* and the X matrix
- ϵ is the error term

The basic assumptions of OLS are correct specification, strict exogeneity, no linear dependence and spherical error.

5. Results

5.1. Scatterplots

For US states, a higher climate change risk score is correlated with higher median family income, higher unemployment, and lower poverty rates. Specifically, one extra point is associated with an extra $93514 (SE: 18442) median family income, a 0.05 (SE: 0.017) increase in the unemployment rate, and a 0.09 (SE: 0.036) decrease in the poverty rate.

Apart from unemployment, higher climate risk therefore correlates with better economic outcomes - a surprising finding given one might expect poorer people to live in more exposed areas due to self-selection of wealthier people into safer areas. Perhaps this correlation captures the effect of other covariates. Figure 3 plots fitted values of these variables for different levels of Risk. Higher climate readiness has little correlation with median family incomes. This is surprising as one would expect wealthier areas to invest more in protection against climate risks, however this might be counterweighted if wealthier individuals self-selected in safer areas. Higher readiness is associated with lower unemployment rates and slightly associated with lower poverty rates. Specifically, one extra point is associated with a $947 (SE: 29555) decrease in median household income, a 0.06 (SE: 0.0235) decrease in the unemployment rate and a 0.029 (SE: 0.49) decrease in poverty rate. Figure 4 plots fitted values of these variables for different levels of Readiness.
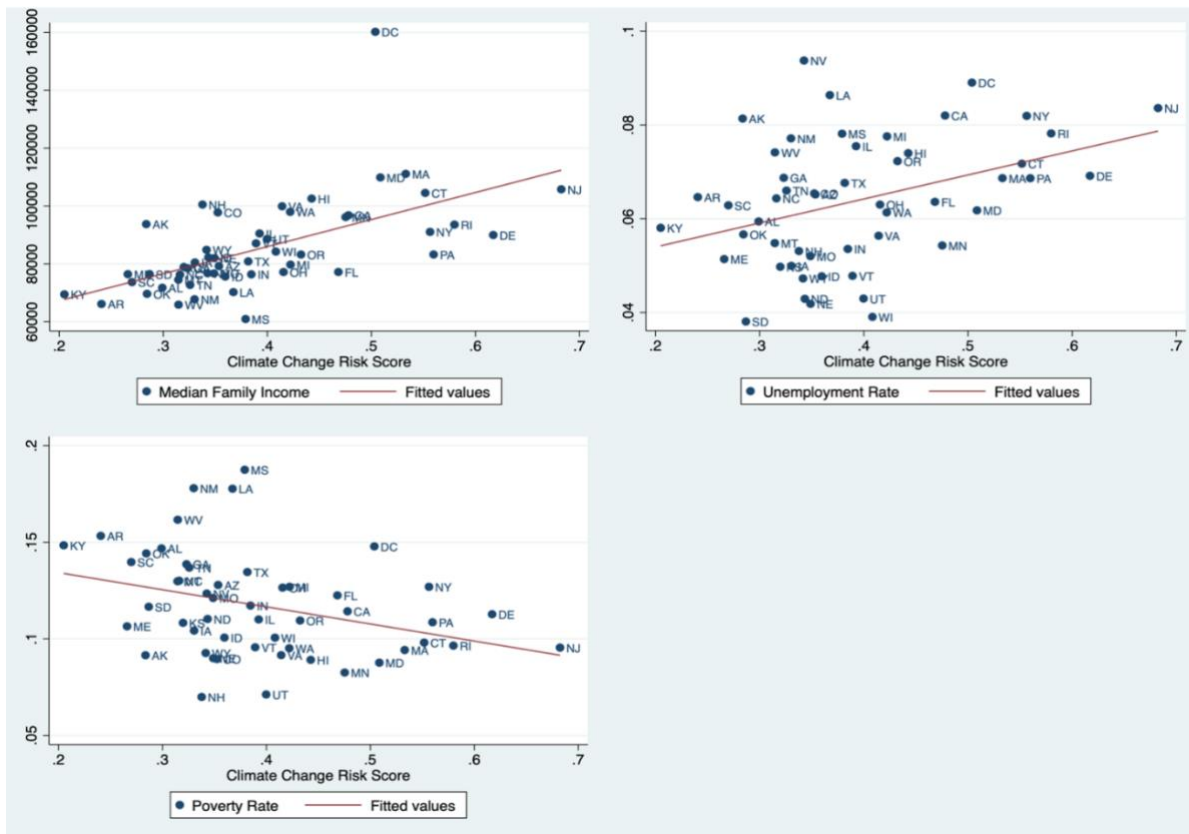
Figure 3: Climate change risk and economic outcomes
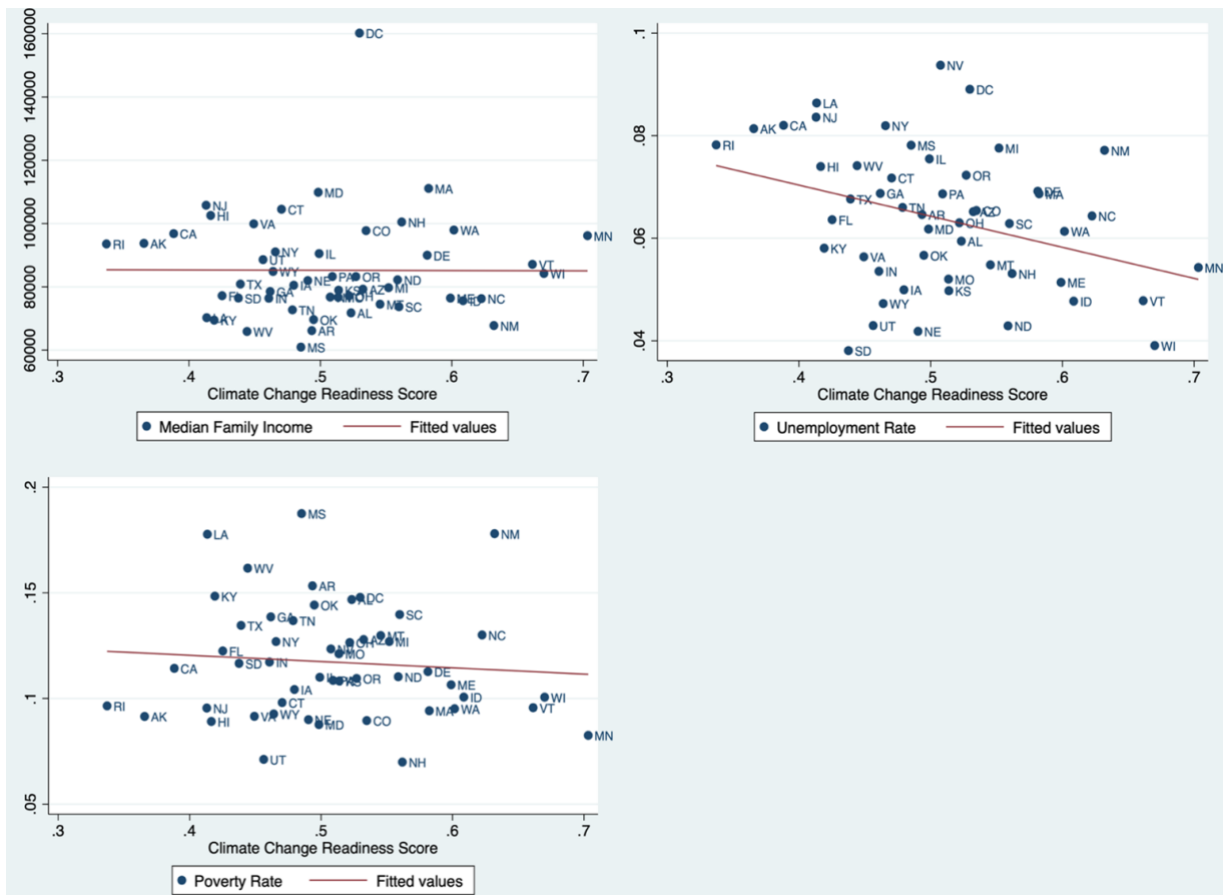
Figure 4: Climate change readiness and economic outcomes

5.2. Linear regressions

The goal of this section is to estimate how state-level climate scores (i.e., *risk* and *readiness*) impact economic outcomes such as median family incomes, unemployment rates and poverty rates. Tables 2, 3 and 4 repetitively show the results of 2 multiple linear regressions for median family income, unemployment rate and poverty rates as dependent variables. In the 3 tables, the independent variables are (1) risk and readiness and (2) all the variables.

Independent variable	(1)	(2)
Constant	43894.94*** (14928.18)	7974.365 (256051.6)
Risk	94054.6*** (18668.1)	1878.729 (9762.391)
Readiness	8789.484 (24228.32)	-10462.24 (9426.649)
Only the variables from the Census that are significant at 10% are reported		
Private_HU	-	59454.58** (27254.35)
College	-	-71383* (40726)
Computer_access	-	223066.6*** (73805.55)
Race_1 (white alone)	-	-444433.2** (215153)
Race_2 (black alone)	-	-409798.7* (212761.8)
Race_3 (native alone)	-	-402281.3* (205097.3)
Race_6 (other alone)	-	-410149.7* (209564.3)
Race_7 (mixed race)	-	-544276.2** (243958.3)
Occupation_1 (management, business, science, and arts occupations)	-	288799.4*** (73692.98)
Share_pop_under_18	-	-180925.3** (76748.71)

Table 2: OLS results with *Median Family Income* as dependent variable (standard errors in brackets)
* significant at 10%, ** significant at 5%, *** significant at 1%

Independent variable	(1)	(2)
Constant	.0733474*** (.0136459)	-.7178007 (.5074005)
Risk	.0478172*** (.0170646)	.0332551* (.0190021)
Readiness	-.0556861** (.0221472)	-.0155255 (.0196043)
Only the variables from the Census that are significant at 10% are reported		
Sex_ratio	-	1.276013*** (.4473252)

Table 3: OLS results with *Unemployment* as dependent variable (standard errors in brackets)
* significant at 10%, ** significant at 5%, *** significant at 1%

Independent variable	(1)	(2)
Constant	0.1728606*** (0.0286775)	2.149898*** (0.6415435)
Risk	-.0910554** (0.035862)	-0.0167751 (0.0291044)
Readiness	-0.0391109 (0.0465433)	0.0071954 (0.0288896)
Only the variables from the Census that are significant at 10% are reported		
Private_HU	-	-0.1517957* (0.0837421)

Table 4: OLS results with *Poverty Rate* as dependent variable (standard errors in brackets)
* significant at 10%, ** significant at 5%, *** significant at 1%

Firstly, we can note that the results between columns (1) and (2) change considerably, reflecting the fact that the economic outcomes considered here are explained by many variables other than climate risk and readiness. Secondly, we can also note that it is not the same variables that significantly explain the 3 economic outcomes.

In the first regression (1), *Risk* is found to be a significant (at 10% or less) predictor of the economic outcomes I consider while *Readiness* is only significant for unemployment. Such significance disappears, however, when controlling for more Census data in the second regression (2). However, there is one exception: although its size effect diminished, *Risk* is still found to significantly affect unemployment rates in a state. Specifically, a 1 unit increase in the score (higher risk) is associated with a 0.0332551 increase in the unemployment rate. Surprisingly enough, out of the 26 independent variables considered, *risk* is the variable with the highest significance in predicting unemployment (with only one other variable - the share of people on private healthcare - found to be significant).

If regression (2) were to control for all covariates likely to influence estimations of the size effect of *Risk* on *Unemployment*, we could conclude that living in a state whose main cities are more exposed to climate risk leads to higher unemployment rates. However, the *Risk* variable is comprised of many factors (e.g., water quality, access to vehicle) which could each indirectly correlate with unemployment. In a future project, I would have to look at these elements individually.

6. Discussion

6.1. Implications for Policy Making

Under the assumptions laid out throughout the paper, higher exposure to climate risk in its main cities is associated with a higher state unemployment rate. Although it is impossible to establish a causal relation, this finding does provide descriptive evidence towards a possible causal chain, highlighting how interconnected environmental and economic issues are, and suggests both issues can be tackled simultaneously. If we could establish a clear causality using more elaborate econometric analysis, this would suggest that some of the economic cost of increased spending against climate change can be mitigated by savings on unemployment benefits, for instance. Furthermore, tackling these two issues together can create positive feedback. In fact, Benegal (2018) finds that lower local unemployment rates lead to a reduced likelihood of being a climate change denier, among Americans identifying as either Republicans and Democrats.

6.2. Study Limits and Further Research

6.2.1. Cities and States

An important assumption was made in section 3 when I created state-level variables from city-level data. This assumed cities within a state shared some correlation for climate risk and readiness, which is not necessarily the case:
- In the case of *Risk*, cities from the same state are geographically closer to each other, and thus share certain characteristics that could affect Risk (e.g., latitude). However, many geographic characteristics depend on other factors (e.g., proximity to the coast affects the likelihood of flooding).

- In the case of *Readiness*, many policies are decided at a state level (for instance, education policy which in turn impacts beliefs about climate change). However, there can be sharp differences between cities. In fact, drawing the parallel with political opinions, the county-level results of the 2016 Trump vs Clinton presidential election show a much sharper contrast between coastal and rural areas than between states. In fact, most states contain counties who voted for both parties (Carpenter, Brauer and Niedenthal, 2020).

There are therefore some elements to support my choice to transpose data from the city level to the state level. However, further research that only focuses on the city level would yield more accurate results.

6.2.2. Impact on Inequality

The extent to which the impact of climate risk on unemployment affects inequality levels deserves further investigation. This is something similar to the work done by Diffenbaugh & Burke (2019). By using the relationship between temperature and growth identified by Burke, Hsiang & Miguel (2015) and creating counterfactual levels of growth, the authors estimated how much this effect contributed to between-country income inequality. A similar method could use the relationship between climate risk and state unemployment rates to estimate how much "unemployment inequality" is linked to between-state variations in climate risk.

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Monetary Policy, Portfolio Heterogeneity, and the College Wealth Gap

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Abstract

This paper investigates the relationship between monetary policy and wealth inequality by college education. I first highlight the extent to which college education drives salient differences in the portfolio composition of U.S. households, and then study how this, in turn, affects households' exposure to asset price changes following an expansionary monetary shock. This paper contributes to an evolving body of literature exploring the role of portfolio choices and, in particular, stock market participation, on the distribution of capital gains following policy shocks. I show that accommodative monetary policy substantially exacerbates the existing wealth gap between college-educated households and households without a college degree. Monetary policy is thus limited, as it cannot stimulate economic activity without widening wealth inequality.

Keywords: Monetary Policy, Wealth Inequality, Education, Portfolio Effects

1. Introduction

Inequalities caused by education have traditionally been outside the purview of monetary authorities. However, an evolving strand of literature has explored the role played by household heterogeneity in the transmission mechanisms of macroeconomic policies. In this paper, I investigate the correlation between monetary expansion and wealth inequality by college education. At the heart of this study is the idea that expansionary monetary policy may exacerbate existing disparities in wealth due to its effect on the valuation of housing and equity. As my analysis shows, college education is indeed strongly correlated with salient differences in household portfolio composition, thus driving heterogenous exposure to capital gains following monetary shocks.

Most of the existing academic literature on monetary policy and inequality has focused on the so called 'earnings channel' (see Coibion et al. (2017)); by stimulating economic activity, monetary easing particularly benefits individuals who would otherwise be unemployed. Since workers who are drawn into the labour market are predominantly low-skilled and from low-income households, inequality as measured by earned income and employment gaps is reduced. On the other hand, an investigation of the 'portfolio channel' of monetary policy and its distributional implications is still very much in its infancy. Moreover, while a growing number of papers have highlighted the role played by heterogeneity in household portfolios (e.g., Kaplan et al. (2018) and Cloyne et al. (2020)), an effort to identify structural drivers of such balance sheet differences is almost entirely absent from the existing literature.

In order to measure the effect of monetary shocks on the college wealth gap, I first rely on survey data on US households from an extended version of the Survey of Consumer Finances (SCF+). Using this data, I measure the extent to which college education is correlated with not only the size, but also the composition of families' portfolios. As I shall explain in greater detail, there is compelling evidence that whether or not households hold a college degree and their exposure to stock- and house-market booms are strongly related. Importantly, this correlation remains strong when households with the same income are compared. I then move on to study the movements of asset prices following an expansionary monetary policy shock. To that end, I estimate local projections over a horizon of 48 months using the Romer and Romer (2004) monetary shock series for identification of exogenous changes in the federal funds rate. Point estimates from this analysis show substantial and temporary increases in stock prices (up over 8% at their peak), and more modest but significant and persistent increases in house prices (peaking at just short of 4%) following a 100bp expansionary monetary policy shock.

By combining the point estimates from the local projections with evidence from the SCF dataset, I show that monetary easing leads to substantially larger wealth gains for households with a college degree. Indeed, the average household with a college degree gains over five times as much as the average household without college education. Substantial inequalities persist if households within the same income group are compared. Interestingly, when gains are computed as a percentage change in wealth rather than as the dollars-denominated difference in average wealth, benefits appear more equally distributed. Nevertheless, I argue that absolute capital gains matter more for inequality than per cent ones given the initial level of concentration of wealth.

As the following section highlights, this paper might be thought of as building on the work of Bartscher et al. (2021), who find that expansionary monetary policy increases racial inequality between black and white households in the United States due to its price effects. By focusing on a different driver of balance sheet heterogeneity, i.e. college education, I bring greater generality to the distributional implications of monetary shocks. Moreover, evidence from the UK and US shows that inequalities in educational attainment are particularly persistent at higher (e.g. university) qualifications (see Blanden and Mcmillian (2016) for the UK and Chetty et al. (2020) for the US). Hence, the paper's focus on college education is relevant as it identifies a redistribution channel of monetary policy likely to persist despite the general expansion in educational level. Hence, along with evolving evidence from the academic literature, this paper highlights practical limitations of monetary policy, and it warrants broader policy mixes.

Structure of this paper: Section 2 provides a discussion centred on the existing literature on monetary policy and inequality. In Section 3, I first describe the survey data available through the SCF, and then show how college education increases exposure to asset price changes. The instrumental variable local projections (LP-IV) approach which I implement to obtain impulse responses is presented in section 4. The distributional effects of the monetary shock are computed in Section 5, where I combine the micro data with point estimates from the LP-IV model. Section 6 concludes.

2. Literature Review

2.1. The Distributional Impact of Monetary Policy: Evidence from the Literature

2.1.1. The Earnings Channel

Academic literature on the distributional effects of monetary policy is still in its infancy, with most of the previous research focusing on income rather than wealth. Since poorer households are generally worse hit in a recession, expansionary monetary policy decreases income inequality by stimulating employment. Coibion et al. (2017) refer to this effect as the 'earnings channel'. Their work, based on survey data of US households, suggests that higher interest rates have significant adverse effects on labour earnings and consumption inequality. Similar findings are reported by Mumtaz and Theophilopoulou (2017) for the UK, and by Furceri et al. (2017) - based on a study of 32 advanced and emerging economies. Samarina and Nguyen (2019) point to the same channel when measuring the effect of expansionary monetary policy shocks in the Eurozone.

2.1.2. The Portfolio Channel

A growing number of papers investigates a second channel which operates through the effect of easier monetary policy on asset prices. Given the concentration of asset holdings among households, this channel increases inequality as measured by wealth and capital income. Kaplan et al. (2018) explore the transmission mechanisms from conventional monetary policy to household consumption in a Heterogeneous Agent New Keynesian (HANK) model. The model's results show that elasticity of consumption is higher for households with sizable ownership of illiquid assets, equity being the most important. The primary role of equity and housing holdings is also highlighted in Domanski et al. (2016) and Cloyne et al. (2020); the latter conclude that households owing mortgage debt (and hence the lot of middle-income households) are the most responsive to decreases in interest rates. This group is characterized by little or no liquid wealth and sizable illiquid wealth, thus displaying hand-to-mouth behaviour, i.e. high marginal propensity to consume out of small changes in their income. It is worth noting that the consumption response to monetary policy does not necessarily reflect higher wealth gains for middle-income households relative to others. Indeed, Albert and Gòmez-Fernàndez (2018) focus on the wealth-effect of expansionary monetary policy, showing simulations that predict that the poorest and wealthiest benefit the most when monetary policy is loose. Ongoing work by Melcangi and Sterk (2020) for the Federal Reserve Bank finds that the stock market channel of monetary policy quantitatively dominates the consumption channels often emphasized in the literature. In the same vein of research, Holm et al. (2021) use HANK models to investigate the role played by household liquid asset positions on the direct and indirect effect of monetary policy in Norway. The authors show that wealth inequality decreases in response to a monetary tightening, an effect driven primarily by capital losses accruing from risky financial assets. Andersen et al. (2021) investigate the wealth of Danish households using administrative data, and find a monotonic relationship whereby lower interest rates increase wealth and total income more the wealthier is the household to begin with. The general consensus in these papers is that household heterogeneity is key in order to pin down the true distributional implications of monetary shocks.

2.2 Drivers of Wealth Composition: Education and Portfolio Choices

To the best of my knowledge, very few researchers have narrowed their focus to a particular driver of differentials in households' portfolio composition. Bartscher et al. (2021) explore the role of race by studying the effect of expansionary monetary policy on earnings and wealth differentials between White and Black households in the United States. The authors show that the portfolio shares of housing, equities and bonds, are significantly larger for White households, thus exposing their wealth to changing asset prices much more than for Black households. Overall, a small reduction in the earnings gap is dwarfed by the increase in the wealth gap, implying that expansionary monetary policy has a significant adverse effect on racial inequality. Clearly, a similar argument holds for different drivers of balance sheet heterogeneity (i.e. other than race). Previous research on educational differences conducted by Bartscher et al. (2019) has documented significant heterogeneity in terms of financial developments, giving rise to different exposures to asset price changes. Lusardi et al. (2013) construct a stochastic lifecycle model characterised by endogenous financial knowledge accumulation. The simulations show that financial literacy can explain a large fraction of the observed wealth inequality.

3. College Education and Wealth Composition: Evidence from Survey Data

In this section, I provide a description of the household survey data which inform the first empirical analysis of this paper. I use information on families' financial positions and savings decisions to uncover the extent to which households with different educational levels in the United States make different portfolio choices.

3.1. Survey Data: The Extended SCF Dataset

The first part of this research makes use of survey data from an extended version of the Survey of Consumer Finances. The SCF is (normally) a triennial cross-sectional survey of US households. It contains rich information on families' financial position, including balance sheet composition, pensions, income, and relevant demographics. An important feature of the survey is that it over-samples wealthy households; all of the results shown in the paper are re-weighted following Kuhn et al. (2018) to avoid biased estimates.[1]

The SCF was extended by Kuhn et al. (2018) based on historical surveys conducted at an annual frequency from 1947 to 1971, and again in 1971, by the Survey Research Centre of the University of Michigan. Table 1 shows how I combined such financial information available with the SCF+ to construct variables of household holdings of all asset classes. I do so consistently with Bartscher et al. (2021) (see footnote 6 in their paper), who in turn use the approach of Bricker et al. (2017)

Final variable	Composition using SCF+ dataset
Bonds	Bonds + Saving bonds
Housing	Asset value of house + Other real estate
Stocks	Equity and other managed assets + business wealth + mutual funds
Liquidity	Liquid assets + Certificates of deposits
Other financial	Other financial assets + Life insurance assets + Pensions
Other non-financial	Other non-financial assets + Vehicles

Table 1: Computation of Household's Wealth Holdings by Asset Type

NOTE: Variables in the right column are already available with the version of the SCF+ which was kindly provided by Moritz Kuhn and Alina Bartscher (see footnote). Variables on the left were generated following the approach in Bartscher et al. (2021)

In this extended version of the SCF, data is available from 1947 to 2019. However, distinction between households with a college degree and without is only available in waves of the survey from 1956 onwards. Hence, all of the results shown in the following sections are obtained by truncating the sample (i.e. dropping observations from before 1956).

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[1] The SCF+ was kindly provided by Moritz Kuhn and Alina Bartscher (Bonn University). The formatted dataset includes the 'weight' variable used to account for oversampling of wealthy households.

As mentioned in the introduction, the survey data is used to estimate how much obtaining a college degree correlates with household exposure to asset price changes (see Section 3.2). Since data is at the household- rather than individual-level, I divide households into 'college' or 'non-college' groups depending on whether the household head holds at least a bachelor's degree. Householders with 'some college education' are included in the group of non-college households. This approach is consistent with Bartscher et al. (2019) and reflects notable portfolio differences between households with some college versus a college degree. It should also be noted that the dataset contains multiple imputed observations which are averaged for the regressions.

3.2. Results; Asset Price Exposure by College Education

As anticipated in Section 3.1, the extended SCF dataset allows the study of the relationship between households' level of education and their saving decisions. What is more relevant to this paper, it allows us to measure how, on average, households with and without a college degree diversify their wealth across different asset classes.

Before looking at this, it is worth investigating the more general effect of college education on wealth, and hence observe how the 'college wealth premium' has evolved over time. Fig. 1 recreates and extends results from Bartscher et al. (2019) by showing the trend in wealth from 1956 to 2019 for households with and without a college degree. Fig. 1(A) clearly displays the widening of the college wealth gap starting from the 1980s. When individuals within the same wealth group are compared (Fig. 1(B)), the positive college wealth premium remains evident for households in the top 50 percent of the wealth distribution. These figures display unconditional averages, meaning that they do not show what role demographics and other characteristics play for the observed wealth gap.
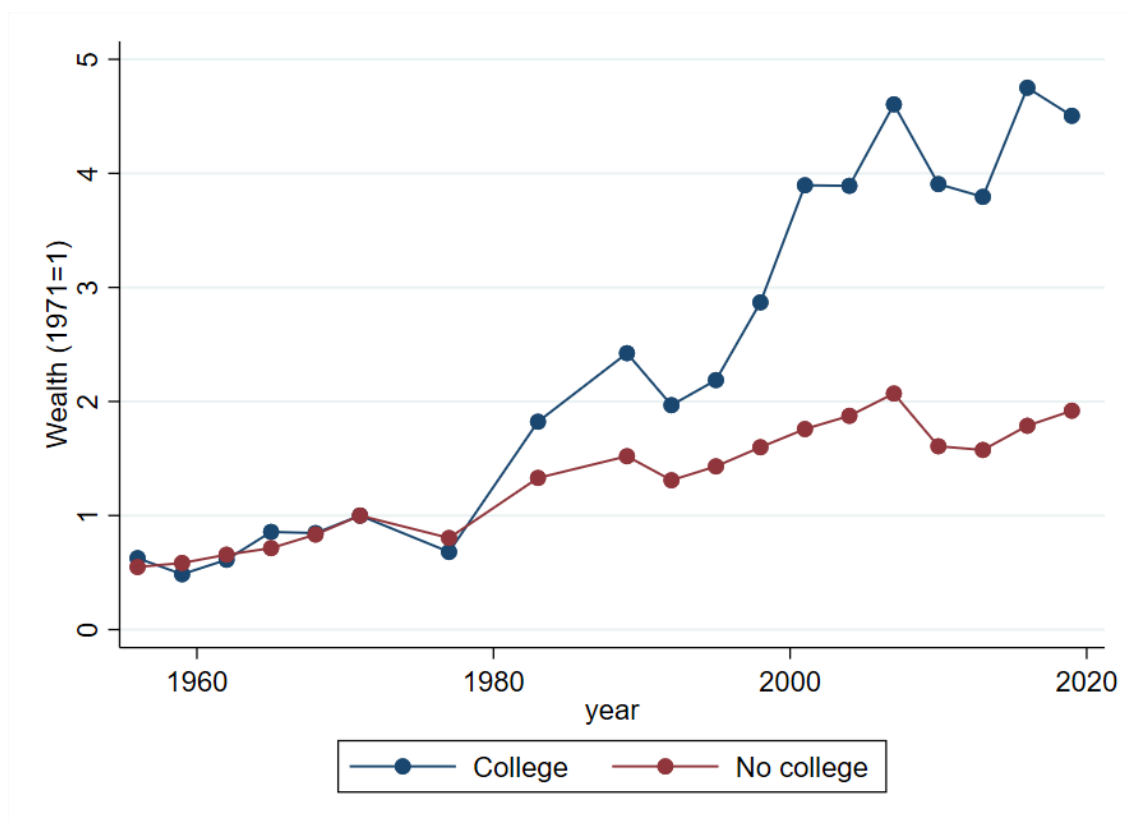
Figure 1(A)
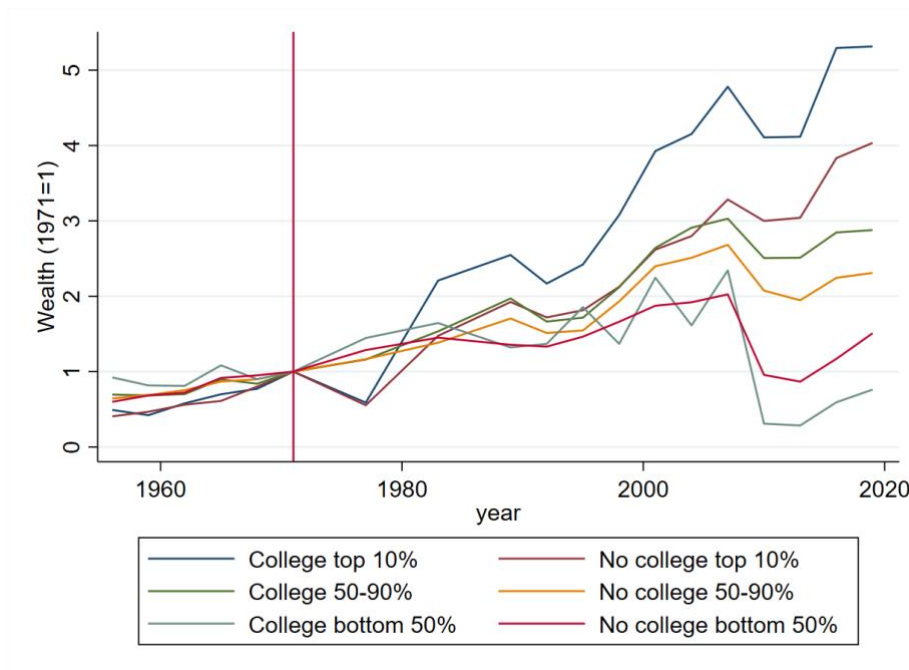
Figure 1(B)

Further extending results from Bartscher et al. (2019), I estimate regression equation 3.2.1.

$$W_{it} = \beta_0 + \beta_1 c_{it} + \sum_{t \geq 1956}^{2019} \beta_{2,t} \mathbb{1}_{[year=t]} \cdot c_{it} + \sum_{t \geq 1956}^{2019} \beta_{3,t} \mathbb{1}_{[year=t]} + \gamma' X_{it} + \epsilon_{it}. \qquad (3.2.1)$$

where c_{it} is a binary variable equal to 1 if household i holds a college degree and 0 otherwise. 1[year=t] is an indicator function to capture survey wave fixed effects for t = {1956, 1959, ..., 2019}. I also add a vector of controls X including a full set of age dummies, number of children in the family, marital status, race, and, importantly, family's total income. Fig. 2 shows the time trend of the estimated parameters $\widehat{\beta}_1 + \hat{\beta}_{2,t}$.
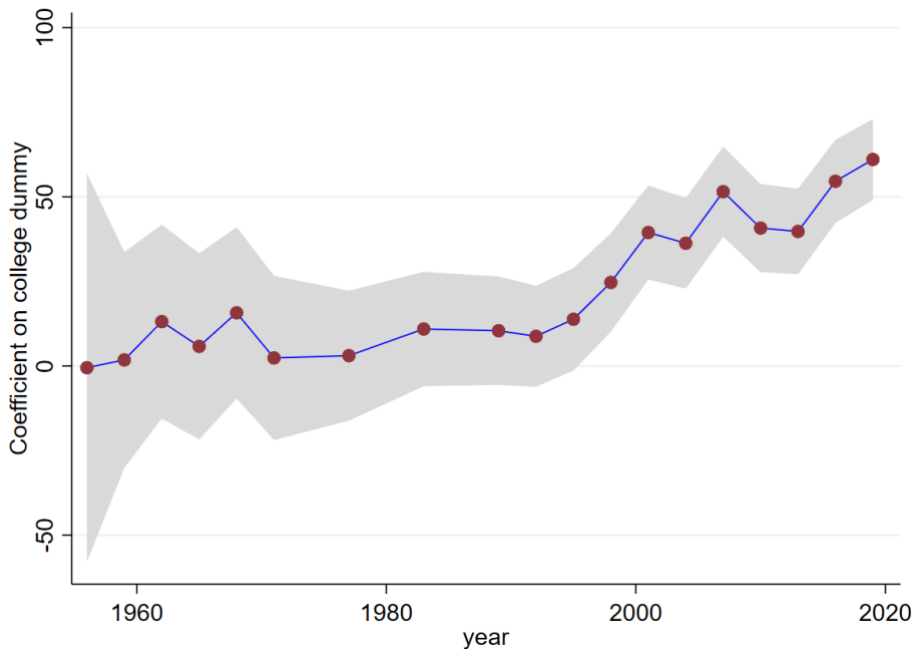
Figure 2

This shows that, even after controlling for total income, the increase in the college wealth premium over time is strong. Everything else being equal, in 2019 holding a college degree is estimated to increase household wealth by over $60,000 US dollars. Appendix A.2 provides numerical results of the regression model above.

Having shown the general trend in wealth inequality between college- and non-college educated families, I now turn to analysing whether a relationship exists between education and the composition of household balance sheets. To do so, I construct variables of asset classes as shown in Table 1, and compute the wealth share of each asset. This allows us to obtain a first sense of salient differences in asset price exposure. Results are shown in Fig. 3. This is readapted from Figure 12 in Bartscher et al. (2019) to fit the asset classes composition shown in Table 1. It is worth noting that the results shown in this section are consistent with their main findings, i.e. that there are substantial differences in the portfolio composition of US families based on their level of education; in particular, that stocks, bonds, and other financial assets take up a much larger share in families' balance sheets if the household head holds a college degree, while the opposite is true for housing and non-financial assets. In addition, representativeness in the SCF+ dataset allows us to make the claim that such differences are not just a consequence of sampling variation.
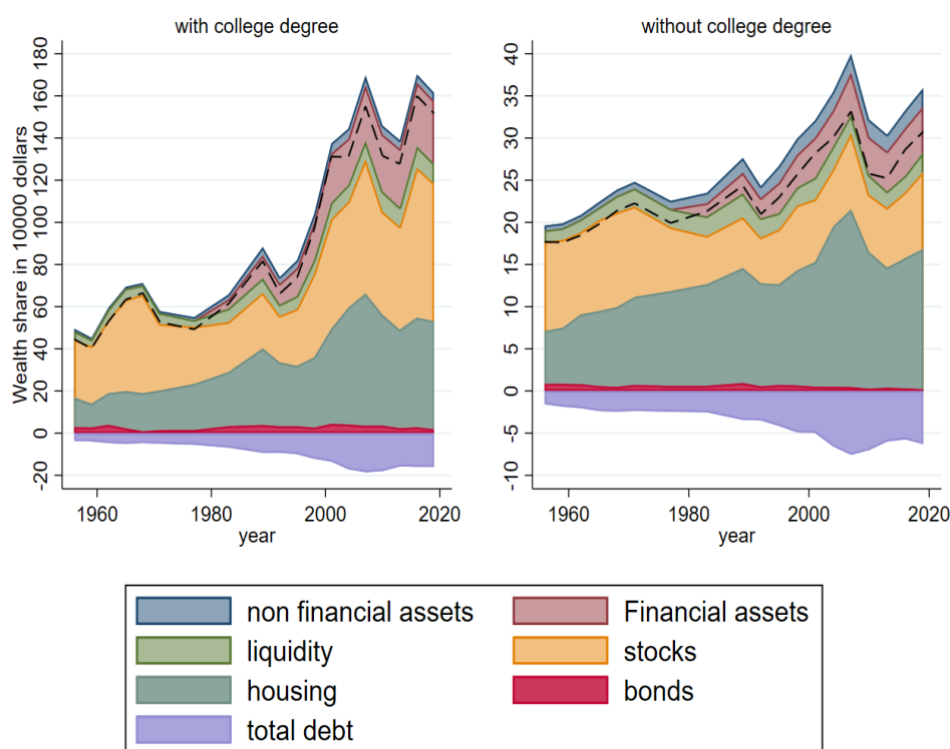
Figure 3

NOTE: The black dashed line in the panels shows total real net wealth. Indeed, we can notice that the sum of all assets minus debt almost exactly matches the black dashed line (net wealth) in both panels.

The figure shows the evolution in the composition of wealth by 'asset class' for households with a college degree (left panel) and without college degree (right panel). The most notable findings are:

1. Households with a college degree are significantly more exposed to changes in the valuation of stocks and other financial assets compared to less educated families.
2. Non-college households are, at least as a percentage of total wealth, more exposed to changes in house prices.

This is consistent with results by Domanski et al. (2016), who find that changes in house and equity prices tend to have opposite effects on wealth inequality. Fig. 4 shows the wealth share of each asset class in 2019:
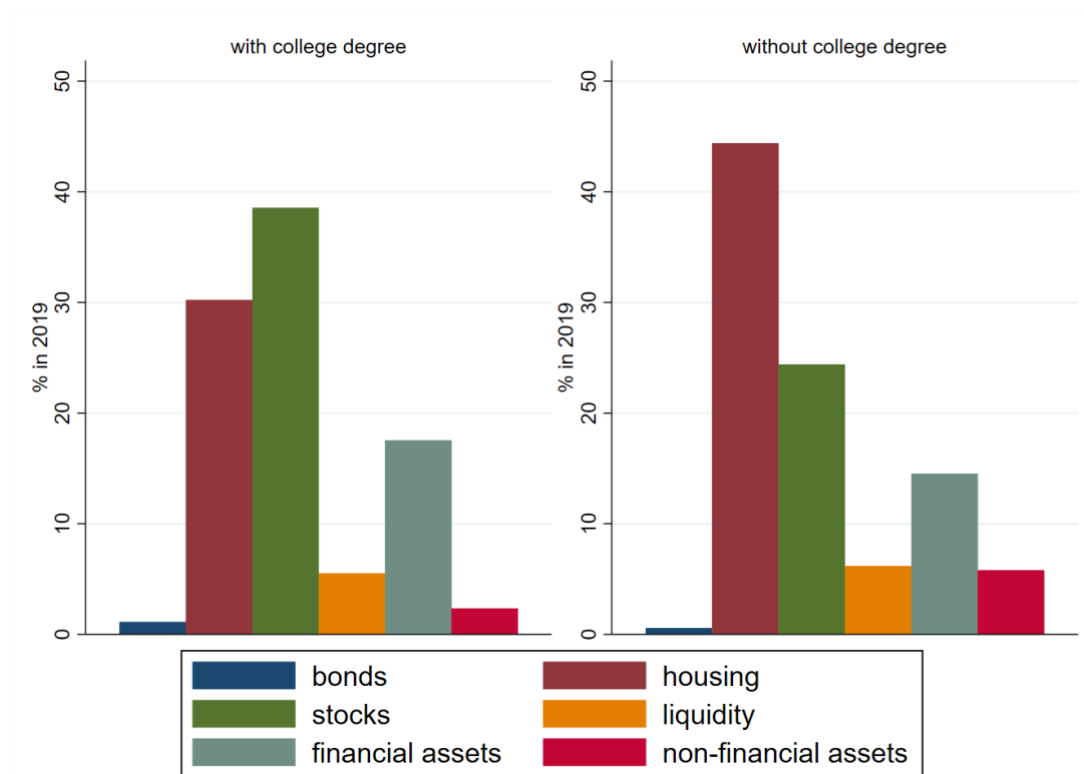
Figure 4

College-educated households save 38.56% of their wealth in stocks, and 30.22% in houses and other real estate. On the other hand, non-college households save, on average, 44.39% of their wealth in housing and 24.39% in stocks. In both groups, housing and stocks account for just short of 70% of their total wealth. Hence, movements in equity and house prices have significant portfolio effects for US households. It should be noted that this paper does not claim to measure the *causal* effect of college education on either the size or composition of families' balance sheets. For example, unobserved family traits unrelated to income might contemporaneously affect households' saving decisions as well as their attitudes towards university education; an example of such traits might be risk aversion. Nevertheless, by documenting a strong relationship in the data between educational level and portfolio choices, this work adds to an active research agenda questioning the neutrality of monetary policy.

Following Bartscher et al. (2021), I multiply a 10% increase in asset prices with the average stock of asset holdings of the respective educational group. So far I have not accounted for differences in income among households. When computing measures of asset price exposure, I distinguish between households based on their income group. In particular, the SCF+ allows us to compare capital gains for households in the bottom 50% of the income distribution, in between the 50 and 90%, and in the top 10%. The purpose of such differentiation is twofold: firstly, it investigates whether differences in asset price exposure between college and non-college households remain significant even when households belong to the same income group; secondly, it provides interesting insights into the interaction of education and income in shaping households' saving decisions. The results of this analysis are shown in Fig. 5 as well as Table 2.
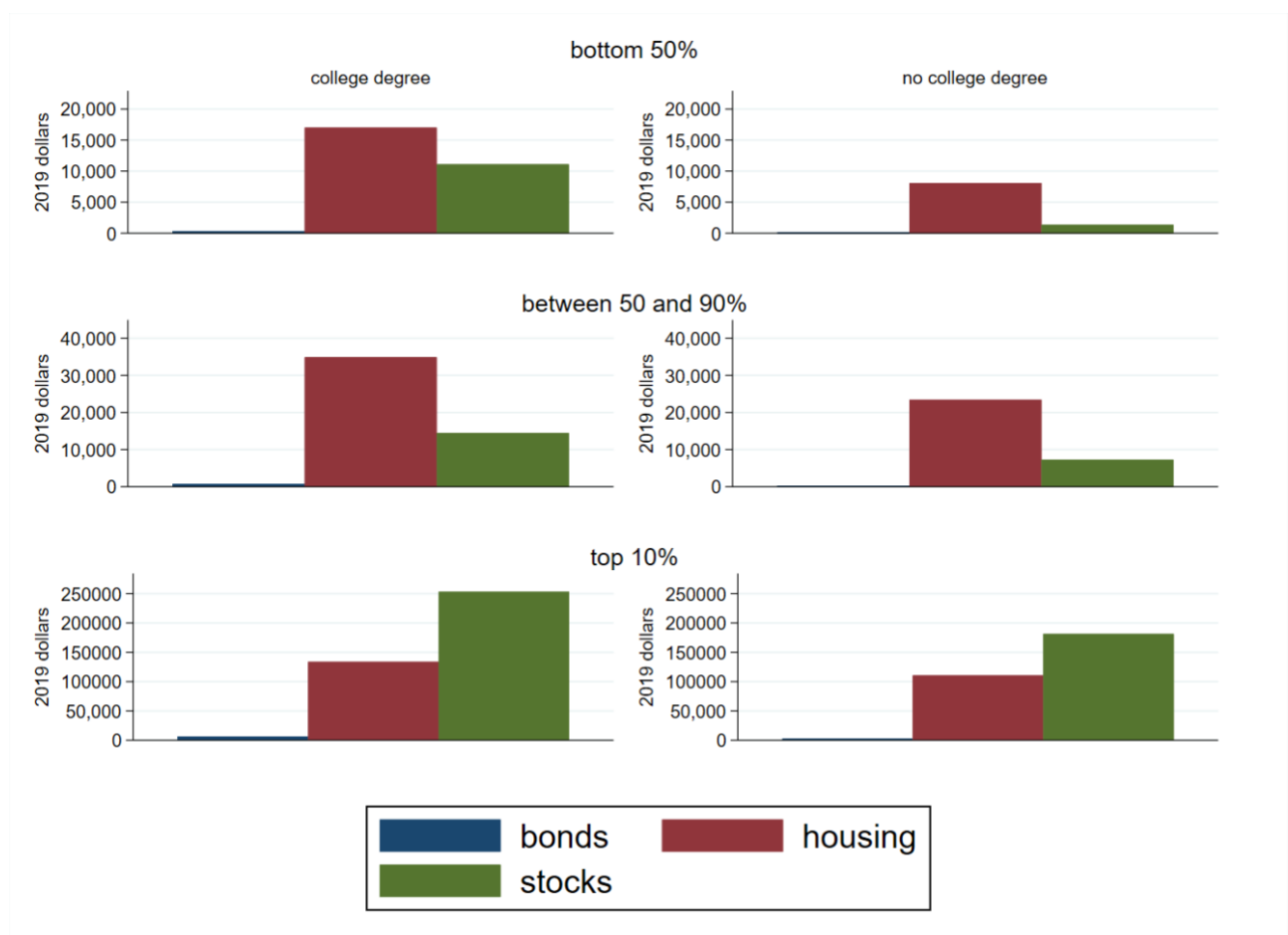
Figure 5

As shown in the figure, college education in the SCF+ remains positively correlated with exposure to asset price changes even when college and non-college households are in the same group within the income distribution; this is true across all income groups and asset classes. An interesting finding is that housing actually constitutes the main asset for both college and non-college households apart from the top 10%, which saves most of its wealth in equity. Therefore, the equity share of wealth in excess of housing shown for college households in Fig. 4 is driven entirely by the top 10%. This is consistent with findings by Kuhn et al. (2018), who uncover that stocks are an asset class primarily held by the top 10%.

Asset type	College Degree			No college degree		
	Bottom 50%	Between 50% and 90%	Top 10%	Bottom 50%	Between 50 and 90%	Top 10%
Stocks	$11101.84	$14457.24	$253294.60	$1347.287	$7295.84	$181340.80
Housing	$17023.78	$34898.17	$133766.50	$8087.49	$23415.30	$110630.50
Bonds	$345.82	$742.80	$6561.40	$43.60	$285.14	$2781.41

Table 2: Capital Gains from a 10% Asset Price Increase by Education and Income Group
NOTE: The table shows the numerical results from Fig. 9. All of the results are in 2019 US dollars.

Numerical results in Table 2 show that, averaged across all three asset classes, capital gains are 1.33 times larger for households in the top decile if they hold a degree, 1.62 times larger for households in the 50-90% range, and 3 times larger for households

at the lower end of the income distribution. It is important to highlight that such gains are computed in absolute value, i.e., not as a percentage increase in wealth.

4. Portfolio Effects of Expansionary Monetary Policy

This section investigates the movements of asset prices following an expansionary monetary policy shock. I first present the data and theoretical framework implemented, and then move on to show my findings.

4.1. Data; Macroeconomic Variables and Monetary Policy Shocks

To study how monetary policy shocks affect asset prices over a 48-month period, I use instrumental variable local projections (LP-IV) following Stock and Watson (2018) and Jordà (2005). For this purpose, I collect publicly available macroeconomic time series data as listed in Table 3.

Variable	Description	Source
Federal funds rate	Federal Funds Effective Rate	FRED
Industrial Production	Industrial production index	Mertens K. and M.O. Ravn (2013)
Unemployment rate	US unemployment rate	Mertens K. and M.O. Ravn (2013)
CPI	Consumer price index	Mertens K. and M.O. Ravn (2013)
Bond yield	Moody's BAA corporate bond yield (%)	FRED
Treasury yield	10 year treasury yield at constant maturity (%)	FRED
Stock prices	S&P composite price index	Robert J. Shiller's website
House prices	Case-Shiller house price index	Robert J. Shiller's website

Table 3: Macroeconomic Variables

NOTE: The table provides a description of the macroeconomic variables used in the local projections. It also specifies the source of each variable. All variables are at monthly frequency.

In order to identify the surprise component of variations in the federal funds rate, I use the monetary shock series developed by Romer and Romer (2004) and extended to December 2008. To generate their shock series, which is widely used in macroeconomic analysis, the authors infer the intended Federal Reserve's policy rate by examining minutes of the FOMC meetings. The intended policy rate is then regressed on the current federal funds rate and Greenbook forecast of output growth and inflation (as well as other controls); the residuals from this regression are used to measure the monetary policy shocks.

In the following analysis, I do not include the RR series as a direct measure of monetary policy shocks. This is because the series does not take into account the central bank's intended rate as inferred, for example, in speeches by FOMC members (see Stock and Watson (2018)). Therefore, while the RR variable remains correlated with the true unobserved shock, it does not capture it completely. Assuming the series is orthogonal to any other structural shock, it can be used as an instrumental variable for the actual surprise component of monetary policy. The following subsection includes greater details on the theoretical assumptions behind the LP-IV approach used in this article.

4.2. Methodology; Local Projections with IV Identification

The instrumental variable local projections method (LP-IV) allows to obtain impulse responses of macroeconomic variables over time following a monetary policy shock. Let r_t denote the federal funds rate at time t, and let y_{t+h} denote the outcome variable at time t + h. The model is implemented by estimating regression equation 4.2.1.

$$y_{t+h} = \alpha_h + \beta_h \hat{r}_t + \gamma_t' X_t + u_{t+h} \quad \text{for} \quad h = 0, ..., H - 1. \tag{4.2.1}$$

where $H - 1$ is the maximum horizon of the local projections (in this case 48 months). Note that $\hat{r}_t$ are predicted values of the federal funds rate from the first-stage regression:

$$r_t = a + \delta RRshock_t + \eta' X_t + \epsilon_{-r,t}. \tag{4.2.2}$$

The vector of controls X_t includes two lags of the outcome and shock variable.[2] It also includes contemporaneous values and two lags of the other endogenous variables and predetermined variables such as unemployment rate, industrial production index, CPI, and asset prices. As explained in Jordà et al. (2020), the inclusion of contemporaneous variables provides insurance against variation in the policy intervention known to agents at the time of the policy treatment.

The model relies on standard relevance and exogeneity assumptions for instrumental variable estimation. Let $\epsilon_{r,t}$ denote the actual monetary shock at time t; also let $\epsilon_{-r,t}$ denote any other structural shocks. Following Stock and Watson (2018), the assumptions can then be written as:

$$(i) \ Relevance: \quad E[RRshock_t \cdot \epsilon_{r,t}] \neq 0.$$
$$(ii) \ Contemporaneous \ exogeneity: \quad E[RRshock_t \cdot \epsilon_{-r,t}] = 0.$$
$$(iii) \ Lead\text{-}lag \ exogeneity: \quad E[RRshock_t \cdot \epsilon_{t+j}] = 0 \quad for \quad j \neq 0.$$

Note that condition (iii), which is usually not included in standard IV models, arises because of the dynamics. In particular, the RR shock at time t must identify the shock $\epsilon_{r,t}$ alone. Hence, it must be uncorrelated with all other shocks at all leads and lags. It is worth noting that the instrument can be serially correlated yet still satisfy requirement (iii). To see why this is the case, suppose the following model holds:

$$RRshock_t = \theta\epsilon_{r,t} + \zeta_t. \tag{4.2.3}$$

where ζ_t is a serially correlated error term which is statistically independent of the sequence of serially uncorrelated structural shocks $\{\epsilon_t\}$: then, the instrument is auto-correlated but does satisfy the lead-lad exogeneity condition. Assuming the Greenbook forecast of future GDP growth and inflation contains all information used by the Federal Reserve to make its policy decisions, then if the Fed responds to a shock for reasons other than its effect on future output or inflation, this response (captured by the RR series) will satisfy the above conditions and can therefore be used as an instrument for monetary shocks .

Before turning to the empirical results, it is important to specify that the errors u_{t+h} are usually auto-correlated for $h > 1$. Therefore, I use heteroskedasticity- and autocorrelation-robust (HAC) standard errors in order to construct confidence intervals.

4.3. Results; Impulse Responses Following a Monetary Shock

Having obtained measures of asset price exposure by college education (see Section 3), I now study movements in stock and house prices over the 48 months following a 100bp expansionary monetary policy shock. Fig. 6 presents my estimates using the Romer and Romer shock series. More detailed results including confidence intervals are provided in Table 4

---

[2] The choice of 2 lags is optimal according to both Schwarz's Bayesian information criterion (SBIC), and the Hannan and Quinn information criterion (HQIC). Moreover, the final prediction error (FPE) and Akaike's information criterion (AIC) also recommend 2 lags for stock prices, whose impulse responses are the most sensible to the number of lags.
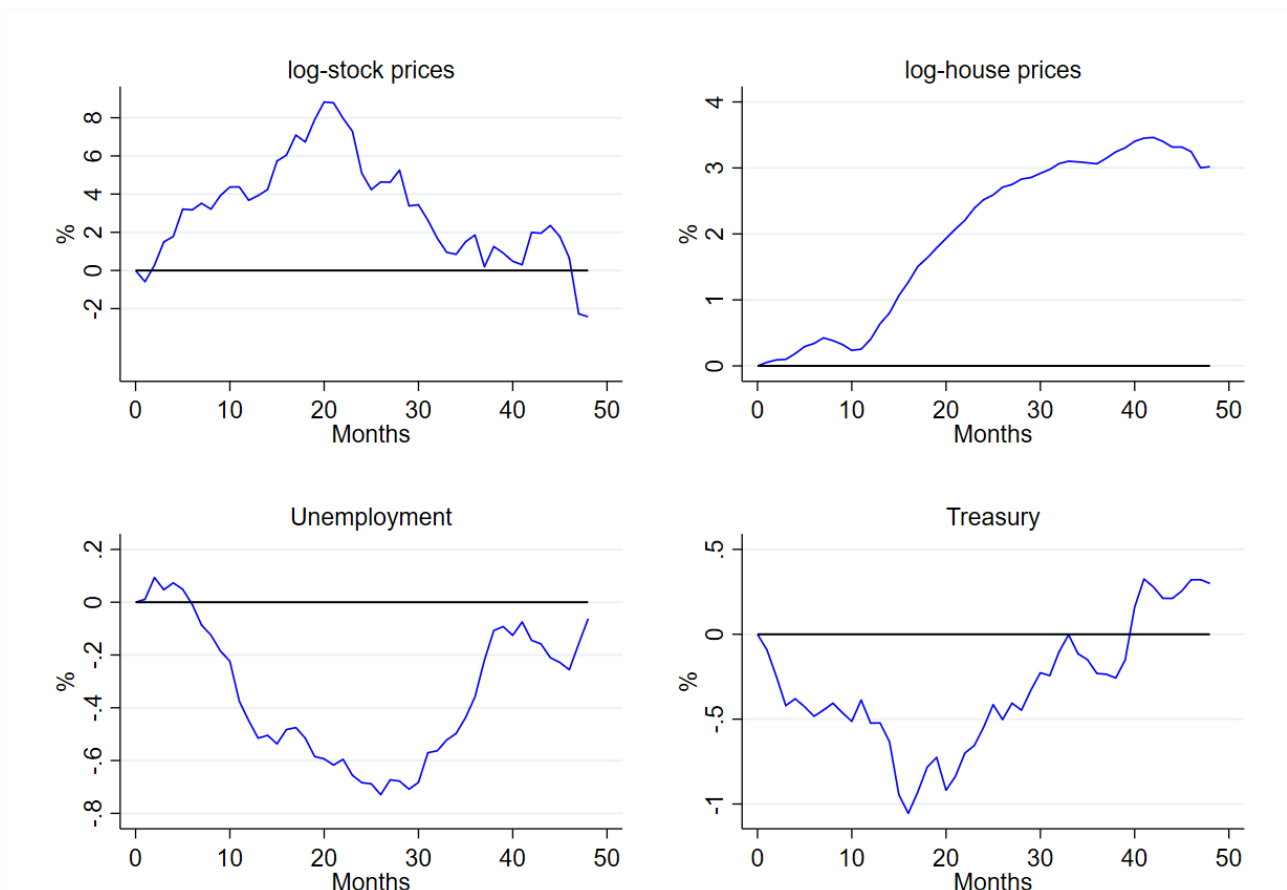
Figure 6

We can see that, consistently with findings by Bartscher et al. (2021), the increase in stock prices is the most prominent. My estimates show an increase in stock prices equal to 6.64% after only two years from the shock (such effect is statistically significant at the 5% level); it then reduces to 0.6% in the fourth year. It should be noted that Bartscher et al. (2021) find a roughly monotone increase in stock prices along a 5 year horizon. This is due to differences in the model specification (e.g. choice of lags) and the fact that they rely on a longer sample period. My results are in fact based on monthly data from March 1969 to December 2005 (Bartscher et al. use an extension of the Romer and Romer series and go up to 2015). Indeed, a recent paper by Paul (2020) finds that monetary policy today has more persistent effects on asset prices than before the global financial crisis.[3] As mentioned before, the last official extension of the series goes up to 2008. However, I decided not to include the years of the financial crisis in order to avoid potentially significant effects of confounding shocks to the macroeconomy. Appendix A.4 shows that reworking the empirics with the full sample (up to 2008) does not cause fundamental changes to the results. To provide further support for the empirical soundness of the estimates shown here, Appendix A.5 compares my results with those of Ramey's chapter for the Handbook of Macroeconomics (see Ramey (2016)). Ramey's results are obtained using the original Romer and Romer shock series (up to December 1996), and look remarkably similar to my own estimate.

---

[3] I decided not to use any extension of the Romer and Romer shocks. The series generally stops in 2008, given that this is when the zero lower bound on interest rates was reached. Following private communication with Professor Oliver Coibion, I preferred to limit my analysis to a slightly shorter time horizon rather than re-estimating the Romer and Romer shocks in an environment of bounded-below interest rates.

Horizon	House prices %	Stock prices %	Unemployment rate pp	Treasury yield pp
Year 1	0.237	2.493	-0.091	-0.368
	[-0.236, 0.711]	[-1.871, 6.858]	[-0.293, 0.112]	[-0.711, 0.008]
Year 2	1.652**	6.64**	-0.563	-0.770
	[0.321, 2.983]	[0.418, 12.854]	[-0.969, -0.158]	[-1.428, -0.114]
Year 3	2.919***	2.920	-0.592	-0.264
	[1.158, 4.680]	[-3.135, 8.977]	[-0.976, -0.209]	[-0.809, 0.281]
Year 4	3.276***	0.596	-0.153	-0.145
	[1.266, 5.287]	[-5.240, 6.434]	[-0.546, 0.240]	[-0.537, 0.827]

Table 4: LP-IV Estimates for Response to 100bp Expansionary Monetary Policy Shock
* significant at 10%, ** significant at 5%, *** significant at 1%

NOTE: The rows for each shock series show the point estimates of the response after 1 to 4 years. Square brackets below the point estimates at each horizon show the 95-percent confidence intervals.

House prices are initially sticky, which is consistent with textbook macroeconomics. They then start increasing following a bell-shaped behaviour (this is more evident when the horizon is extended to 60 months, and is similar to point estimates in Bartscher et al. (2021)). After 4 years from the shock, the increase in house prices is around 3.3%, and is strongly significant. In appendix A.6 I provide impulse responses for all the variables included in my model.

Note that the relation between bond yields and their prices could be added to the capital gains which I present in the next section. However, given that exposure to bond prices shown in Fig. 5 pales compared to capital gains from stock- and house-market booms, this paper neglects their portfolio effects. Including such bond effects is not likely to lead to significantly different results. If anything, given that bonds make up a higher percentage of wealth for college-educated households, an increase in their prices would add to the wealth inequality caused by the monetary shock.

5. Combining Macro and Micro Data: The Distributional Effect of MP Shocks

Given my estimates of asset price effects of monetary easing, it remains to combine such results with evidence from the survey data shown in Section 3.2. The objective is to compute capital gains by college education and income groups following a 100bp expansionary Romer and Romer shock. I first do so in absolute levels (i.e., showing gains in thousands of dollars), and then as a percentage increase in wealth.

5.1. Absolute Capital Gains from Monetary Shock

In order to compute capital gains, I multiply the yearly averages in asset price changes shown in Table 4 with the average holdings of housing and stocks found in 2019 in the survey data. In particular, assume the monetary shock occurs at time t. Following Kuhn et al. (2018), let $A_{j,t}^i$ denote holdings of asset j by household i in period t; in this case, j = {housing, stocks}. Let also Π_{t+h}^i denote capital gains of the individual at time t + h, where h (= 0, 1, 2, 3, 4) indicates the number of years after the shock occurred. Finally, I define the price index for asset j a time t as $P_{j,t}^i$. We can then express capital gains every year following the shock as:

$$\Pi_{t+h}^i = \left(\frac{P_{housing,t+h}}{P_{housing,t}} - 1 \right) \cdot A_{housing,t}^i + \left(\frac{P_{stocks,t+h}}{P_{stocks,t}} - 1 \right) \cdot A_{stocks,t}^i \qquad (5.1.1)$$

In this case, gains are averaged across households by college group. Moreover, as in the earlier discussion, I preserve the distinction by income group so as to highlight potential differences in capital gains along the income distribution. My results are shown in Fig. 7. Capital gains are larger for households with a college degree every year following the shock. Importantly, this is true across all income groups.
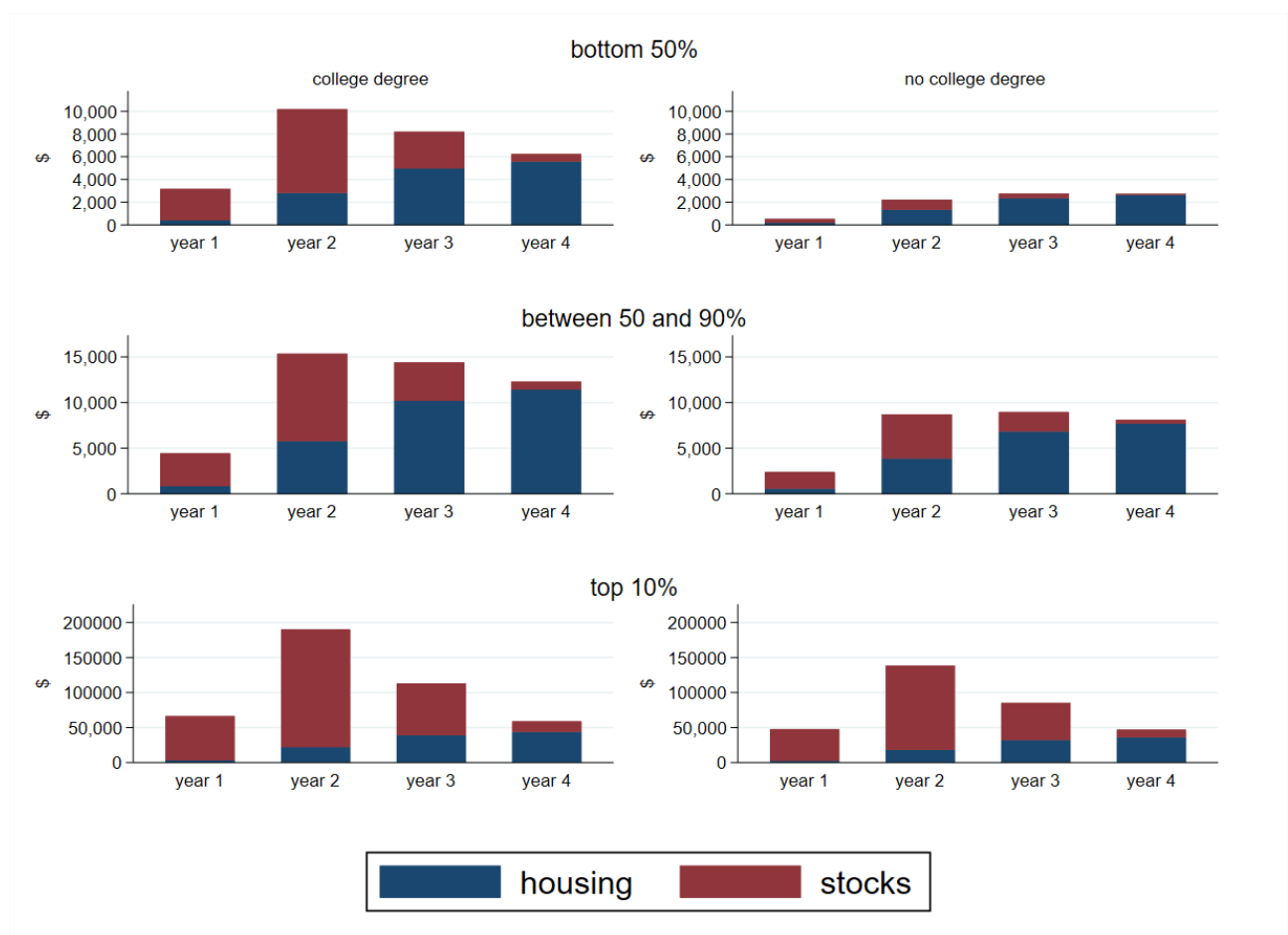
Figure 7

The largest effect in the first two years from the shock comes from significant changes in equity prices. Because the increase in house prices is more persistent, the 'housing effect' dominates the 'equity effect' in the third and fourth year. Consistently, Fig. 7 shows that households with a college degree benefit particularly in the second year following the shock, with capital gains approaching $10,000, $15,000, and roughly $180,000 respectively for households in the bottom 50%, between 50 and 90%, and top 10% of the income distribution. On the other hand, households without a college degree and in the bottom 90% of the distribution hold a larger share of their wealth in housing, which is reflected in capital gains being maximal in the third year. Nevertheless, the richest amongst the non-college educated also save the majority of their wealth in equity, which is reflected in capital gains being highest in the second year following the shock. In general, gains to non-college households peak at roughly $3,000, $8,000, and $140,000 along the income distribution.
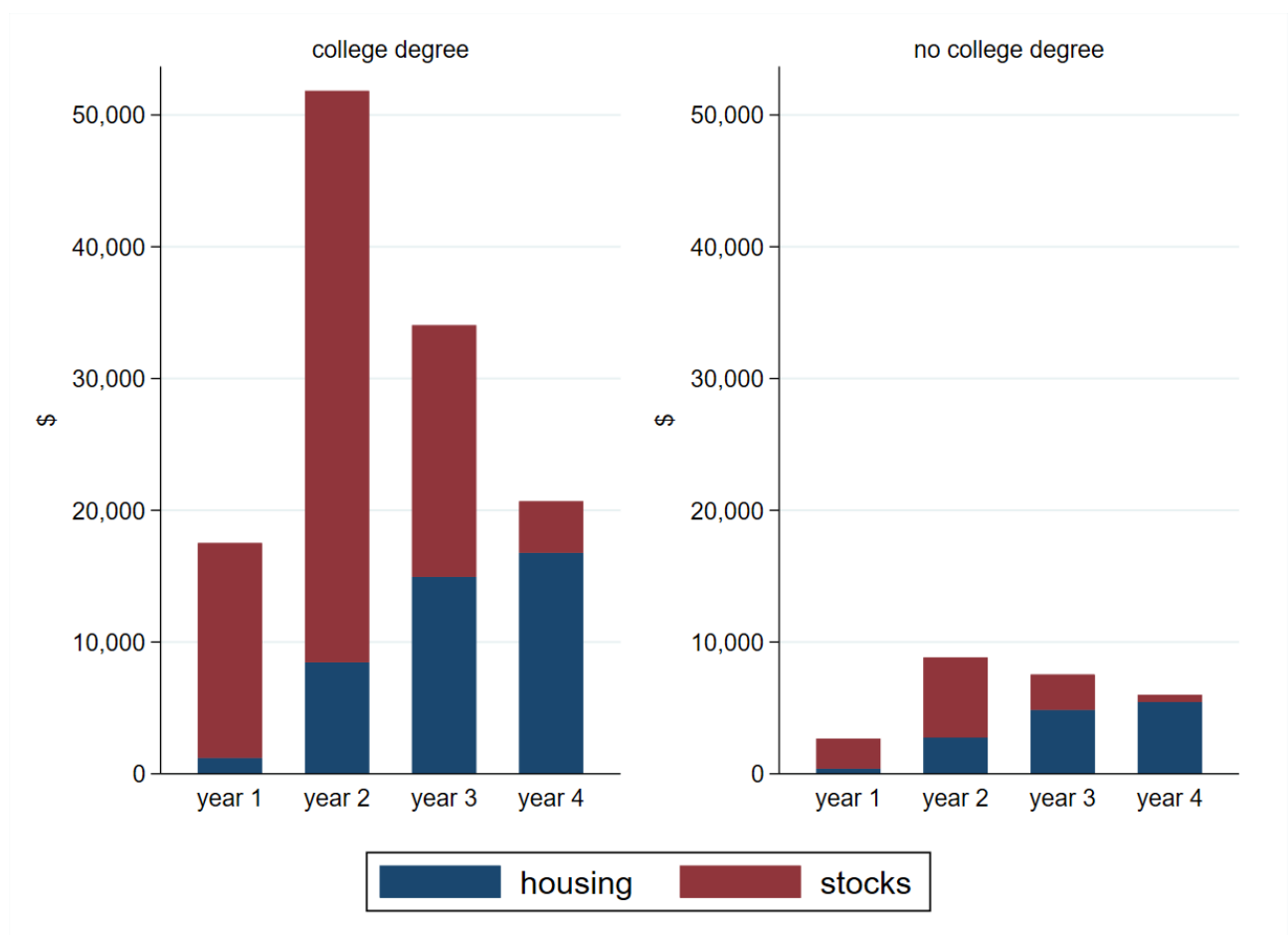
Figure 8

It follows that the college-wealth gap increases substantially following an expansionary monetary shock. It is very important to highlight that the increase in wealth inequality holds for all three income groups. Fig. 8 shows capital gains without sorting by income group. As mentioned before, results are re-weighted to account for over-sampling of wealthy households and should therefore be interpreted as gains to the average household with and without a college degree in the United States. The magnitude of the distributional effect is striking. At the peak, households with a college degree gain over $50,000, compared to less than one fifth for households without a college degree.

Before drawing conclusions, in the next section I also investigate whether results look substantially different if gains are computed as a percentage change in total wealth rather than in dollars.

5.2. Capital Gains as a Percentage Increase in Wealth

The claim that wealth inequality has increased following monetary expansion depends on how inequality itself is measured. So far, I have been thinking about wealth inequality between college and non-college households as simply the gap (in dollars) between the average wealth of the two groups. An expansionary monetary shock widens such a gap since households with a college degree reap greater capital gains from the resulting house- and stock-market expansions.

However, since non-college households hold a larger share of their wealth in housing, we might expect capital gains to be larger than for college households after the second year from the shock (since house prices continue to increase while stock prices increase only temporarily). This is at odds with results shown in Fig. 7. The reason is that while college-educated families save a lower share of their capital in housing, such share still constitutes a higher dollar figure than for non-college households. Consequently, absolute capital gains remain larger for households with a college degree.

It is interesting to check whether wealth gains are more equally distributed if measured as a percentage increase in existing wealth. In order to do so, I simply divide the capital gains shown in Fig. 7 by pre-shock wealth.

More formally, let W_t^i denote household wealth at time t (i.e., at the time of the shock). The percentage change in wealth at time t + h is given by:

$$\frac{\Pi_{t+h}^i}{W_t^i} = \left(\frac{P_{housing,t+h}}{P_{housing,t}} - 1 \right) \cdot \frac{A_{housing,t}^i}{W_t^i} + \left(\frac{P_{stocks,t+h}}{P_{stocks,t}} - 1 \right) \cdot \frac{A_{stocks,t}^i}{W_t^i}$$

$$\rightarrow q_{t+h}^i = \left(\frac{P_{housing,t+h}}{P_{housing,t}} - 1 \right) \cdot \alpha_{housing,t}^i + \left(\frac{P_{stocks,t+h}}{P_{stocks,t}} - 1 \right) \cdot \alpha_{stocks,t}^i \qquad (5.2.1)$$

Where q_{t+h}^i denotes the growth rate of household wealth from capital gains and $\alpha_{j,t}^i$ denotes the portfolio share of asset j. As in the previous subsection, results are shown for the average household by college education and income group.

Fig. 9 shows percent changes in wealth over time. As expected, the figure tells a very different story from the findings shown in Section 5.1. Indeed, monetary easing seems more or less neutral, with college-households gaining slightly more in years immediately following the shock – due to the rapid uptake in stock prices – and non-college households experiencing larger percentage gains in the last two years thanks to the persistent increase in house prices.
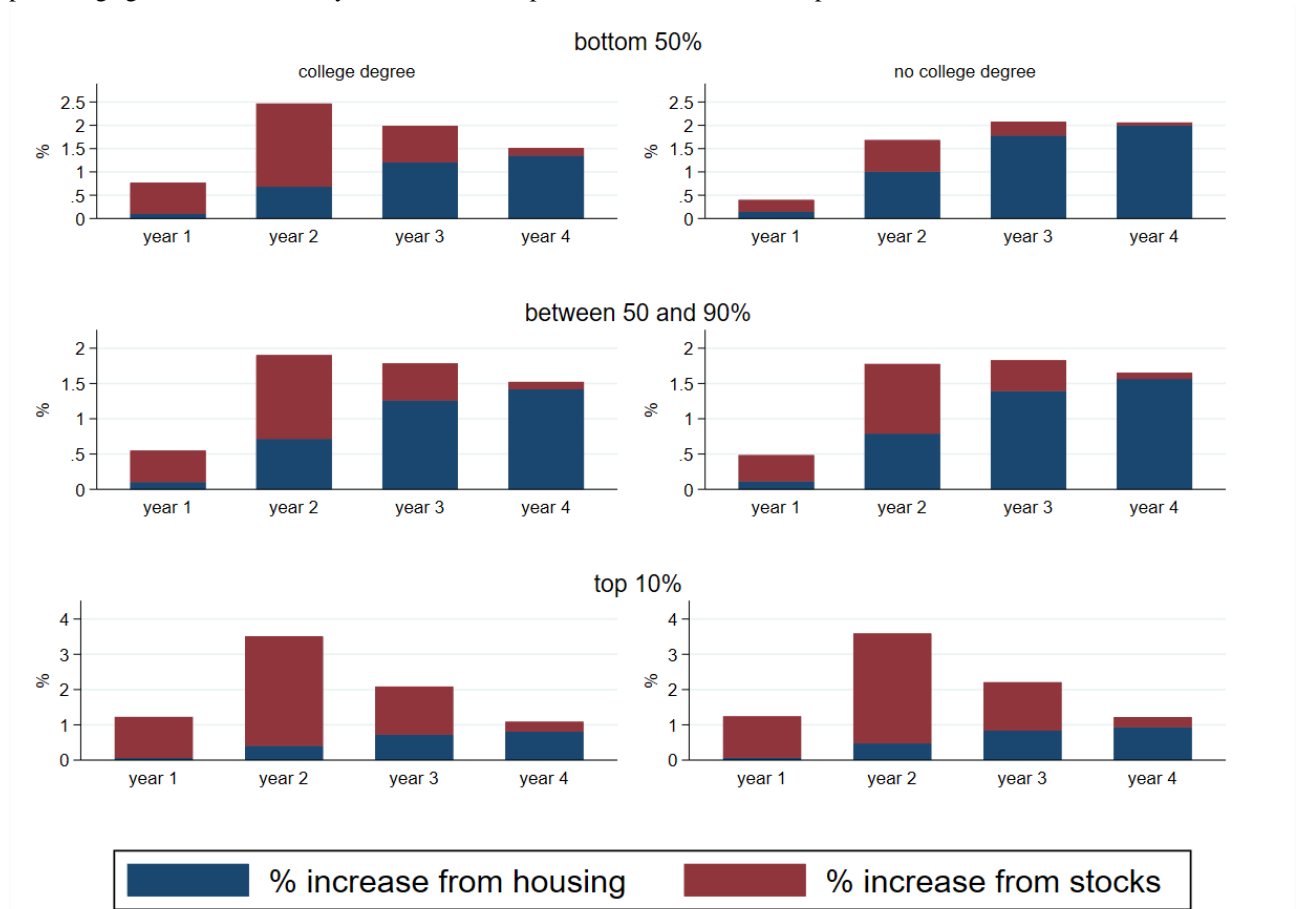
Figure 9

Moreover, households in the bottom 50% of the income distribution attain a larger percent increase in wealth than households in the 50-90% group. This is true for both college and non-college households. Nevertheless, households in the top 10% continue to take up the largest percentage gain in the short run. Note that this is consistent with simulations by Albert and Gòmez-Fernàndez (2018), whom I mentioned earlier in Section 2.1.
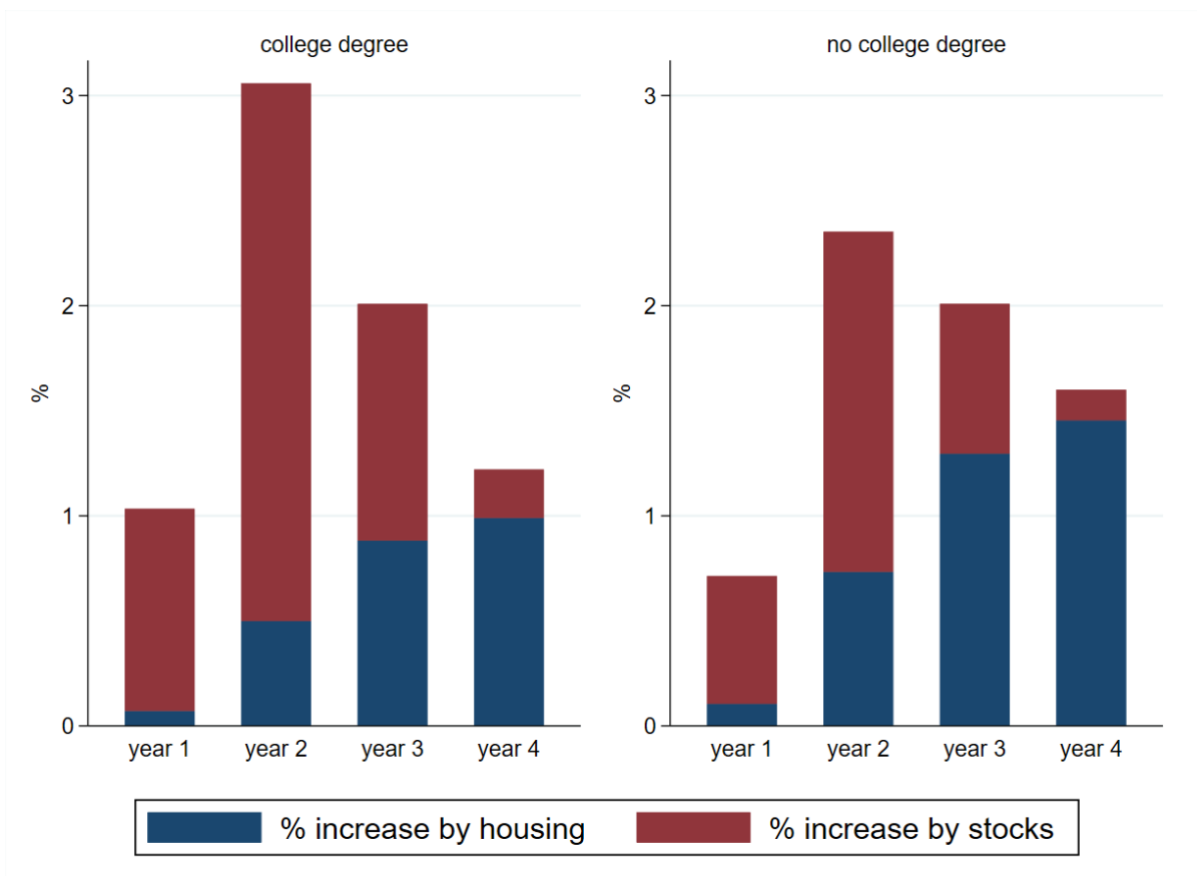
Figure 10

Fig. 10 shows the same result for the average household in the two educational groups. Despite the results in this subsection, it should be noted that, given how unequal the initial distribution of wealth between college and non-college households is (see Fig. 5), absolute capital gains are probably more relevant to inequality than per cent ones.

6. Conclusion

In this paper, I start by using survey data in order to highlight how households with and without a college degree in the United States diversify their portfolio across a range of asset classes. The key result from this analysis is that college-educated households are significantly more exposed to absolute capital gains following stock- and house-market booms compared to less educated families. I move on to analysing the movements in asset prices following a 100bp expansionary monetary policy shock. For this purpose, I compute local projections of asset prices using the Romer and Romer (2004) shock series as an instrumental variable for exogenous shocks to the federal funds rate. To complete the empirical analysis, I combine the point estimates from the LP-IV model with evidence from the survey data; this allows me to measure capital gains over time following a monetary easing shock. My results show that capital gains are unevenly distributed, as households with a college degree benefit disproportionately from the shock. However, this appears much less evident when gains are computed as percentage changes in existing wealth.

In light of the aforementioned results, I argue that monetary policy alone lacks the tools to stimulate economic activity without exacerbating wealth inequalities by college education. When these findings (specific to one dimension of inequality) are coupled with the rapidly growing literature highlighting potential adverse distributional consequences of monetary policy, a more general conclusion may be drawn, i.e., that monetary policy is limited in its ability to respond to economic shocks without creating winners and losers.

Acknowledgements

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Article

How Online Reviews Affect Consumer's Quality Belief: Ex-Ante and Ex-Post Preference of Consumption Decision

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Abstract
Although many studies investigate the impact of online reviews on sales, much fewer investigate consumer satisfaction following the purchasing decision. I hypothesised that online reviews would have an impact on both sales and product returns. I developed an analytical model that demonstrates how risk-neutral reference-dependent consumers form a pre-consumption quality belief and a post-consumption consumption utility. I empirically tested the hypothesis using a cross-sectional data set collected from Taobao.com. By controlling for the effect of product type, and adding monetary incentives (in return for leaving positive reviews) as the instrumental variable for positive review rates, I ran 2SLS regressions of sales and returns on reviews. The result supports the proposition that the positive review rate is positively associated with both returns and sales, while the negative review rate is negatively associated with both returns and sales. Consumers tend to overestimate true product quality with positive reviews, while negative reviews tend to be more informative about the true quality of products. This is because sellers generally manipulate positive reviews and ratings to attract potential buyers. The result suggests that consumers could discount their quality beliefs before making the purchasing decision. This would increase the reference-dependent consumption utility and reduce the transportation cost of returning products, achieving a more efficient allocation of resources.

Keywords: Online reviews, Purchasing Decision, Returning Decision

1. Introduction

With an accelerating rate of technological development and a general improvement in living standards, an increasing number of people discovered the convenience, diversity, and selectivity of online shopping. The outbreak of the global pandemic and the lockdown policy further induced the need for online shopping services. The increasing number of e-commerce sales worldwide (Fig. 1) stresses the significant role played by online markets.
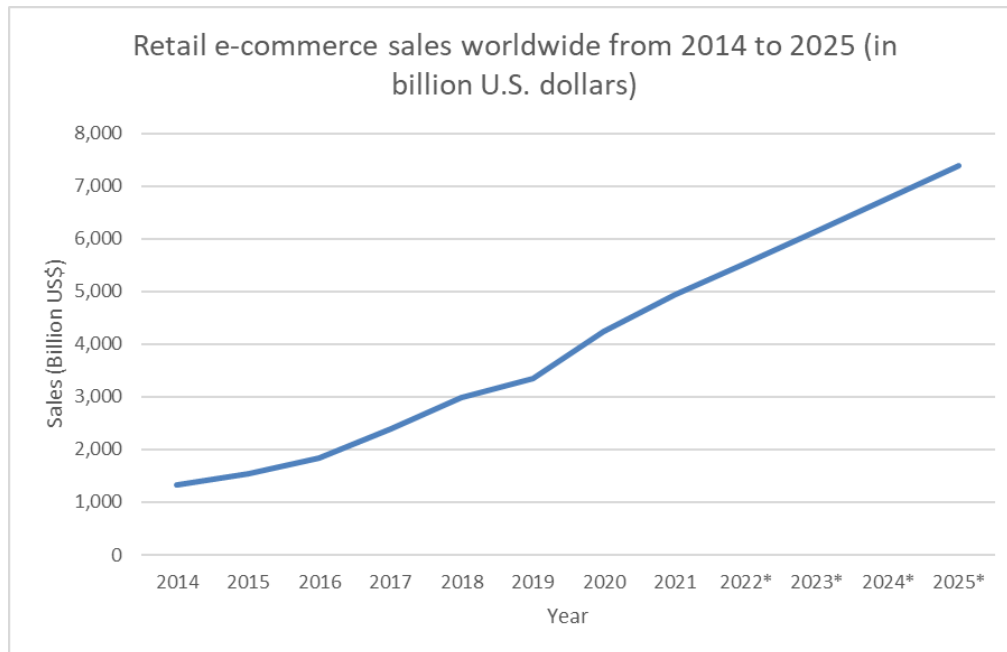
Figure 1: Retail e-commerce sales worldwide from 2014 to 2025 (*Source: Statista*)

Similar to other markets, individuals that are involved in the online market need to behave strategically. According to the theory of information transmission, asymmetric information is the obstacle for a competitive market to achieve efficient information exchange (Hayek, 1945).

When there exist conflicts of interest, people would be motivated to lie about messages the other party cannot access for higher profits. This could be demonstrated by the interaction between buyers and sellers. For instance, firms could choose the level of quality information to disclose when it comes to products that consumers cannot precisely evaluate actual quality. Zhao et. al. (2020) found that firms tend to disclose high-quality products and conceal low-quality products when facing strategic consumers. Inefficient allocation of resources is further exaggerated since online buyers cannot scrutinise the quality of online products.

However, when the interests of the two parties are aligned, the problem of asymmetric information can be alleviated. With low costs, informal talk and self-signalling constitute a major part of information sharing (Farrell and Rabin, 1996; Spence, 1974; Hurwicz, 1973). For example, since there is no conflict between buyers and former buyers, cheap talk via product ratings and reviews could improve the accuracy of information transmission. The existence of the third party restricts the seller's power of manipulating information about product quality to alter consumers' purchasing decisions. However, sellers also acknowledge the importance of comments from the third party. Therefore, they may pay people to write positive reviews and give higher ratings of the product. Moreover, many online shopping firms have shifted from online shopping to mobile shopping on apps. Some of the product information is concealed due to the reduced screen size, enabling sellers to adjust the layouts and guide consumers to buy their products.

Overall, it would be important to investigate the behaviour of online buyers in response to various information that is true or fake, to achieve a more efficient allocation of resources.

Most of the studies investigated the effect of product reviews on sales, such as valence (Li & Hitt, 2008), volume (Chintagunta

et al, 2010), and pathos of the reviews (Ren & Nickerson, 2016). Others are trying to find how individual-specific characteristics presented in reviews affect sales (Yin, 2020; Forman et al, 2008). However, only a few papers discuss the actual consumption utility after purchasing, namely, how reviews affect return rates. To fill the research gap, this paper investigates how revealed information such as online reviews, ratings, and selling amounts affect consumers' ex-ante quality beliefs and ex-post satisfaction to check whether consumers' quality beliefs based on reviews are biased.

This paper analyses information presented on e-commerce websites such as reviews, ratings, returns, and product types. However, due to the limitations of data collection, the analysis does not include information related to individual customers such as age, gender, wealth, or literacy level.

I analysed ex-ante consumer expectation and ex-post consumption satisfaction with cross-sectional data. To check how positive and negative review rates are associated with sales and returns, I ran 2-stage least square regressions with fixed effect of product types. The regression results show that the positive review rate is positively associated with sales and the negative review rate is negatively associated with sales. Similarly, the positive review rate is positively associated with returns and the negative review rate is negatively associated with returns. The outcome suggests that consumers form upward biased quality beliefs based on positive reviews, while the accuracy of negative reviews is relatively higher. Therefore, negative reviews could be more helpful when making purchasing decisions while positive reviews may give biased beliefs. To avoid overestimating actual quality, consumers could discount their expectations after forming quality beliefs. This would not only improve the reference-dependent consumption utility but also reduce the transportation cost of returning products. Thus, achieving an increase in both consumption utility and total welfare.

The paper proceeds as follows: Section 2 is a review of related literature. Section 3 outlines the theoretical framework in two parts. Firstly, describing the model of reference-dependent utility about how consumers form quality beliefs and how consumption utility is affected by consumer expectations and resulting propositions that I would like to prove in this paper. Secondly, giving a conceptual framework for constructing the dependent, independent, and control variables for the regression analysis. Section 4 is the summary of the data collected. Section 5 describes the modelling and results. Section 6 discusses the results and elaborates on causal relationships with behavioural factors. The conclusion in section 7 presents key findings and implications of the result.

2. Literature Review

We will initially approach this topic by looking at how consumers form quality beliefs.
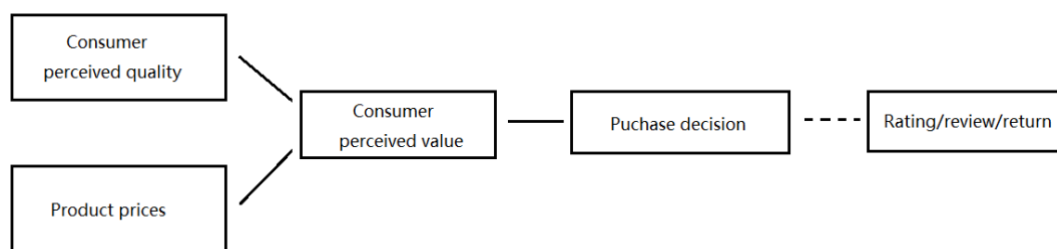
Figure 2: Customer valuation theory

According to the customer valuation theory (Fig. 2) (Zeithaml et al., 1996), consumers' perceived value is formed based on consumers' perceived quality and product prices. Since the perceived quality cannot be measured, consumers' purchasing decisions could act as a signal about consumers' perceived value. If consumers believe the product is worth buying given the prices, they would buy the product.

Price is the most important source of signals that are sent by sellers to reflect product quality. One of the areas of study is the price searching behaviour of online consumers with the impact of search costs, discounts, or attention. Moreover, other studies investigated consumers' valuation of the products (Jung et al., 2014), the effect of prices on shopping intentions (Wu et al., 2013), price sensitivity (Garrow et al., 2008), and price changes on consumer behaviour (Chatterjee, 2011; Weisstein et al., 2013). Moreover, due to differences in price elasticities of demand, price changes may result in different responses in sales.

Furthermore, consumers tend to consider prices with other related factors. For expensive products, consumers prefer to buy from sellers with a large number of mixed reviews (positive, negative, and neutral) instead of buying from sellers with a small number but homogeneous positive reviews. While for low-priced products, consumers may be indifferent between the number of reviews and the configuration of reviews (Chou et al., 2013). Considering price as a source of losses, a lower price is associated with lower risks; while a high price means higher risks, thus a large number of former buyers may share the risk taken by the individual. Risk aversion is closely related to loss aversion when making buying decisions. Frey et al. (2017) proposed that revealed preference is one of the most used measurements of risk aversion. However, the empirical evidence is mixed. Moreover, there arises some criticism and scepticism about those measurements (Friedman et al., 2014; Beshears et al., 2008). Due to the validity of measurement results and the continuous changing of the propensity of each individual, real-world financial institutions seldom incorporate revealed preferences for analysis (Friedman et al., 2014). In this paper, I would like to assume all customers are risk-neutral and are indifferent between high-risk and low-risk products.

Consumer perceived quality is relevant to additional information such as ratings and reviews. Consumers' preferences may change according to different information received.

Many people post their ratings toward certain online products after consumption (Godes and Silva, 2012). Some e-commerce platforms exhibit histograms or pie charts to demonstrate the distribution of ratings; others may give an average rating of the product. Consumers could easily get cues regarding product quality from those statistics. Researchers explored the relationship between rating statistics and consumers' purchasing decisions (Chatterjee, 2001), and the result demonstrates a strong relationship between ratings and purchasing amount. Marketers, same as buyers, also acknowledge how influential the ratings and reputations are, paying someone to give high ratings in order to raise average ratings to attract more customers (Ludwig et al. 2013). Therefore, online reviews that affect consumers' perception would be needed to give more reliable information about actual product quality. Other than a simple number, online reviews that involve pictures, comments, and pathos are relatively more persuasive. Moreover, an online review forum could act as a trust-building device for online shopping since most of the members are former buyers. Kee (2008) suggested that about 70% of consumers read at least 4 product reviews before making a purchasing decision. The reliability of reviews, however, would depend on the incentive for former buyers to give comments about those products. The motivation of reciprocity or retribution that is purely due to consumption could give more reliable comments. Conversely, if former buyers receive a request with gifts from sellers to give positive reviews, the reliability may be impaired.

This paper, therefore, focuses on the relationship between online reviews and consumers' quality beliefs. Literature mainly falls into two categories: investigation of product reviews and the investigation of product returns. Starting from 2006, most of the studies devoted attention to the study of online product reviews and sales, while only a small number of studies explore the number of returns that may reflect consumer satisfaction.

Research generally corroborates the proposition that online reviews could influence consumers' buying decisions, therefore affecting the number of sales (Shen et al., 2016). For example, Clemons et al. (2006) and Duan et al. (2008) checked how ratings and reviews affect sales. Both of the studies found that positive reviews and the volume of reviews significantly improve sales on e-commerce platforms. A large part of the studies analysed different characteristics of reviews such as text length (Chevalier and Mayzlin, 2006), textual content (Archak et al, 2011), top reviews / expert reviews / peer reviews, recentness, and helpfulness (Huang et al, 2017; Jia and Liu, 2018). Findings corroborate the idea that consumers read review text in addition to summary statistics and ratings, therefore, textual content would affect sales as well as consumer preferences. Archak et al. (2011) used text mining to decompose reviews into segments describing different product features. Positive reviews and highly useful reviews have more adoption rates and improve consumers' attitudes towards the product and intentions to purchase the product.

Other studies look more deeply into the impact of consumers' characteristics and attitudes. For example, Forman et al. (2008) investigate how individual characteristics affect purchasing decisions, the result shows that identity-relevant information shapes community members' judgement of products and reviews. Therefore, consumers may address reviews or products that they are familiar with. Moreover, Branco et al. (2012) found that customers may incur search costs to learn further product information and update their expected utility of the product from time to time. The study incorporates search costs into investigating the likelihood of purchase changes with the ex-ante utility. Ren & Nickerson (2018) investigate the arousal level of reviews. Due to variances in arousal level, some studies may find online review valence is more influential, while others may find that online review volume could have more impact on sales. Similarly, Yin et al. (2020) studies anger expression. The study contradicts the view that more helpful online reviews exert a greater impact on consumer attitudes and purchase decisions. Their findings

suggest that anger expressions may decrease customers' perception of the helpfulness of the review, the actual purchasing decision shows that anger expressions eventually are more persuasive and negatively influence customers' expectations toward products. However, Li et al. (2019) ran the regression with an interaction term of ratings and texts, finding that numerical ratings may mediate the effects of textual sentiments.

Meanwhile, some studies investigated product returns. Rather than trust online reviews, some consumers trust sellers' return policies more when making purchasing decisions. Firstly, we need to understand the formation of return rates. Hess and Mayhew (1997) show that return rates vary across product categories with some having return rates as high as 25% (e.g., shoes) and others having virtually no returns (e.g. socks). Moreover, the return rate becomes higher in online shops due to the convenience of returning products. Sahoo et al. (2018) managed to investigate the relationship between product reviews and product returns for offline shops and online shops. The result shows that unbiased online reviews help consumers make better purchase decisions, leading to lower product returns, while biased reviews that are recommended by sellers positively affect return rates.

With the development of e-commerce platforms, sellers pay more attention to modifying their review forums and concealing most of the return rates. Despite the research interest in online reviews and product returns, studies are generally unaware of the investigation into how online reviews affect both expectation formation (purchasing decision) and actual consumption utility (returning decision) for online products. This is a significant gap in the literature. Online reviews are significant sources of information when making purchasing decisions, meanwhile, the return rate is a vital indicator of consumption utility. By investigating the impact of online reviews on sales and corresponding returns, this paper fills this gap.

3. Theoretical Framework

3.1. A Model of Reference-Dependent Utility

Since people's perceptions, judgments, and evaluations are relativistic and adaptable, consumers are generally characterised by reference-dependent utility (Kahneman & Tversky, 1979). In the context of this paper, the reference point (r) or ex-ante expectation is the combination of consumers' perceived quality and prices according to the customer valuation theory.

$$r = E(c) = f(perceived\ quality, price)$$

Consumers would buy the product if and only if the ex-ante expectation is greater than 0. The expected utility would be affected by both the impact imposed by product reviews and consumers' propensity (Elster, 1989).

From the consumers' perspective, an important behavioural factor, limited attention, may alter consumer's perceived value of the product. Assume that an individual pays full attention to the visible component of the value but only partial attention to the opaque component (i.e. ratings). Suppose a consumer perceives the value

$$\hat{V} = v + \theta o$$

θ measures the degree of inattention: the higher θ is, the more attentive the consumer is to the opaque component. Therefore, the perceived quality in the model would then be:

$$Perceived\ Quality = v + \theta o$$

The value of the reference point would change correspondingly. I will elaborate on the effect of inattention in the discussion.

To further understand consumers' perceived quality, I will examine how online reviews, the primary source of information, are formed. In particular, what the underlying incentives for consumers to give insights from their consumption experience are. Although online reviews always appear in large numbers, research shows that not all consumers tend to provide reviews of products, thus resulting in biases in the evaluation of the quality of the product. Both intrinsic and extrinsic motivation could trigger the consumer to write reviews. Intrinsic motivation means that people are doing activities simply for the enjoyment of the activity itself, while extrinsic motivation is defined as doing something for a separable outcome (Ryan & Deci, 2000). Given these motivations, reference dependent utility would be one of the explanations for the appearance of positive and negative

reviews.

Prospect Theory (Kahneman & Tversky, 1979) requires people to consider reference points in addition to consumption while Kőszegi and Rabin (2006, 2007, 2009) re-introduced the standard consumption utility and assume utility is separable from reference-dependent utilities. By separating consumption utility and reference-dependent gain-loss utility, we can analyse consumer behaviour more precisely. Therefore, this paper modifies the model proposed by Kőszegi and Rabin to explain consumer behaviour in online buying. Individuals' reference-dependent utility is given by:

$$u(r) = m(c) + n(c|r)$$

Where *m(c)* represents the consumption utility of the products and *n(c|r)* represents the gain-loss utility. Consumption utility *m(c)* is assumed to be increasing and globally concave like standard expected utility, thus exhibiting decreasing marginal utility. The gain-loss utility is calculated as a function of the difference between consumption utility and the reference point, consumers' expected consumption utility:

$$n(c|r) = \mu[m(c) - E(c)]$$

The function μ is the gain-loss function. According to loss aversion (Kahneman & Tversky, 1984), losing something generally weighs heavier than gaining the same thing one does not own. The same situation could be applied to online shopping where people have the perception of owning something before physically receiving it. When the perceived gains are higher than actual gains, people may feel more disappointed than additional satisfaction when there are higher actual gains. Therefore, I would propose the gain-loss utility as:

$$n(c|r) = \mu(x) = \begin{cases} \eta x & if\ x > x^* \\ \lambda \eta x & if\ x < -x^* \\ 0 & if\ -x^* \leq x \leq x^* \end{cases}$$

x* represents the value of a threshold of the difference between actual utility and expected utility. When the difference is higher than the threshold x*, there would be a gain, the utility would be calculated by multiplying a coefficient η; When the difference is lower than the threshold -x*, there would be a loss, the utility would be calculated by multiplying two coefficients λ and η; when the difference is between the two thresholds, the gain-loss utility would be zero.

There are 3 possible intrinsic motives in the model, resulting in 4 possible results: writing positive reviews, negative reviews or neutral reviews, and returning products. When consumers think the actual utility gained from consumption is much higher than perceived utility (x>x*), people tend to give positive reviews or even positive reviews with pictures to praise the good quality of the products. This may be due to the incentive of reciprocity (Fehr & Gachter, 2000). In response to friendly actions, people tend to be nicer and more cooperative. Namely, since the product received exceeds consumers' expectations, people may attribute this difference to the seller, therefore are willing to help the seller by recommending the products to others. Conversely, when consumers think the actual utility gained from consumption is much lower than the perceived utility (x<x*), people tend to give negative reviews or even negative reviews with pictures to stress the poor quality of the products. This may be due to the incentive of retribution (Boehm, 1984). The negative feelings of consumption would be reflected in negative reviews so that notify others to keep away from those products. Other than posting negative reviews, consumers could choose to return the product without giving any comments. This response relates to consumer satisfaction but is seldom taken into account in studies. Therefore, this paper includes this behaviour in empirical analysis. Lastly, consumers may be indifferent between posting positive or negative comments about the products when the quality is similar to their expectation (-x* ≤ x ≤x*), therefore, they may not provide their experience. Above all, peer reciprocity could act as a main motive to provide reviews. For example, 32% of the participants in Munzel & Kunz's (2014) study indicate that they prefer giving reviews to benefit the community.

Literature proposes other behavioural factors that may affect consumers' decisions to provide product reviews. Altruism is the main factor that gives intention to consumers to write reviews (Reimer & Benkenstein, 2016). Studies show that altruism is a fundamental motive for consumers to provide product reviews and an altruistic individual may give slightly more useful reviews compared to others (Munzel & Kunz, 2014; Cheung & Lee, 2012). However, the role of altruism is still unclear when it comes to analysing the number of reviews. Therefore, this paper will not take altruism into account in the empirical analysis.

Sellers tend to provide extrinsic motives to further increase positive reviews. Although extrinsic motivations tend to crowd out intrinsic motivations (Deci et al. 1999), weak extrinsic motives such as a request from the seller to write reviews could give more positive feedbacks. For example, Munzel and Kunz (2014) found that when hotels ask visitors to provide reviews, there are an increasing number of reviews. Further, a request with a small gift could achieve a better result as Wu (2019) corroborates the reciprocal behaviour of consumers. Financial incentives are a relatively stronger motive for customers to provide reviews (Straaten, 2021). Although it is unclear how financial incentives affect the valence of reviews, Neumann & Gutt (2019) found that monetary motives could increase the volume of reviews. Adding monetary incentives (i.e., voucher) in the theoretical model gives:

$$u(r) = m(c) + n(r) + u(voucher)$$

In this way, the increase in total utility u(r) by u(voucher) would give higher possibility for consumers to write positive or neutral reviews.

Due to the loss-aversion motive in the reference-dependent utility and the underlying incentives of providing product reviews, I put forward:

Proposition 1: Negative reviews are generally less in number compared to positive reviews, but customers may rely more on negative reviews when making a purchasing decision.

- If consumers give more trust to negative reviews, higher negative review rates would give lower sales

Moreover, consumers need to engage in strategic thinking and have limited cognitive ability to precisely evaluate the quality of products. To elaborate, consumers may not be able to capture and process all information provided by the seller and the third parties. Customers may easily be attracted by particular identities, words, or emotions expressed in texts. Therefore, consumers tend to employ heuristics (i.e., specific positive reviews) to simplify the decision-making process to prevent cognitive overload. This would lead to systematic biases in the valuation process. Thus, I put forward:

Proposition 2: Consumers' expectations about the quality of the products are biased.

- If consumers form higher-quality beliefs from a positive review, positive reviews would associate with higher return rates.
- If negative reviews carry more accurate quality information, negative reviews would associate with lower return rates.

3.2. Conceptual Framework
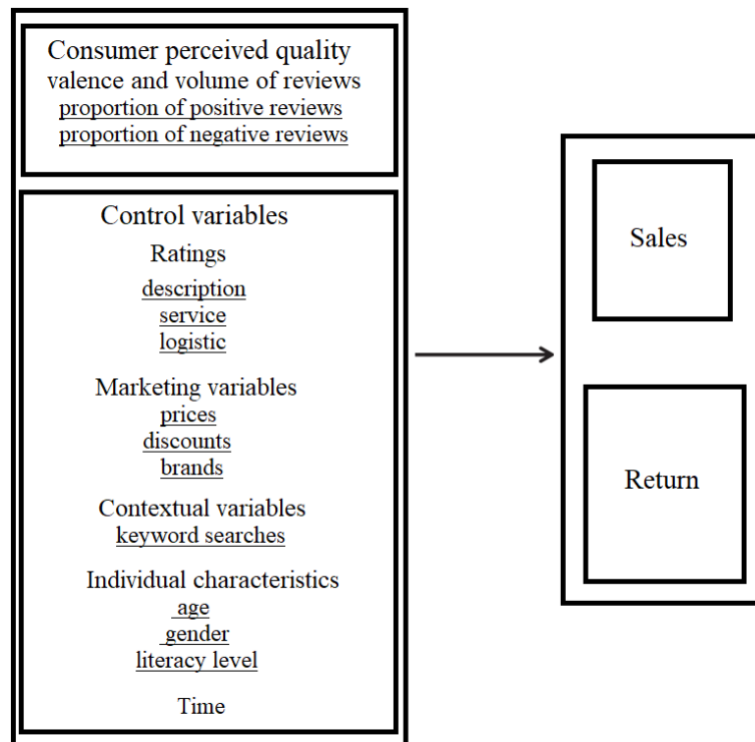
Figure 3: Conceptual framework on how reviews, ratings, product, and individual characteristics affect sales and returns

3.2.1. Dependent Variable

In accordance with the analytical model above, I propose that there are two decisions that the consumer needs to make: purchasing decision and returning decision. Purchasing decisions could be represented by the number of sales on the seller's website. However, the sale amount does not subtract the number of returns. Therefore, the actual satisfaction could be indicated by the return rates. Since sellers tend to conceal actual return rates even if the platform asks for disclosure, the return rates are generally 0% and may not be representative. There are other return statistics as well, such as the time span for returning request acceptance and the time span for receiving refunds. Moreover, sellers' willingness to return (WTR) is also included in return statistics. WTR is calculated by:

$$\frac{No.\,of\;returns\;resolved\;by\;sellers}{No.\,of\;returns\;resolved\;by\;sellers\;+\;No.\,of\;returns\;resolved\;by\;the\;platform}$$

In Taobao, the seller and the platform are two entities, the seller has the power to decide whether to accept the return request from customers. If the customer is unsatisfied with the sellers' decision on the return request and the customer's appeal is reasonable, the customer could seek help from the platform. The platform has the power to make the seller accept the return request. According to Zhao et al. (2020), sellers conceal product quality when the true quality of the product is poorer than the actual quality, thus tend to be more unwilling to accept return requests; the willingness to return (WTR), in this way, could reflect the actual quality of products. Therefore, returns would be calculated by the average of return rates, return span, refund span, and 1-WTR. There would be two regressions for ex-ante perception and ex-post satisfaction, with sales and returns as dependent variables respectively.

3.2.2. Independent Variables

Consumers need to form a quality expectation about the product. The review forum could give specific information about the product. The number of positive reviews and negative reviews could help consumers know the proportion of customers that are satisfied with the product. When considering the number of positive and negative reviews, the data may result in the problem

of reverse causality. Namely, the number of positive reviews affects sales, but the number of sales affects the number of positive reviews as well. In order to minimise the effect of reverse causality, I calculated the proportion of positive and negative reviews among all reviews as the independent variable – positive review rates and negative review rates.

$$positive/negative\ review\ rates = \frac{number\ of\ positive/negative\ reviews}{total\ number\ of\ reviews}$$

Since sales could affect both the number of positive (negative) reviews and the total number of reviews, the effects could offset each other as it is presented in both numerator and denominator. Moreover, despite positive and negative reviews, some customers are unwilling to spend time writing reviews or are indifferent between positive or negative reviews as I mentioned earlier, they tend to post a neutral review. Since the neutral review rate is calculated as 100% less the percentage of positive and negative reviews, this variable may result in the problem of collinearity. Therefore, we only use positive review rate and negative review rate as independent variables for regression. In addition, Sahoo et al. (2018) mentioned fit information in the study. Fit information is whether the product fits specific individuals, for example, the size of clothes. Therefore, the helpfulness of certain reviews would be different for different individuals. Controls for these are discussed below.

3.2.3. Control Variables

Control variables include marketing variables, contextual variables, and individual characteristics. For marketing variables, prices, ratings, discounts, and brands could all result in changes in consumer decisions. Prices include the prices of the product and the price of transportation. Some of the retailers charge high transportation costs (return costs) in order to prevent returning products. Therefore, I choose sellers with low or without return costs. Numeric ratings could help consumers get a general idea about product quality. Both average ratings of a specific product and whether the average ratings are higher or lower than ratings of other close substitutes are important. Discounting is a popular marketing strategy to attract consumers and improve positive review rates. Therefore, the degree of discount needs to be controlled. Moreover, brand loyalty means some consumers trust only a few brands and buy products from those brands. So that reviews and ratings may not change their purchasing decisions. Therefore, I eliminate the effect of brands by dropping data collected about specific famous brands such as Nike. People may hold different preferences towards various categories of products. Therefore, I choose 5 categories of products with the highest sales among all categories: Food, stationeries, clothes, shoes, and electronics. I tried different keywords to find close substitutes from these categories to omit potential biases due to differences in product categories. Therefore, I included sub-categories under the general 5 categories according to different keyword searches.

Customers' characteristics could also affect their purchasing decisions. For instance, they may choose to buy products that seem familiar and trust reviews written by a person who carries similar characteristics. However, due to the protection of consumer privacy, the data I collected from the e-commerce platform does not include information related to customers.

Time is another variable that may change consumer purchasing decisions, especially in the context of the global pandemic. For example, at the beginning stage of the pandemic outbreak and lockdown, the sales of facial masks would increase and reach a scarce level, therefore, consumers may not care about ratings and reviews. Afterward, people may address the storage of foods. In these periods, the fluctuations in sales amount may not be representative. Therefore, product statistics are collected from the e-commerce platform in March 2022.

Above all, the hypothesised effects of positive review rates and negative review rates on sales and returns are presented in Table 1 according to propositions and the theoretical model. Positive reviews would have a positive effect on sales while negative reviews would have negative effects on sales. However, since the reviews could be biased, consumers tend to overestimate the actual product quality given positive reviews, therefore, a higher proportion of positive reviews could lead to a lower level of satisfaction and a higher rate of returns.

Variables	Hypothesised effect on sales	Hypothesised effect on returns
Positive review (%)	+	+
Negative review rates (%)	-	-

Table 1: Hypothesised effect of independent variables on sales and returns

4. Data

Data are collected from the largest e-commerce retailer in China, Taobao. Due to the prevalence of big data technology, the keyword searching result is personalised, showing different prices or quality of products to different individuals according to their previous buying patterns. Therefore, I collected the data using 3 users' login details. Python codes for collection are in Appendix 2. The information for products is collected in March 2022. All the data collected are exactly the same information that other consumers could access, thus, the result could mimic how consumers process the information and reach the final purchasing decision. The return statistics, which consumers with mobile apps cannot access, are used to measure ex-post satisfaction levels.

The data set includes 1749 randomly selected products. It consists of information about products, product reviews, ratings, purchases, keywords (categories), and returns. The description of the dataset is found in Table 2.

Variable	Observations	Mean	Std. dev.	Min	Max
Price	1,749	517.62	1000.57	1.8	5498.00
Sales	1,749	7627.89	12449.96	1	200000
Reviews					
Positive %	1,749	26.71	24.33	0	100
Negative %	1,749	27.70	72.72	0	100
Neutral %	1749	45.70	71.26	0	96.20
Ratings					
Description	1,749	4.80	0.07	4.5	4.9
Service	1,749	4.76	0.07	4.5	4.9
Logistic	1,749	4.81	0.07	4.6	4.9
Return	1,749	4.65	0.38	2.79	5.04

Table 2: Summary of the data

Sale amounts could reflect consumers' purchasing decisions. Return is calculated by the average of return rates, return span, refund span, and 1-WTR. These are the two dependent variables for two regressions. According to the customer valuation theory, prices are also an important factor that affects consumers' decision-making process. The valence and volume of positive and negative reviews are included in the form of the proportion of positive / negative reviews among all reviews. Ratings about the product are divided into three categories: description, service, and logistics. The "description" is about whether the product description is in accord with actual quality; "service" includes consumers' evaluation of sellers' attitudes; and "logistics" is about the speed and quality of transportation of the products. The description of variables is illustrated in Table 3.

Variable	Description
Sales	The dependent variable: the number of sales of the product within March 2022
Returns	The dependent variable: average of return rates, return span, refund span, and (1-WTR) within 30 days
Price	The price of the product at the time of purchasing
Positive %	The proportion of positive reviews at the time of purchasing
Negative %	The proportion of negative reviews at the time of purchasing
Ratings (1-5)	The average ratings of the products, including ratings about product description, services, and logistics

Table 3: Description of variable names

Before describing the econometric model, I would like to show the plots that visually depict how sales and returns vary with different categories of products. The box graphs (Fig. 4) demonstrate the impact of different categories on sales and product return rates.

a)

b)
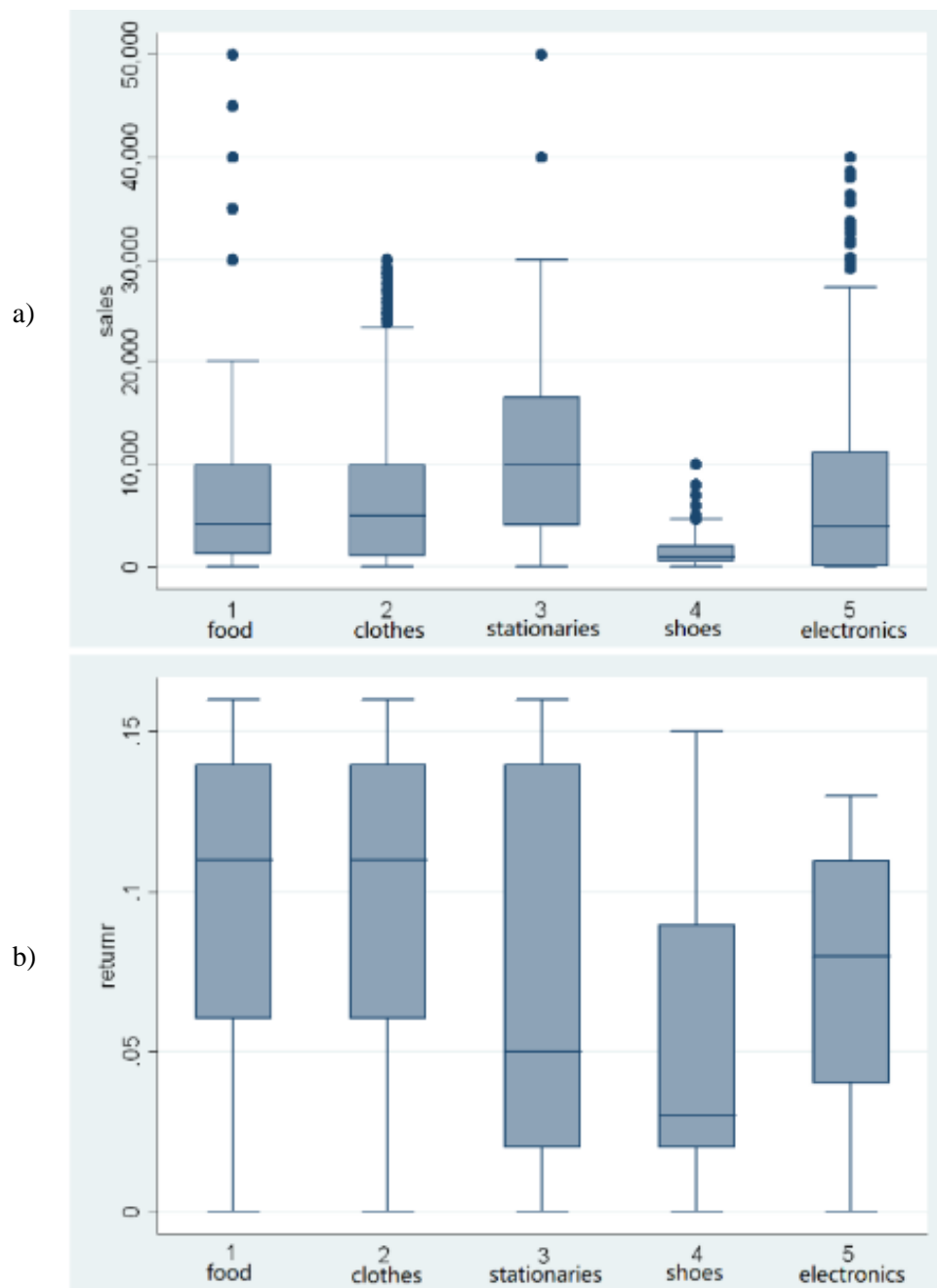
Figure 4: Box plots of a) sale and b) return rates by product category

We see that the sales for stationaries are the highest and the sales for shoes are the lowest. Moreover, the range of sales for food and electronics is large so these two categories have more extreme values. The average return rate for stationery and shoes is relatively low, while for food and clothes is generally high. The two scatter graphs (Fig. 5) plot the number of sales against the positive and negative review rates.
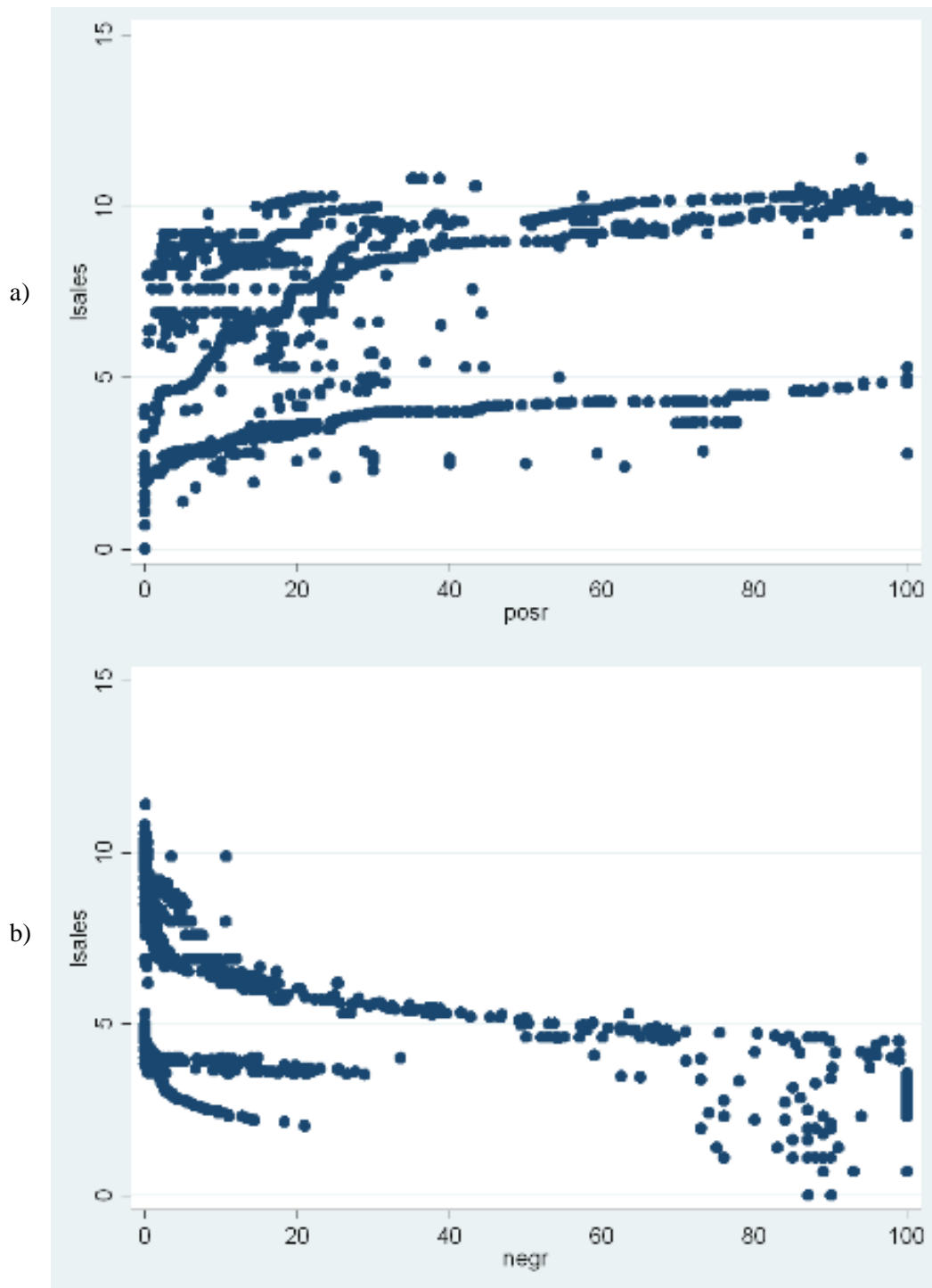
Figure 5: No. of sales vs a) positive review rate and b) negative review rate

Similarly, two graphs below (Fig. 6) plot the return statistics against positive and negative review rates.
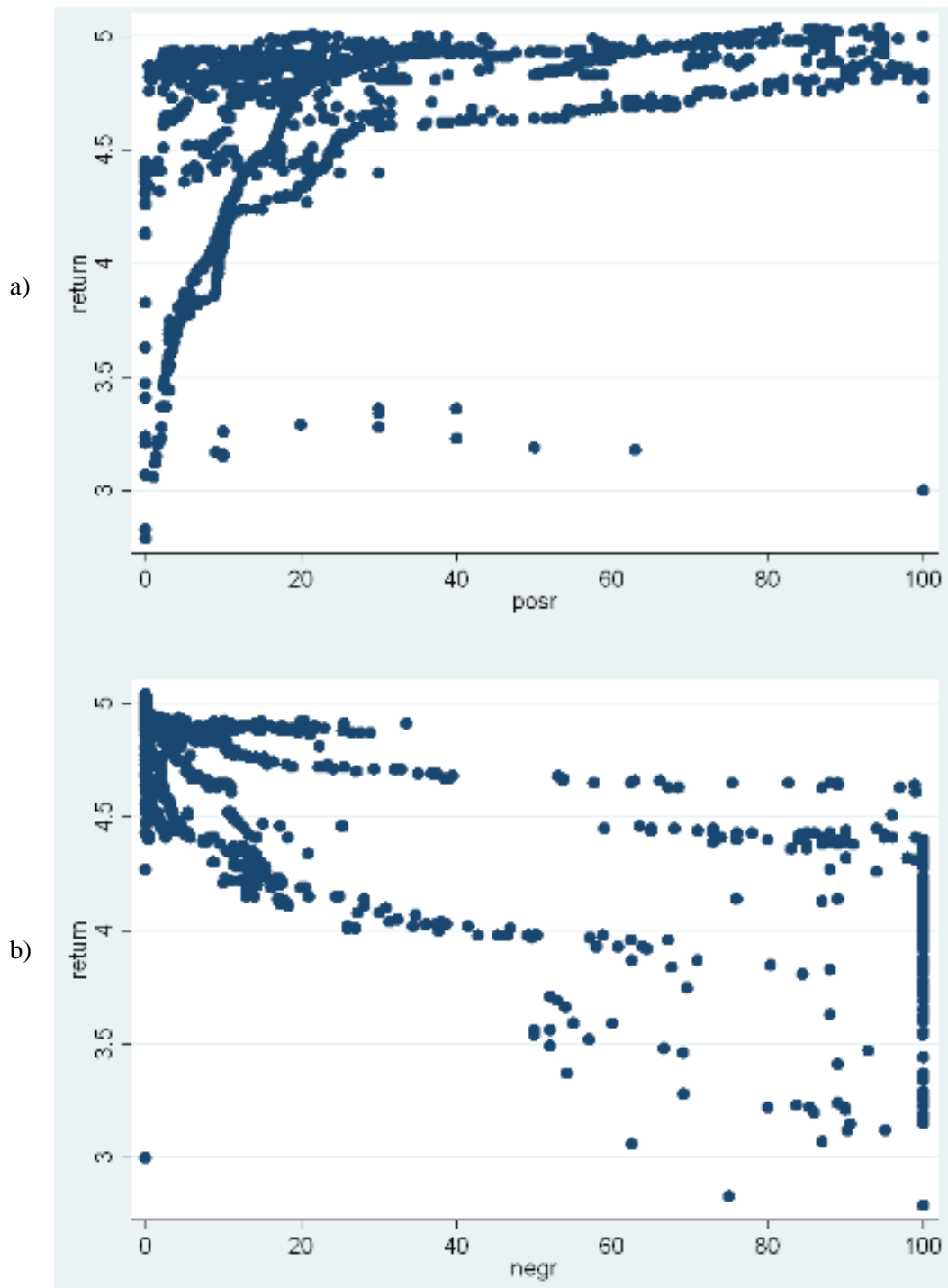
Figure 6: No. of returns vs a) positive review rate and b) negative review rate

To get a precise estimate of the effect variables of interest, a more complete model that controls other factors is needed.

5. Modelling and Results

Previous studies mainly used two models to estimate the effect of product reviews: the OLS-fixed effect model with Granger causality tests and binary choice model with maximum likelihood estimation. Given the nature of the data I collected, this paper uses least squares estimation.

There are two main assumptions for this model. Firstly, all consumers are risk-neutral so that they are indifferent between high

and low risks in the trade-off between price and quality. Secondly, product descriptions are similar among close substitutes which means that consumers could only use information from third parties to distinguish among those products.

5.1. Ex-ante Expectations

For ex-ante expectations, consumers generate the perceived value of the products from the price of the product (P) and the perceived quality (Q). The perceived quality is the function of ratings, positive review rates, and negative review rates. Therefore, the regression model is:

$$ln\ Sales_i = \alpha + \beta' Q_i + \gamma P_i + \varepsilon$$
$$Q = g(ratings, positive\ \%, negative\ \%)$$

However, this regression would have the problem of endogeneity. Therefore, I control for product categories in the regression:

$$ln\ Sales_{ijk} = \alpha_{jk} + \sum_j \sum_k \beta' z_{ijk} + u_i$$

α_{jk} is the category-specific fixed intercept to control for category-specific unobserved characteristics that affect sales. j represents the general categories of products. k represents the sub-categories in general categories, for example, staple food or snacks in the food category. z_{ijk} represents the explanatory variables, with the coefficient matrix β'.

j	Food		Clothes		Stationery		Shoes		Electronics	
k	Staple	Snacks	Shirts	Trousers	Pens	Notebook	Formal	Casual	Large (i.e.laptop)	Small (i.e. headphones)

Table 4: Category Controls

To further reduce the endogeneity problem, I use an instrument variable for the endogenous variables of positive review rates. Apart from intrinsic motives for writing reviews, extrinsic motives such as monetary incentives could also affect positive review rates. Therefore, I collected data about whether the seller gives monetary incentives to the customer and asks for positive reviews. Since the monetary incentive (MI) is provided after making the purchase, this variable provides an exogenous variation in the dependent variable of interest without causally affecting the outcome of interest. MI affects positive review rates and give high ratings, indirectly affecting the dependent variable. Hence, the two assumptions for an instrument variable, exclusion ($Cov(MI_i, \varepsilon_i) = 0$) and relevance ($Cov(MI_i, Q_i) \neq 0$), hold. Therefore, we have the first stage regression:

$$pos\%_{ijk} = \theta_{jk} + \sum_j \sum_k \delta\ MI_{ijk} + v_i$$

The regression results are presented in Table 5, where (1) has no category-specific fixed effects, (2) has category controls, and (3) is the 2SLS regression with category controls.

Independent Variable	(1)	(2)	(3)
Positive %	0.0012*	0.0101***	0.0384**
	(0.0001)	(0.0009)	(0.0026)
Negative %	-0.0411*	-0.0482***	-0.0486***
	(0.0025)	(0.0007)	(0.0010)
Price	0.0001	-0.0001***	0.0001
	(0.0001)	(0.0000)	(0.0002)
Description	4.6754**	2.7718**	1.7398
	(0.8662)	(0.2736)	(1.0952)
Service	5.2472**	2.6876**	0.3603
	(0.9754)	(0.3084)	(2.2128)

Logistic	3.2075 (0.8481)	2.5475* (0.2716)	0.5488 (1.9375)
Food (staple)	-	0.0305*** (0.0652)	0.0291*** (0.0814)
Clothes (trousers)	-	0.0207 (0.0651)	0.0315 (0.0787)
Stationery (pens)	-	0.0068** (0.0650)	-0.0037 (0.0786)
Shoes (formal)	-	-1.0461*** (0.0699)	-0.0429 (0.0801)
Electronics (small)	-	0.0270 (0.0844)	0.1046 (0.1210)

Table 5: Regression results with *ln(sales)* as dependent variable (standard errors in brackets)
* significant at 10%, ** significant at 5%, *** significant at 1%

5.2. Ex-post Consumption Utility

For ex-post consumption, the return rates could be a good measure of consumer satisfaction besides than reviews. Similar to the above regression model:

$$return = \alpha + \beta'Q + \gamma P + \varepsilon$$
$$Q = g(ratings, positive \%, negative \%)$$

In order to solve the problem of endogeneity, I add the product fixed effect,

$$return_{ijk} = \alpha_{jk} + \sum_j \sum_k \beta' z_{ijk} + u_i$$

α_{jk} is the category-specific fixed intercept to control for category-specific unobserved characteristics that affect returns. j, k, and z_{ijk} represents the same things as before. Further, I use the same instrument variable MI for the endogenous variable positive review rates, with first stage regression:

$$pos\%_{ijk} = \theta_{jk} + \sum_j \sum_k \delta MI_{ijk} + v_i$$

The results of the regressions are presented in Table 6, where (1) has no category-specific fixed effects, (2) has category controls, and (3) is the 2SLS regression with category controls.

Independent Variable	(1)	(2)	(3)
Positive %	-0.0013 (0.0003)	-0.0007** (0.0004)	0.0023* (0.0006)
Negative %	-0.0065** (0.0003)	-0.0064*** (0.0003)	-0.0061*** (0.0002)
Price	-0.00004** (0.0000)	-0.0000 (0.0000)	0.0000 (0.0000)
Description	0.3361* (0.1183)	0.4318*** (0.105)	0.5276** (0.2511)
Service	0.8194* (0.1332)	0.7704*** (0.1182)	0.6349 (0.5074)
Logistic	0.4038 (0.1158)	0.3701** (0.1041)	0.2125 (0.4442)
Food	-	-0.0073	0.0033**

(staple)		(0.0250)	(0.0187)
Clothes	-	-0.0054	-0.0037*
(trousers)		(0.0250)	(0.0180)
Stationaries	-	0.0045	0.0031
(pens)		(0.0249)	(0.0180)
Shoes	-	0.0302	0.0287
(formal)		(0.0250)	(0.0184)
Electronics	-	-0.0290	-0.0073
(small)		(0.0324)	(0.0277)

Table 6: Regression results with *Return Rate* as dependent variable (standard errors in brackets)
* significant at 10%, ** significant at 5%, *** significant at 1%

6. Discussion

6.1. Information from Reviews and Control Variables

For the ex-ante regression, the positive review rates at the time of purchase have a significant positive association with the change in sales. A 1 percentage point change in positive review rate is associated with a 3.8% change in sales. Moreover, negative review rates at the time of purchase have a significant negative association with changes in sales. A percentage point change in negative review rates is associated with a -4.8% change in sales. This supports proposition 1 that negative review rates may have a larger association with sales.

While for the ex-post regression, the coefficients for positive review rates and negative review rates show a similar trend. The positive review rates at the time of purchase have a significant positive association with change in returns. 1 percentage point change in positive review rate is associated with a 0.23% change in returns. Moreover, negative review rates at the time of purchase have a significant negative association with changes in returns. 1 percentage point change in negative review rates is associated with a -0.61% change in sales. This result could support the second proposition that consumers form upward biased expectations from positive reviews while negative reviews would give a negative association with returns. In order to further test the second proposition, we could show the coefficients for positive review rate in the two regressions have the same signs and the coefficients for negative review rate in the two regressions have the same signs via the student t-test.

With H_0: $\widehat{\beta}_{pos\%} = 0$ and H_1: $\widehat{\beta}_{pos\%.} > 0$; H_0: $\widehat{\beta}_{neg\%} = 0$ and H_1: $\widehat{\beta}_{neg\%} < 0$ for both regressions. The formula for the t-value is:

$$t = \frac{\hat{\beta} - 0}{se(\hat{\beta})}$$

The null hypothesis is rejected at a 5% significance level. Therefore, the coefficients for positive review rate in the two regressions are positive and the coefficients for negative review rate in the two regressions are negative. The result implies that consumers tend to form biased beliefs about quality products with positive reviews.

Ratings of the product have more space for the sellers to manipulate. For ex-ante expectation formation, we could see that ratings of the description of the product have a relatively higher association with sales (1.7398) compared to ratings about services and logistics. Moreover, rating for services has the least importance for the consumer to consider when making purchasing decisions (0.3603). On the contrary, for ex-post returning decisions, ratings generally have a significantly higher association with returns. Ratings about product description and logistics are associated with 0.5276 and 0.2125 increases in returns. While the rating of services has a larger association with returns, which is 0.6349. Overall, consumers pay more attention to product descriptions when making purchasing decisions, while the attitude of the seller and service quality becomes deterministic when consumers make returning decisions.

Prices are positively associated with sales. When taking prices in the form of cost, a higher price would result in lower sales; however, when price acts as an indicator of quality, a higher price may imply higher quality, therefore, a higher price would

result in higher sales. The association between prices and returns is 0.00001 and not significant, implying that prices may not affect returns in general.

6.2. Explanations with Behavioural Factors

Due to bounded rationality, consumers' behaviour usually depends on mental shortcuts rather than elaborated processes that calculate the expected quality of products. Therefore, we need to consider behavioural factors that cannot be quantified but could act as mental shortcuts. In this way, we could infer the underlying explanations for the regression result. In this section, we mainly discuss behavioural factors that are related to individual characteristics, including status quo bias, inattention, social proof, liking and authority, and scarcity.

6.2.1. Status Quo Bias

Once people choose or write something, they tend to stick with their standpoint. People's tendency for commitment and consistency could raise the predictability of their behaviour. This would result in brand loyalty or consumers' commitment to certain sellers. For example, people tend to buy products from a single seller, therefore generating brand trust and brand loyalty. In this way, there would be a positive feedback cycle that raises both sales and the number of positive reviews of the seller. Besides, the mere agreement effect (Pandelare et al., 2010) states that people are much more likely to agree to a subsequent request if they have a positive response to requests beforehand. This could be interpreted as a consumer who purchases the product being more likely to follow the seller's request to write a positive review, therefore the number of positive reviews could be closely correlated with sales. Further, sellers tend to provide both intrinsic and extrinsic motivations to guide consumers to make a determined commitment. For instance, sellers could give discounts or coupons for later consumption, this strategy engages customers for their own benefits and results in uplifting sales for especially retailing products (Humby, 2004). External motivation involves positively labelling consumers as above average when consuming certain types of products (this could be represented by a higher price especially for luxuries), the psychological hint could result in higher involvement rates (Tybout & Yalch, 1980). However, the salience of labels would decrease over time so the increases in sale amount would be temporary. In addition, status quo bias implies that people tend to be reluctant to return products once they receive them. This could explain the smaller estimators (0.0023 < 0.0384) for regression of returns.

6.2.2. Inattention

Independent Variable	(1)		Independent Variable	(2)	
Positive %	0.0430**	0.0144	*Positive %*	0.00361*	0.00442
Negative %	-0.0503***	0.0029	*Negative %*	-0.00723***	0.00090
Price	0.0001	0.0001	*Price*	0.00003	0.00003
Food (staple)	0.0283	0.0856	*Food (staple)*	-0.00950	0.02622
Clothes (trousers)	0.0243	0.0855	*Clothes (trousers)*	-0.00312	0.02619
Stationeries (pens)	-0.0041	0.0859	*Stationeries (pens)*	0.00319	0.02630
Shoes (formal)	-0.0254	0.0874	*Shoes (formal)*	0.03823	0.02677
Electronics (small)	0.0578	0.1439	*Electronics (small)*	-0.03483	0.04409

Table 7: Regression results with (1) *ln(Sales)* and (2) *Return Rate* as dependent variable
* significant at 10%, ** significant at 5%, *** significant at 1%

Individuals may not pay full attention to all the information presented by the seller. As I have mentioned earlier, ratings are often put in less visible corners of webpages. Therefore, buyers may ignore ratings when making purchasing decisions. As such, I run the 2SLS regression with fixed category effects but without the effect of ratings. The result is illustrated in Table 7. We could see that although we are not controlling the effect of ratings, the results for positive review rates and negative review rates

are significant and support the propositions. Ratings, therefore, may not play a pivotal role in determining consumer perceived quality of the product.

6.2.3. Social Proof

Social proof is another influential factor that affects consumer behaviour. People naturally refer to others' actions as a cue on what to do when they are uncertain about something. This means that only when the person is hesitating between close substitutes, the influence of others' decisions could be successful. In the context of this paper, when people form a quality belief about a specific product, they tend to refer to others' consumption behaviours even when other people's purchasing decisions are wrong. Asch's experiment on social conformity verified the proposition that people tend to trust others' choices even if they are wrong. Nord and Peter (1980) also suggested that people may adjust their behaviour to follow others. When consumers are hesitating among close substitutes, the number of sales could be a direct clue for other consumers' behaviour. People tend to buy products with higher sales so the number of sales could affect the number of reviews and consumers' buying decisions. Moreover, the positive reviews could create an indirect clue for others' behaviour which is far more effective than direct messages. When consumers are uncertain about the expected quality, they tend to seek clues from product reviews, therefore, positive reviews could play a significant role in determining consumers' perceived quality - consequently giving biased quality beliefs.

6.2.4. Liking & Authority

People are susceptible to things with particular similarity, closeness, in-group feeling, attractiveness, and familiarity. Specific characteristics that are mentioned in reviews, similar identities disclosed by the reviewer, or particular in-text sentiments could all create a sense of liking between unfamiliar people. In this way, consumers tend to trust reviews from customers with similar characteristics (Forman et al, 2008). A recommendation from authority is influential as well. This includes authority-directed signals (i.e. brands, superstars) or legitimate authority positions (i.e. nutritionists, doctors, professors). This could be because those who are in authority positions have usually demonstrated certain skills to get to that particular position so trusting them could be beneficial via a heuristic mental shortcut to make good decisions or rational choices. However, the problem is, people do not need to be an expert to show authority; appropriate signalling is enough. Making two-sided arguments or powerful language when writing product descriptions or reviews could make the texts seem more persuasive. Studies (Yi et al., 2019; Sahoo et al., 2018; Huang et al., 2017) support the proposition that variances in the language of online reviews would alter consumers' decision-making. People tend to follow reviews with longer text lengths or persuasive tones, ignoring other information that may be useful. With recent studies in China, those who are employed by the seller to write positive reviews need to write "high quality" reviews to attract consumers. Therefore, consumers tend to trust those high-quality reviews and overestimate product quality.

6.2.5. Scarcity

Lastly, scarcity plays a deteriorating role in the robustness of the data at different times. When people believe something is scarce or difficult to obtain, in quantity, time, or availability, they tend to add value to that thing, resulting in an upward biased expected quality. Therefore, consumers are compelled to buy something they do not need or would not buy normally. Due to the global pandemic and the lockdown policy, people prefer storing a certain amount of food in case of emergency. Especially in January 2022, the Chinese government indicated that families need to ensure food storage. This policy resulted in a jump in the sales of staple foods in January, and there is a decreasing trend in sales afterward. In this way, people's purchasing decisions would be irrelevant to other information since they only care about the product itself. This situation could apply to medical products such as disinfectants or face masks that may change with the outbreak of the pandemic. Another way to interpret scarcity is about sellers' strategy, this applies to the sale of limited-edition shoes or electronic devices. Sellers usually use "last chance" or similar words to show supply-based scarcity. Whether this tactic could be successful is closely related to the sellers' reputation (Lee et al, 2014) or brands. In this way, the effect of scarcity would make sales a self-perpetuating factor and induce increases in buying orders.

Above all, behavioural factors could explain biased quality beliefs. Hence, customers could employ techniques that help them to make higher-quality purchasing decisions based on information received. For example, they could simply discount the perceived quality of products formed on reviews and ratings to obtain a relatively precise estimation of the product quality.

Moreover, having a more accurate quality perception could not only improve consumers' welfare but also improve social welfare. A relatively low reference point about the products enables the consumer to have positive gain-loss utility with a higher probability. Thus, there would be a reduced number of product returns, decreasing the costs of returning products such as the opportunity cost of returns and transportation costs. In this way, consumer behaviour could be further investigated to give better strategies to improve the efficiency of the market and total welfare.

6.3. Limitations

There are some limitations of this study. First of all, some of the products do not have the data needed for this study. Besides, since the data collected are all provided by the e-commerce platform, the validity of the data cannot be verified. Moreover, variables related to individual characteristics are not included in the analysis. However, this problem could be solved by surveys, questionnaires, and experiments. In addition, the study is about the largest online retailer in China and may not be representative of consumers using other e-commerce platforms. Nonetheless, policies and the outbreak of the pandemic could affect sales and people's purchasing intentions. Future studies focus on how individual and policy variables affect consumer behaviour when making purchasing and returning decisions may be undertaken.

7. Conclusion

This paper first investigates the formation of quality beliefs based on online reviews and other relevant information. Then using corresponding returns to measure consumer satisfaction after making the purchasing decision.

There are two major findings. Firstly, when forming quality beliefs, consumers acknowledge the importance of negative reviews and negative review rates have a significant negative effect on sales. Secondly, after consumption, consumers turn out to overestimate the actual quality of the product. Although consumers are fully aware of the importance of negative reviews, the effect of negative reviews cannot counteract the effect of positive reviews. Empirically, consumers underestimate the influence of positive reviews, thus, quality belief is upward biased. Moreover, consumers' decision-making also depends on other behavioural factors such as mental shortcuts, social proof, and sellers' tactics. The findings echo other studies that investigate indirect clues triggering behavioural changes. I analysed the motivation for writing reviews and support the hypothesis that monetary reward is a significant process to request positive reviews according to the theory of reciprocity. The analysis of literature also provides some insights about variations in consumers' expectation formation process.

This paper makes some contributions as well. Firstly, it fills the research gap in the measurement of consumers' evaluation of the actual quality of products. Prior studies on online product reviews focus on the impact of the valence and volume of reviews on consumers' buying decisions. This paper incorporates the investigation of ex-ante and ex-post consumer behaviour regarding purchasing decisions and returning decisions. Moreover, qualitative analysis of the underlying motivations for writing reviews and forming quality beliefs could contribute to the understanding of online consumer behaviours as well.

In addition, the result could provide some insights to buyers. From the buyers' perspective, when making purchasing decisions about online products, the positive impression about the product quality gained from positive reviews needs to be discounted. Moreover, buyers could employ commitment devices to avoid using mental shortcuts and other biased indicators that are mentioned in this paper to form a biased expectation. In this way, there would be improvements in customers' welfare and reduced costs for returning products.

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Article

Insects on our Plates? Potential, Challenges and Opportunities in the Edible Insect Market

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Abstract
Our food system is a major polluter and perpetrator of climate change and biodiversity loss. Animal-based protein sources are the most energy-intensive and polluting food products. Edible insects have been touted as an alternative to traditional meat sources. This paper quantifies the sustainability of the edible insect production process. Then, it will explore the challenges edible insect companies are facing to change consumer behavior. Insects as food are still met with disgust, neophobia and are not considered as a viable food option. Through stakeholder interviews, I will be looking at how these companies are attempting to change that, notably through indirect entomophagy, increasing familiarity and building communities. I also recommend other potential strategies such as increasing familiarity by selling insect by-products, targeting a younger audience and establishing edible insects as a unique food category. Finally, I look at the government's perspective on this novel food, whether or not it should support its development and how supply side policies could be implemented to do so.

Keywords: Consumer behaviour, Microeconomics, Environmental economics, Innovation, Entomophagy, Marketing, Government intervention, Entrepreneurship, Market entry

1. Introduction

The first evidence of entomophagy, or the practice of eating insects, is found in the tools of the Australopithecus (2-4 million years ago). (Derrico, 2001) Since then, there are countless writings of different human cultures consuming insects. From Aristotle in Ancient Greece treating himself to cicada, to John the Baptist eating a diet of locusts and wild honey and silkworm pupae eaten in Ancient China. (Bodenheimer, 1951) Today, entomophagy is most popular in tropical regions because the warmer and more humid temperatures are ideal for insects to grow. Some cultures view it as a delicacy, others as food for the poor or as a last resort when there are droughts. (FAO, 2013) Over the past millennia, hundreds of insect species have been recorded as having been eaten by humans. Today, however, most Western countries do not eat insects and developing countries are slowly steering away from entomophagy.

Yet, during COP26 in 2021 in Glasgow, political leaders, activists and international organisations called for a rethink of our food production system and supply chain. There is a good reason why our food system is under fire. Agriculture occupies half of our global habitable land, uses 70% of our freshwater withdrawals and is responsible for nearly four fifths of the global ocean and freshwater pollution (eutrophication). (Poore & Nemecek, 2018) Livestock represents 94% of the mammal biomass on our planet today. What is even more striking is that meat, eggs and dairy are responsible for 83% of the food emissions of a European diet. (Sandstrom et al, 2018)

Nearly 80% of agricultural land is used to produce feed for livestock or their grazing, yet, they produce only 18% of global calories supply and 37% of global protein supply. Too much land is being used for non-protein dense foods, and that is a problem. (UN FAO, 2020) Protein is crucial to humans as it enables our bodies to repair cells and create new ones. (Arentson-Lantz et al, 2015)

This trend of environmental damage is expected to worsen if nothing is done about it. Meat, which is the most environmentally damaging source of protein, will see its consumption rise in the coming decades. As we've seen across history and more recently with China, as lower income countries become more prosperous, they will consume more protein and especially more animal-based protein. The world's population is predicted to peak at close to 10 bn by 2050, with this growth coming from sub-Saharan Africa, India, and Indonesia, among others. Lower income countries currently get between 12% to 30% of their protein from animals, while the number for higher income countries is around 60 to 70%. (UN FAO, 2020) Meat is seen as a luxury due to its higher price and presumed health benefits. (Berenicka & Pawlonka, 2018) We can see how this will put immense pressure on our food system and, by consequence, our environment.

Edible insects is a protein alternative that has been consumed for millennia, and is part of the traditional diet of 2 bn people. However, they are still neither eaten regularly nor on a large scale. In the past decade, edible insects have been on the rise in the novel food space, without having seriously taken off yet. Nevertheless, the market for edible insects continues to grow as consumers, governments and businesses are looking for more sustainable, ethical and novel food alternatives.

First, I will quantify the sustainability and efficiency of edible insects and compare them with traditional meat sources. I argue that this is one of the reasons why entrepreneurs are entering the edible insect industry. Edible insects are able to create value, opening up a business opportunity.

Then, I will explore what are the challenges that edible insect businesses face regarding consumer behavior and acceptance. Through stakeholder interviews, we will understand what strategies these start-ups are using to solve these challenges and link those with current microeconomic research. I will also offer recommendations based on an up-to date literary review.

Finally, I will discuss why governments might want to encourage the edible insect industry, the risks that government should mitigate and potential policies it could implement.

This paper makes novel calculations to compare traditional meats with edible insects and assess the sustainability and profitability of insects. It also summarises the micro-economic literature on consumer behavior, product adoption and food consumption and links them with current strategies being used in the industry. This is done through interviews with edible insect businesses. I then explore other potential strategies that are not and could be used by edible insect companies.

2. Motivations for Edible Insect Businesses

Entrepreneurs and environmentalists have long been enthusiastic about edible insects as a protein alternative. In 2013, after the publishing of a landmark report by the UN's Food and Agricultural Organisation (FAO) outlining the opportunities of edible insects, they started becoming very popular. (FAO, 2013) Millions of dollars were invested by venture capitalists and angel investors in edible insect startups. After a few years, however, the majority of them had disappeared and the money had dried up. Various reasons accounted for this failure, such as regulatory issues, scalability and commercial viability. The last few years have seen a resurgence of edible insect startups. What are the motivations behind those entrepreneurs taking on the challenge of convincing consumers to eat bugs?

There are thousands of insect species that are consumed around the world; however, this paper will focus on commercially produced insects for human consumption. There are currently three insect species that are being developed for large scale production: the mealworm, the black soldier fly (BSF) and the cricket. I will be focusing on the cricket as it is the most popular insect sold directly to consumers. The appendix has a more thorough description of each species. The following analysis will also be based on the production process of Instar Farming, the largest cricket farm in the UK, for which the production process is also explained in the appendix.

2.1. Sustainability

Proponents of edible insects claim that insects have a low environmental footprint. (FAO, 2013) Here, I will be testing this claim.

I used different studies estimating the inputs needed to produce 1 kg of protein for different animal-based protein-dense foods. I then make calculations to convert them to have a consistent comparison, which will be 1 kg of protein. I need to take into account whether the product's weight was for live weight or edible weight, if it included bones/inedible parts and take into account protein content.

Input per 1kg of protein	Land use (m2)	Water use (L)	GHG Emissions (kg CO2 equiv.)
Beef	1,636	11,200	128
Pig	107	5,700	38
Lamb	1,848	6,300	401
Chicken	71	3,400	20
Crickets	0	1	7

Table 1: Inputs needed to grow various meat sources. (Poore & Nemecek, 2018; FAO, 2013; Mekonnen & Hoekstra, 2012)

Firstly, it is noticeable that edible crickets only need a minute amount of land to grow. Lamb and beef (depending on the type of cattle farming method) need more than 10 times the area of land needed to farm pigs and chickens. (Poore & Nemecek, 2018) Insects barely need any land to grow even compared to chickens. (Instar Farming, 2022) That is because they are grown in boxes and can be stacked up high. In addition, the processing facility only requires one large tub where the crickets are fried or grounded into flour.

Secondly, crickets need next to no water as they can efficiently extract the little water needed from the humidity in the air and the moisture in the feed. (Mekonnen & Hoekstra, 2012) This substantially reduces the environmental cost of producing edible insects as seen in Figure 1.
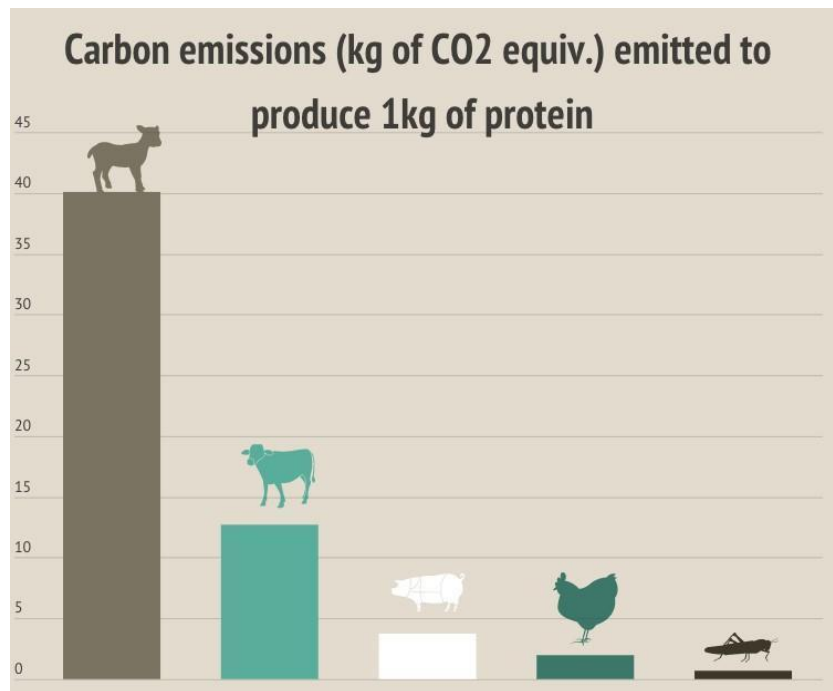
Figure 1: Crickets emit considerably less GHG compared to other animal-based protein sources

Finally, regarding greenhouse gas (GHG) emissions, lamb and beef are the least environmentally friendly meat sources. A typical kg of beef in the US emits around 22 kg of CO_2-equivalent GHG. This comes from their waste (manure) and the gases they emit. (Avery & Avery, 2008) By taking into account protein content and edible weight, studies clearly demonstrate that crickets do not produce any emissions themselves nor any waste for that matter. The emissions come from the production process and transport, which is still less than 3 times that of chicken and around 18 times less than beef.

Next, these improvements can be quantified in monetary terms. I have taken price information from various sources to calculate how much monetary gain a farmer or producer would get from farming insects instead of traditional meat sources.

- Savills estimates that an acre (4,047 m^2) of agricultural land costs on average £7,000. (Savills, 2021)
- According to Agrismart, one cubic metre of water (1000 L) costs £1.75 in the UK. (Agrismart, 2013)
- The AHDB estimates that concentrate feed prices are around £0.29 per kg of feed. Note that higher protein content makes feed more expensive. (AHDB, 2022)
- The UK's Emissions Trading Scheme, which enables businesses to trade emission futures, was trading at £82.94 per tonne of CO_2-equivalent on March 17 2022. Note that the prices of ETS futures are predicted to rise in the coming years as emission quotas are reduced and governments attempt to meet their emissions target. (Ember, 2022)

Cost of inputs per 1kg of protein	Value of land (£)	Cost of water (£)	Cost of GHG emissions (£)	Feed cost (£)
Beef	2,830	20	11	7
Pig	186	10	3	2
Lamb	3,197	11	33	4
Chicken	122	6	2	1
Crickets	1	0	1	1

Table 2: Price of Inputs. (Savills, 2021; Agrismart, 2013; AHDB, 2022; Ember, 2022)

Land needed to produce 1 kg of lamb protein is worth close to £3,200 in the UK in 2021, the value of the land insects are using is just a fraction of this. Also, feed cost for beef production is seven times that of insects. Additionally, purchasing carbon credits for 1 kg of protein of lamb and beef would cost £33 and £11 respectively, 10 and 30 times more than for the equivalent insect protein.

These calculations confirm that edible insects emit less emissions, occupy less land and use less water. Thanks to their biological efficiency, edible insects require much less inputs and raw materials to produce the same amount of protein compared to traditional meat sources. Therefore, by switching to insect protein, the environmental impact of our food can be reduced. This is one of the main reasons why more and more entrepreneurs are founding edible insect start-ups: consumers are looking for more environmentally friendly sources of food and edible insects can, in theory, meet that need.

2.2. Efficiency & Value Creation

Crickets and insects are incredibly efficient. Since they are cold-blooded animals, they do not waste any energy keeping their bodies warm. (Kim et al, 2019) This is reflected in their Feed Conversion Ratio (FCR), which shows how much kg of feed is needed to produce one kg of edible product. The lower the FCR, the more efficient an animal is in converting feed into meat. Crickets have an FCR of 2, compared to 25 for beef and 6 for pig. (Alexander et al, 2016) The protein conversion ratio is a similar metric but looks at the protein conversion efficiency. Protein conversion numbers for all protein sources are very similar to their FCR. FCR and protein conversion values across animal protein sources are depicted in the table below. In addition, humans can usually eat 80% of a cricket, compared to around half for other meats. (FAO, 2013) This means that less feed and energy are needed to grow and harvest insects for consumption.

Efficiency per 1kg of protein	Feed Conversion Ratio	% of animal edible	Protein Conversion Ratio
Beef	25	40	26
Pig	6	55	12
Lamb	15	N/A	16
Chicken	3	55	5
Crickets	2	80	2

Table 3: Crickets are incredibly efficient creatures. (Alexander et al, 2016; FAO, 2013)

The output of crickets and other animal-based products are compared below. This analysis is novel in that it helps us compare the current market value of insects versus traditional meat sources. I took typical products from Tesco and from Bugvita, one of the most popular edible cricket sellers in the UK. Figure 2 visualises how the most caloric and protein-dense products are the crickets, sold as whole or as a powder.

Output per 1kg edible	Product	Calories (kcal)	Protein (g)	Retail Price (£)	Price (£)/1k calories	Price (£)/100g protein
Beef	Diced Beef	1,840	350	9	5	2
Pig	Fresh Diced Pork Topside	1,950	400	7	4	2
Lamb	Lamb Diced Leg	2,310	250	19	8	8
Chicken	British Diced Chicken Breast	1,410	330	10	7	3
Crickets	Whole Roasted Crickets	4,450	610	104	23	17
Crickets	Cricket Powder	4,450	690	43	10	6

Table 4: Comparison of output by meat source (As of February 2022). (Bugvita, 2022)
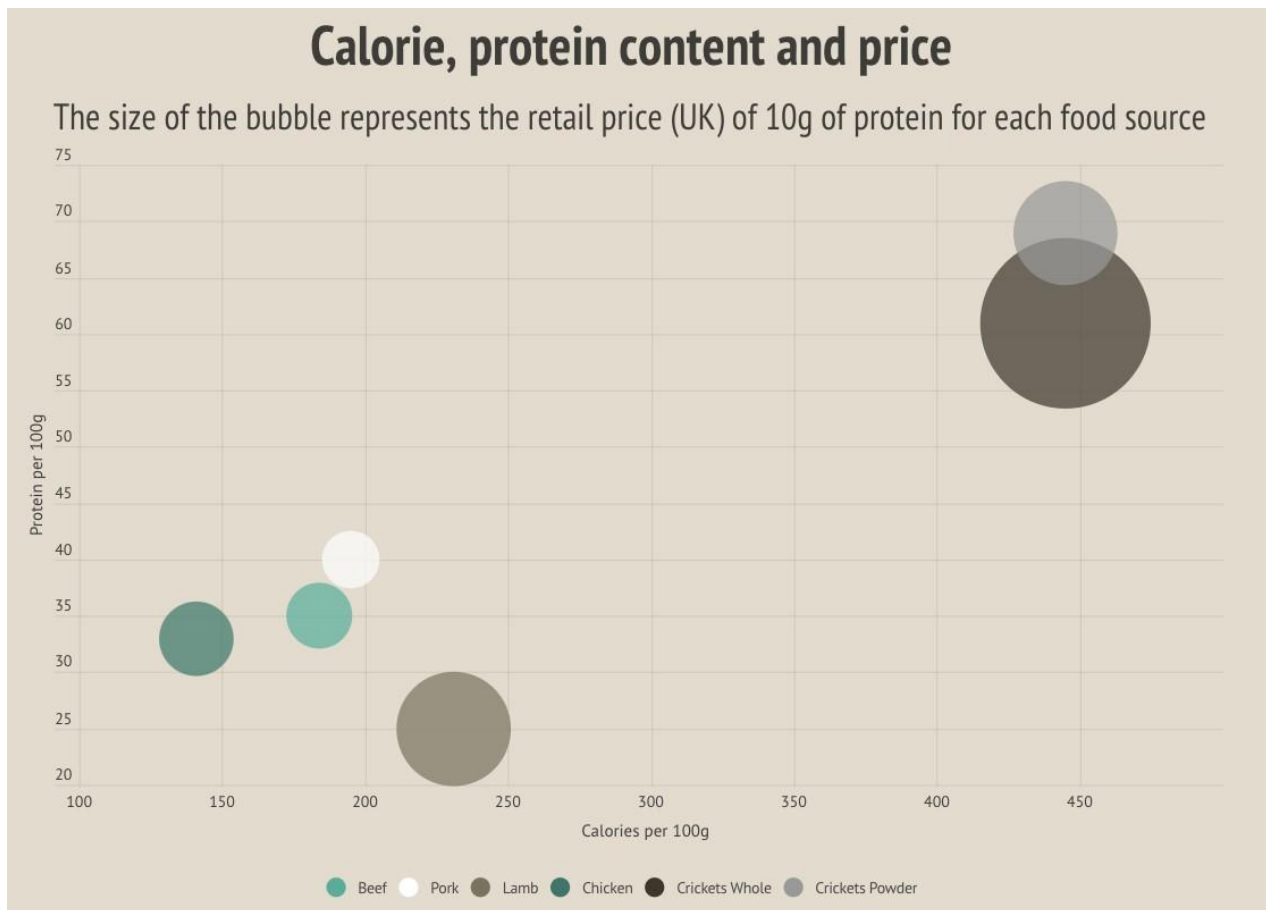
Figure 2: Crickets are the most caloric and protein-dense but also the most expensive

The least protein-dense product is lamb, which, incidentally, is one of the least environmentally friendly meat sources. Beef, chicken, and pork all have a higher ratio of protein to calorie than lamb. However, they have substantially lower protein content than the insect products. Whole crickets and cricket powder both have nearly double the protein content of chicken and triple its calories. Crickets sold as whole, as the size of the bubble indicates in Figure 2, are the most expensive of the food products compared, while pork is the least expensive. Insects' efficiency is shown by the fact they are very dense in calories and protein. They need minimal output to produce valuable output.

In conclusion, these calculations confirm research made by van. Huis (2013) that insects actually create value through their biological process. They require less input and produce more valuable output. This is the second reason why entrepreneurs are looking at edible insects. They are efficient and produce valuable and sustainable output. They can be sold at a premium to consumers (for the time being) and input costs are relatively low.

2.3. Business Opportunity

On the demand side, consumers want environmentally friendly foods. On the supply side, producers can sell edible insects at a profit. Research by Niyonsaba et al (2021). has shown that the energy, feed and labour margins for BSF farms can range from £-661 to £12,901, mealworm farms from £6,311 to £11,405 and cricket farms from £10,161 to £65,163. These potential margins are much larger than for any other traditional meat source. Another example are the products from Bugvita, where whole crickets are the most profitable. Bugvita sells 100g of cricket powder for £5.22, but is able to sell 50g of whole crickets at the same price. The margins are thus much higher for whole crickets. (Bugvita, 2022) As a result, entrepreneurs see edible insects as a potentially profitable business opportunity. As any business looking to maximise their profits, several start-ups are trying to enter this market early and gain market share.

The advantages of entering a new market, or even creating one, are immense. Companies can essentially set monopolistic prices and maximise their profits, since they do not have any competitors. Yet, as more competitors enter the market to satisfy demand, the market becomes more mature and profits decrease. This is why companies try to enter markets as early as possible. (Saviotti

& Pyka, 2004) Apart from entering a niche market early, firms also want to gain as much market share as possible. It has been shown that the size of a firm's market share is positively correlated with firm profitability. If you have more customers, you can sell more, benefit from economies of scale and better control prices, resulting in higher profits. (Buzzel et al, 1975).

I should note that the retail price for edible crickets is still relatively high in the UK and in Western countries since the production processes are not yet fully optimised. This is due to production still operating on a relatively small scale and the difficulty of reaching customers. (Instar Farming, 2022) It has been shown across studies that brand equity, marketing investment and product differentiation are associated with price levels. In this case, a substantial amount of marketing and signalling to customers is needed to convince them to try insects. (Davcik & Sharma, 2015) Naturally, these marketing costs and outreach efforts increase the cost of goods sold and are reflected in a higher price point. Also, companies are currently able to charge a premium for their insect products as they are still quite novel, often considered a gimmick. As they become more accepted, this premium might have to be reduced as competitors enter the market and the novelty of edible insects wears off.

Having recognised this business opportunity, edible insect companies are now trying to convince consumers to try and stick to eating insects. What are the main challenges that the industry and these companies are facing and what strategies are they using to solve those?

3. Challenges, Strategies, and Potential Solutions for Consumer Acceptance in the Edible Insect Market

Insects have never been part of the diet of Western countries. This is because domestication meant they could find larger and richer sources of meat. Also, insects were associated with pests and ruining harvests. Finally, Western countries are mostly in the Northern hemisphere, where a milder, less humid climate meant that insects were not very large in these regions. (Kim et al, 2019)

Despite the recent interest in edible insects, they are still not widely consumed in Western countries. I will link the challenges that the industry is facing with microeconomic research on consumer behavior and their willingness to consume food products. Interviews with edible insect start-ups have given me additional insights about the strategies they are using to overcome those challenges, leading me to suggest potential solutions. A more thorough introduction of each of the companies interviewed can be found in the appendix.

3.1. Challenges in Reaching Consumers

Insects are often associated with dirt, disease and filth. (FAO, 2013) Across history, they were responsible for pests and carried diseases. (Bodenheimer, 1951) This consumer attitude towards insects is found in many studies including in Brazil and the UK. (Bisconsin-Jnior et al., 2022; Ayla & Jarchlo, 2022) This feeling of disgust is a natural reaction to a product that someone deems unsafe. As a result, insects have often been considered as a poor man's food and as a last resort when there is no other option.

Extending this idea of disgust, uninformed and unfamiliar consumers consider insects to be unsafe and a risk to one's health. When consumers perceive insects to pose a threat to their health, they are very reluctant to try them. (Castro & Chambers, 2019) Work from Tversky & Kahneman (1974) in behavioral economics explained how consumers perceived risk and made decisions based on their judgements. They showed how humans' cognitive limitations result in them making imperfect decisions. Oftentimes, when assessing a situation and the risks associated with it, we rely on heuristics (rules of thumb) to make decisions quickly. However, these can be very misleading, as humans are often risk-averse and assign higher probabilities to dangerous events than what is realistic. In the context of edible insects, it is assumed that consumers often overestimate the risk of getting sick from insects, as the true probability of it is relatively low.

Neophobia, or the fear of the "new", is often associated with novel foods such as insects. Humans like what they know and what they are used to. This makes their lives easier and safer, as they do not need to ask themselves every time whether a specific food is safe or a product is useful. Since most Western consumers have never been in contact with edible insects, they are very reluctant to try them due to their unfamiliarity with them. (Wendin & Nyberg, 2021) A survey by the Food Standards Agency (FSA) in the UK showed that three quarters of respondents were not willing to try edible insects and two thirds of those said that nothing would make them taste it. (Ayla & Jarchlo, 2022) Note that these are only answers to questions (intent) and were not actually given the choice to eat them.

Edible insects are currently still stuck in the "gimmick" phase. (Yumbug, 2022) People buy them as a gift, a dare or a one-time purchase: such purchases are driven by curiosity and context (festivals, food markets). The real challenge for entrepreneurs is to make them a regular, staple food product for households. The latter behavior is driven more by practical constraints. (La Barbera et al, 2021) Rogers (2003) identified five factors in the consumers' decision-making process when faced with an innovation:

- **Relative Advantage**: How much better is the new product compared to the current offering?
- **Compatibility**: Does the product align with the values and needs of consumers?
- **Complexity**: How hard or easy is it to use the product?
- **Trialability**: Can consumers experiment with the product?
- **Observability**: Are the effects of the innovation visible to others?

These questions can be adapted for edible insects, for example:

- **Relative Advantage**: Are edible insects cheaper and tastier than other protein alternatives?
- **Compatibility**: Are edible insects produced in a sustainable and ethical manner?
- **Complexity**: Can consumers easily cook insects, are there readily available recipes and guides?
- **Trialability**: How easy is it to get hold of edible insects, can consumers get them at the local supermarket?
- **Observability**: Can consumers see the positive environmental impact they are making?

I will use some of these factors later on when recommending strategies for edible insect companies.

3.2. Strategies to Convince Consumers

The most popular and successful way to avoid disgust in consumers is through indirect entomophagy. Several surveys have shown that reluctant consumers are much more willing to try an insect product when they cannot see parts of or the whole insect. (La Barbera et al., 2021) An example would be an insect burger where ground cricket flour is mixed with onions and spices. Usually, consumers are more suspicious of raw insects rather than processed ones. (Verneau et al, 2021) Indirect entomophagy can help solve the problem of **compatibility** - aligning with the needs of consumers to have insect parts disguised - and **complexity** - can consumers consume the product without needing to spend time and mental effort to convince themselves?

For instance, Hargol, a commercial grasshopper farm out of Israel, does not show any images of the insect on its products or in its communication. (Hargol, 2021) They are aware that consumers, today, prefer not to eat whole insects and do not want to be reminded they are eating one. Their marketing focuses on the grass that crickets feed on in their farm, the cleanliness of their facility and the modernity of their technology. Their main products are grasshopper protein powder and gummy bears, which are both very removed from the whole insect.

An interesting parallel to draw here is with fungi protein products. Certain fungal species with higher than average protein content have been explored to provide an alternative protein source since the 1960s. However, initially, consumers did not want to eat those: the texture, flavor and thought of fungi growing spores were met with similar feelings of disgust and neophobia as insects are nowadays. As a result, producers decided to mix mycoproducts (fungal products) with other ingredients to mask the taste and flavor. (Barzee et al, 2021) One prominent success story of this approach is Quorn, a UK-based producer of vegan protein products, where the company does not formally classify its products as fungi but instead as a protected trademark, "Quorn[©]".

As seen in the input/output analysis, producing edible insects is far more sustainable than other animal meat sources. They are able to produce more protein and calories per unit of input than other traditional meat sources. This meets Rogers' **relative advantage** factor - edible insects are more sustainable than other protein sources - and **compatibility** - consumers want to consume sustainable food products. Researchers have shown consumers are more attracted to and likely to consume sustainable food products. Paavola (2001) first used a standard microeconomic approach to rational consumer choice, assuming it was an individualistic phenomenon, and found that consumers would consume more of a product if it was environmentally friendly. However, when Paavola analysed interdependent consumer choices informed by self- and welfare-centered values in a simple game-theoretic model, consumers were much more likely than in the first model to consume environmentally friendly products.

It suggests that the influence of society and other consumers can have an impact on an individual's consumption choice, especially regarding sustainable products.

Many edible insect companies put sustainability at the forefront of their marketing. The majority of their websites' homepages tout insects as the new, sustainable super-food. For example, "Producing one of the world's most sustainable sources of complete protein" , "(...) results in negative emissions and very low water usage" or even "Unbelievable yet true, the locust is one of the most efficient sources of protein God and nature have ever produced". (Flyfarm, 2021; Instar Farming, 2022; Biblical Protein, 2021) Yumbug also has a flyer in every one of their products, explaining how sustainable their products are. (Yumbug, 2022)

However, a survey in Poland showed that consumers were aware of the environmental challenges that our food system was facing and that edible insects had certain environmental benefits. However, the majority were still not willing to eat insects. (Kostecka, 2017) Indeed, other research on whether sustainability is the main motivation for consumers' choice shows that it is not the most important concern. There are much stronger predictors of the willingness to consume such as price and availability. As a result, it is unclear whether sustainability-focused marketing is the most effective. (Krger, 2022) The results from this study demonstrate that the sole argument of sustainability is not enough to get people to consume insects, as they have much deeper conscious and unconscious biases that influence their decisions.

Consumers perceive insects to be risky and have trouble trusting the product is tasty, healthy and safe. The key for companies is finding ways to convince them and make them trust that their product is as such. This is especially done through their communication channels. These issues address **relative advantage** - edible insects being tastier and healthier than alternatives - and **compatibility** - is the product safe enough?

Consumers prefer when their food has minimal ingredients and is minimally processed. (Grant et al, 2021) For instance, Hargol focuses on "clean labels", with as few additives and processing ingredients as possible. Other companies also try to be completely transparent about where and how their products are made. Flyfarm, for example, sells live insects, dried ones, insect fishmeal, oil and fertilisers but clearly explains how these products are made from BSF. (Flyfarm, 2022)

Economists have recognised that consumption is not only a process of meeting one's needs, but also a way to create an identity and communicate beliefs. (Dolfsma, 2013) Consumption patterns are a way for an individual to be unique and project an image of themselves onto others. This links to **compatibility** - whether a product is in line with consumers' values.

Religion is a very strong influence on one's consumption. Food choices are a way for religious people to signal to their peers their faith. (Dolfsma, 2013) As Jews eat kosher and Muslim eat halal, they show that they act in line with the teachings of their religion. This is a powerful tool as entire industries have been created from these religious guidelines. Hindus have been shown to turn down insects due to their religious beliefs (vegetarianism), showing that religion can influence the consumption of novel foods. (Krger, 2022)

A peculiar but interesting example employing a religious identity strategy is the insect start-up Biblical Protein. They target orthodox Jews and Christians with edible insect products in the shape of protein bars and shakes. Their inspiration comes from the prophet John the Baptist, for whom the New Testament mentions that he ate "locusts and wild honey". (Holy Bible, 1974) Believers want to get as close to their prophet and the teachings of God as possible and, therefore, want to live like one. Their faith is an important part of their identity, and start-ups like Biblical Protein target consumer products that match it.

However, as a caveat, other studies such as one in Finland, contradict the idea that consumption is only an "identity constructing quest". (Wilska, 2002) It has been found that there are much more important considerations for consumers such as low prices, accessibility, and ease-of-use. In addition, consumers are not always consciously aware of the identity they are constructing, even if they are doing so. Hence, targeting identity may constitute a smart strategy for a niche group of dedicated consumers but perhaps not for reaching the mass market.

Motoki (2020) showed that people were more willing to consume insects with friends and families as well as in more social settings (pubs, restaurants, festivals). This shows the importance of community and connection. Experiences are usually more enjoyable when they are shared with others. For example, this is what the start-up Yumbug attempts to achieve, (Yumbug, 2022) creating a "Bug Community", consisting of a relatively small, but passionate group of bug enthusiasts. They specifically cater to their needs and organise regular "Bug Clubs" where they can meet each other. By offering Yumbug crickets and being part of a tight-knit community, the company encourages a strong sense of connection towards their product, which is invaluable for customer retention. Particularly powerful is the influence of friends and family on the consumption patterns of an individual. Although television and celebrities can have an impact, friends and family have a much bigger influence. (Motoki, 2020; Wilska, 2002) Having a passionate and loyal customer base will help a company spread its products to families and friends of the individuals in that group.

"Early adopters" are especially important for innovation. Early adopters are consumers who intensively like a product, because of the values a product/company has or because it is solving an immediate need that they have. They are even content with an unfinished and sub-par version of the product, usually have a strong relationship with the product, and are very loyal. The benefit of starting with early adopters is that they can give feedback and information on how to improve the product. The company can innovate and change the product without risking this consumer base. These early adopters will enable the company to iterate and grow so that, at some point, it will be ready for a much wider audience. (Palm, 2020) They will also help diffuse and spread the product to the mainstream. (Rogers, 2003) Drawing from the example of Yumbug, their group of bug enthusiasts helps edible insects be more accepted as they talk about it with many people, and spread positive ideas about insects as food.

3.3. Potential Solutions

I have investigated the challenges the edible insect market faces regarding consumer acceptance as well as some solutions current companies are developing. I will now suggest alternative strategies and recommendations companies could use to appeal to a more mainstream audience.

Consumers, especially in Western countries have not been exposed to eating insects, they are unfamiliar with them and are very reluctant to eat them. How can companies change this consumer behavior? One way is that companies could focus on increasing the visibility of insects as a product and normalising entomophagy. An intermediate step to insects as food is having insect by-products.

One of these by-products is organic fertiliser. BSF produce frass as waste, and this excrement can be used as an organic fertiliser. (Barragn-Fonseca et al, 2022) Current synthetic fertilisers use by-products from the petroleum industry. As countries look to reduce their emissions, this insect-based organic fertiliser could mitigate the reduction in the supply of synthetic ones. Experiments have shown that frass-based fertilisers do improve productivity and improve the soil's health and sustainability. (Menino, 2021) Flyfarm produces and sells this organic, insect-derived, fertiliser. (Flyfarm, 2022)

BSF oil can be used for biodiesel. BSF larvae grown on 1kg of cattle, swine, and poultry manure can produce 36, 58, and 91g of biodiesel, respectively. (van Huis, 2013) BSFs could produce 2, 1.9 and 0.01kg of bio-diesel per animal, respectively. (Leip, 2019; Chastain et al, 1998; Williams, 2018) In the US, 4kg (a gallon) of biodiesel cost £4.3 (£1.075 per kg of biodiesel). (IndexBox, 2022) This means that a single cow, pig, and chicken could produce, through the BSF conversion process, £2.15, £2.04, and £0.01 worth of biodiesel through their manure each day, respectively. Flyfarm also uses oil from BSF for livestock feed, replacing poultry fat, fish oil and oilseeds for example. (Flyfarm, 2022) The price of oilseeds has doubled in the past 10 years, opening the door for BSF oils to be used more widely. (Defra, 2022)

Insects as feed is also a great way to normalise having insects on our plates, even if not in a direct manner. A huge issue with the current agricultural system is that a large part of agricultural land and cropland is used to feed livestock: 70% of agricultural land is used for grazing and 34% of cropland is used for feed production. This is taking land away from direct human consumption of crops, fruits, vegetables, and pulses. (Stehfest, 2013) Mealworms and other insects do not need to feed on outputs of cropland as they can feed on produce scraps. Huge amounts of waste from produce is discarded and can be repurposed for feeding mealworms. The UN estimates that around 17% of the world's food production is wasted, creating a huge source of feed for certain types of edible insects. (van Huis, 2013)

Research has shown that consumer acceptance for animals fed with insects is much higher than eating edible insects, suggesting it might be a more viable alternative for insect farming in the near future. (Sogari et al, 2019) Insects are especially useful because of their high protein content, providing a high-quality source of feed for animals. Currently, they are predominantly used for aquaculture feed, especially for salmon. (Agriprotein, 2022) Salmon feed accounts for half of the production costs of a salmon farm (£1.3/kg of feed), so farmers are looking for cheaper feed alternatives, while keeping the protein content and feed quality high. (McCullough, 2019)

The main barrier to using insects as livestock feed, as embodied by Ynsect, the largest edible insect startup in the world, is the fact that current livestock feed is very cheap. Ynsect, having received nearly half a billion USD in funding, has decided in 2021 to shift its focus away from livestock feed to human consumption as it could not compete with current feed prices. However, the cost of livestock feed (including cattle, poultry, pig and sheep) has more than doubled in the past 15 years, suggesting that if this trend continues, insects might become a commercially viable option for farmers in the near to mid-term future. (Defra, 2022)

Surveys currently show that age is not a good predictor of current insect-consuming patterns. Yet, they do demonstrate that children are more "willing" to eat insects than older individuals. (Krger, 2022) Children have less life experience, and thus less time to develop certain biases, influenced by parents, society, or experience. They are more naive and thus more open to insects. In addition, past familiarity with insects makes an individual much more willing to consume them again. The idea of several researchers is that if young children are exposed to and eat insects early on, they will not have the usual disgust and reluctance towards edible insects as their elders had. (Dupont & Fiebelkorn, 2020)

Companies could target younger audiences with specific products and offerings. They might be able to gain a receptive and hopefully loyal customer base. This could include children's birthday parties, products sold in the children section or collaboration with cartoon and animated characters. Collins et al (2019) found that the age where the attitude shifts from a positive to a negative perception of insects as food is around 11 years old, so companies should focus their efforts on children under that age limit. Alternatively, Collins suggests introducing them in school canteens, but that might be more often the remit of public institutions.

An important but abstract goal that edible insect companies should aim for is to provide a positive experience to consumers. (Gmuer et al, 2016) As one would expect, a positive product experience makes a customer return and spread the benefits of the product to friends, family and social media.

A certain segment of consumers is curious about and interested in edible insects, likely a similar customer segment that currently engages in Yumbug's "Bug Club". (Stone et al 2022) These individuals want to experience a less-processed, slightly abnormal food product. In this case, direct entomophagy might actually be a good solution. This is different from the strategy of using indirect entomophagy to reduce the disgust factor, as it caters to the curiosity of a different consumer type. (La Barbera et al, 2021) It might be a good alternative for companies to target both types of customer segments with their products.

Sensory attributes are also crucial to consumers' experience with eating insects.
(Wendin & Nyberg, 2021) These include:

- **Visual:** Not seeing the insect, the insect being small.
- **Auditory:** Crunchy, sharp sounds are preferable.
- **Olfactory:** Insects usually do not smell strong, but it might be better to cover the smell in favor of more known and appreciated ones.
- **Gustatory:** Insects have a mild taste and spices can make the taste more enjoyable.
- **Tactile:** Touching the insect, cooking with it.

Some research by Chow et al (2021) suggests, however, that tactile stimuli do not have a positive impact on consumers' experiences and perceptions. Rather, they just increased the disgust factor of the study participants. Hence, this stimulus should be treated with caution.

Finally, Motoki (2020) showed that positive arousing emotions (fun, excitement) are preferable to positive calming emotions (romance, tranquility) when convincing consumers to try insects. Practically speaking, the context and atmosphere companies should attempt to create when selling insects (packaging, advertisement, stall at a food market) should be one of excitement and novelty.

The final recommendation for edible insect start-ups is to market and present their products as a unique and separate food category. They should not attempt to market edible insects as a meat alternative or substitute. By competing against animal-based protein sources, it would be competing against a well-established food source. The price of meat today is relatively cheap, thanks to years of innovation and scaling, and it will take a long time for edible insects to achieve that price competitiveness. Consumers for the past thousand years have been born and bred eating meat. Culturally it is an accepted food and preference-wise, the majority of people find it a natural food source. Studies have shown that plant-based alternatives cannot compete with meat in terms of flavor, texture and taste. (Zhao et al, 2022) Consumers often buy both animal-based products and plant-based ones at the same time, to compare. Then, they usually revert back to the animal-based product, unsatisfied with the plant alternative.

Therefore, edible insect companies should attempt to create a novel food category, where they can charge a premium and not compete with meat in terms of price and flavor. For example, tofu is by now considered a food category on its own, and is not marketed as a meat-alternative. This way, consumers do not compare tofu and meat on an equal footing.

Lobsters are a further good example of how a food that was once considered to be for the poor was catapulted in the mainstream and eventually the (very) high end, at the start of the 20th century. At some point, lobster used to be banned from US prisons, as it was considered unworthy food for inmates. The lobster industry tried to change that perception. Companies got Hollywood movies to include lobsters, got pictures of celebrities eating it and introduced them to high end restaurants. Slowly, attitudes towards lobsters changed and started to be seen as expensive food for the rich. (Spanier et al, 2015) Edible insects can learn from this success (and many others such as shrimp and sushi), and target higher-end customers to change the public perception of insects.

All these strategies attempt to increase the value that consumers have for edible insects, to ultimately increase demand. However, food history shows that the way that food becomes accepted is usually the other way: through increased supply.

The lobster example mentioned above, was only enabled by a new kind of boat (the lobster smack) that enabled fishermen to transport lobsters alive across distances, so they could fish further out and in higher quantities. Supply was first ramped up, and then demand followed. (Spanier et al, 2015)

By increasing the supply, insects will be more accessible for consumers to trial: (**trialability**) and knowledge about how to consume them will be more widespread: (**complexity**). Also, seeing insects in many different shops and contexts will help the normalisation of insects as food and will encourage and facilitate the diffusion by early adopters and other consumers of the product. Finally, large-scale production will drive costs and prices down for producers and consumers, respectively. This can make insects a much more competitive food product. (Shelomi, 2015)

The issue is that each company, on its own, cannot massively increase the supply without incurring large costs. It can only produce to meet the current demand, otherwise it will be operating at a loss. On the quest to maximise its profits, the company might operate at a loss to acquire new customers, but it still needs to break even at some point. This is where the government and the public sector can come and steer the market in a certain direction, that is in the interest of the wider population.
Next, I will explain why policymakers might want to encourage the edible insect industry, what risks it should aim to mitigate and what policies it could implement to do so.

4. The Role of the Government

Governments can have a role in helping certain industries and products over others, if they deem it beneficial for their population. With important challenges in the coming decades such as climate change, international competition, the race for innovation and the reformation of our food system, governments must find new policies to solve these problems. Do edible insects solve certain problems and what risks do edible insects, themselves, bring to the table?

4.1. Why Should Governments Care About Edible Insects?

Firstly, governments must make sure their population has enough food to sustain itself and has a robust supply chain that can withstand shocks. Food security is defined by the UN as "when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet dietary needs". (FAO, 1996) Thanks to its efficient transformation of inputs, potential for scale and nutritious content, edible insects can help countries achieve food security. They can also fortify foods by adding protein to nutritionally lacking foods. Food security is a crucial component of a country's sovereignty, independence and stability.

If a country depends on other countries for its supply of food, it is vulnerable and dependent on these other countries. It will have to make sure it is on good terms with its suppliers and may need to accept certain trade deals or other agreements in order to protect its food supply. This is dangerous because this essentially means that a country is not fully independent.

The provision of a stable and sufficient food supply is also important for the internal stability of a country. The lack of food, famines and high food prices have been, over millennia, the source of political coups, revolutions and uprisings. The most recent example is during the Arab Spring. Riots started in Tunisia and other Arab regions when grain prices shot up. It resulted in multiple dictatorial regimes being toppled. (Dellmuth et al, 2020)

Second, governments want to make sure their economy is competitive and growing, in turn making its citizens prosperous. They can do so by encouraging innovation. Edible insects can be considered an innovation in that they are a new product and also a new way of producing protein. Innovations enable societies to improve, meet the needs of their population and better the lives of consumers.

Third, a country wants to be integrated in the international trade network, and, thus, needs to have competitive firms. This enables the country and its companies to export and import products. Porter argues that a country's international trade competitiveness comes from the ability of its national firms to innovate. (Porter, 1990) If a country encourages innovation in a certain sector, for example the food sector, it will have a competitive advantage and can increase its exports and improve its trade balance. In addition, trade relationships and integration reduce the likelihood of war between states and promotes cooperation. (Copeland, 1996) Being a leader in a new product can also give the country a head-start in that market and benefit from the "first-mover advantage", these are the profits and advantages those that entered a market early can have. (Lieberman & Montgomery, 1988)

Fourth, edible insects seem to be a more sustainable protein source than traditional meats. As governments have pledged to reduce their greenhouse gas emissions and protect their biodiversity, insects might be part of a solution to "greening" their economy.

Finally, edible insects have been shown to have many health benefits that I will not delve deeper into in this paper. These include a very high protein content, large amounts of B12, iron and zinc. (Schmidt, 2019; Mwangi et al, 2018) The protein quality is also much higher than other protein sources. (Oibiokpa et al, 2018) These benefits can have very important positive effects on the health of humans and, by consequence, can save a considerable amount of money, time, and resources for national healthcare services.

4.2. What Risks Should They Mitigate?

Policymakers need to balance the need of the economy to grow and develop new innovations with the safety and stability of the country. Edible insects do pose some risks that governments will have to address.

The biggest risk in factory farming insects is biodiversity leakage. One can imagine that if an insect species that has been genetically engineered escapes in the wild, it may destroy local biodiversity and bring its ecosystem out of balance. Collins (2022) argues that this risk is minimal for different reasons. First, the likelihood that they escape is low because government regulators are very strict with how insect farms operate. They are required to have a three-layer approach, meaning there are three barriers for insects to get over (the cage, the room and the warehouse). In addition, the probability of a large enough escape is, again, low as thousands of boxes are separate from each other and handled one at a time. Finally, it is most probable that factory insects are not well-suited to the local environment, will therefore not survive and that the local species would have a greater chance of surviving than the factory-bred insects.

Current research on edible insects is looking at how to optimise the nutrient profile of insects to make them as healthy and nutritious as possible. This is done by genetically engineering species to get the desired nutrient profile. Collins (2022) explains that the majority of our food today is manipulated in some way. This is especially true for the meats and produce we consume. As a result, although the idea of genetically engineering insects for consumption might seem futurist, it is in fact normal and in line with current food practices.

Due to the large genetic and evolutionary difference between insects and humans, the risk of zoonotic diseases (diseases transmitted from animals to humans) present in insects is relatively low. (Collins, 2022) However, there is a non-negligible risk of allergies. It has been shown there is a link between crustacean and insect allergies. (Ribeiro, 2017) Around 0.5-2% of humans have a shellfish allergy and it is likely that the majority of them will be allergic to edible insects. Microbial risks (contamination by microorganisms found in the air, food, water, soil), will always be a threat in producing food products, but does not seem to be especially important in insects. (Cappelli et al, 2020)

Policymakers should be wary of the unintended economic consequences of edible insects. Rogers, seminal author on the diffusion of innovations, would predict that larger farms would take over smaller ones, as they scale up and take over the market. (Rogers, 2003) This is what happened when tofu became popular in Western countries but is also a wider trend in the farming industry. (Menzel & D'Aluisio, 1998) There could also be impacts on the price of other products: if competing with the same resources, the price of feed, meat and pet food might increase. (Shelomi, 2015)

The issue with our food system is that we have taken our production close to its maximum with factory farming and intensive monocultures. Our agriculture developed to have a highly efficient system to produce food in the short term, but is damaging our long-term ability to produce food as it is destructive to our ecosystems. More local, less intensive food production systems might be less efficient but might help restore the environmental balance and ecosystem. Consequently, is scaling up edible insects and factory-farming them really the solution? Although the inputs are minimal, producing insects on a large scale may pose some unforeseen problems. It might be better to steer our food system in a different direction, away from intensive, factory farming. This question over factory farming is a dilemma, as the world population is growing and certain regions of the world are suffering from famines. The real issue is actually how we distribute our production, and not how much we produce. Bloomberg (2010) calculated that we can feed two Earths with our current agriculture infrastructure, so innovation might be better directed in how we allocate our production in a fairer manner.

4.3. Policy Recommendations

Policymakers may benefit from encouraging edible insects as a product and as an industry. The most obvious policy would be pricing carbon emissions more heavily. Since insects emit minimal carbon emissions, this would help them reduce costs compared to other food sources. One way to price carbon is to give a certain amount of emissions quotas to companies and let them trade these emissions quotas based on their need. This is called an "Emissions Trading Scheme" and has been implemented in the UK and the EU. If a company wants to emit more, it has to pay more. The European Union emissions trading system has been shown to reduce emissions by 10% without hurting the financial performance of firms. (Dechezleprtre et al, 2018) Pricing carbon would make edible insects more competitive compared to other protein sources.

Governments could also find ways to encourage innovation, which could benefit the insect industry. Innovation enables firms to differentiate themselves, be more competitive and offer better products. Collins (2022) argues that the lack of funding is what is holding the edible insect industry back. This includes funding for researchers looking to optimise the nutrient profiles of edible insects, and those looking at the best way to domesticate insects for human consumption. It also includes grants and funding for entrepreneurs and businesses wanting to sell edible insects. Initiatives such as the "Emerging Insect Technology Hub (EIT-Hub)" (2022) between Africa and Australia are a great example of cooperation and innovation in this space. Another success story is Agriprotein, which developed its own technology to treat food waste so that it is digestible by BSF. This was protected by a patent (Intellectual Property - IP) and enabled them to differentiate themselves from other competitors. Having IP rights leads to above average returns for companies. It is also a type of intangible asset that adds value to a company and can be sold. (Greenhalgh & Dixon, 2002) For example, when Agriprotein did not find enough funding to continue operating, it managed to sell its IP rights to a larger company before being disbanded, without the need to file for bankruptcy.

However, the most basic and important piece of legislation is whether edible insects are a legal food in a country. The EU, for example, considers the mealworm and the cricket as novel foods. These are foods that are traditionally eaten outside of the EU and that the EU deems safe to consume. This gave a huge boost to the edible insect industry and enabled European companies to function within a legal framework. In the UK, however, this is not the case anymore because FSA decided not to keep the EU's legislation regarding novel foods after Brexit. This means that all edible insect companies in the UK are currently operating in a grey area at best, or outright illegal at worst. This obviously hinders the businesses' ability to function, receive funding, expand and market themselves. (Horizon Insects, 2021)

5. Concluding Remarks

Edible insects can be produced in a more sustainable manner than traditional animal-based protein sources. The resources used to produce edible insects is just a fraction of what is needed for traditional meat sources. In addition, they are dense in protein, a crucial macro-nutrient that most humans do not get enough of. Environmental and nutritional benefits are there and are pushing entrepreneurs to enter this industry. The challenge for them is in changing consumer behavior and acceptance. Edible insects are still met with disgust due to cultural norms and neophobia. Insects are still not taken seriously and are often seen as a gimmick.

Edible insect companies are trying to overcome this reluctance with indirect entomophagy and using insects as feed, to normalize the act of eating insect products. Additionally, companies are attempting to build communities, mimicking the early adopters strategy in the technology industry.

We suggest that companies could also increase familiarity by selling insect byproducts, targeting a younger audience and making edible insects a unique food category. Competing directly against traditional meat sources does not seem to work, edible insects should look to differentiate themselves in another manner.

However, the supply side of the market must also be addressed. Diets and food habits change when there is a major improvement in the supply of a certain product, as we have seen with lobsters in the 20th century. Governments might have an interest in promoting insects as food and boosting its supply. Insects could provide an answer to food security, climate change, and economic competitiveness. Legalising edible insects and encouraging innovations in that industry might do just that.

Whether consumers are ready to eat bugs is still an open question, and this is the most crucial one the industry must answer. Further research will be needed to understand the evolving acceptance of insects, the evolution of societal norms, and consumer attitudes. It will be important to identify what strategies work or not, especially those involving children and insects' long term effects on them.

Acknowledgements

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Article

Policy Brief: Right-to-Work Legislation and Union Membership in the US

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Abstract
Union membership rates have been declining in the US since around 1950. After Congress allowed states to pass Right-to-Work (RTW) laws in 1947, 27 states have enacted legislation that outlaws the requirement of joining a union as a condition of employment. Existing research suggests that these RTW laws increase the free-rider problem for union organizations and reduce union membership, therefore decreasing union bargaining power and both union and nonunion wage rates. The value of unions in the US labor market is not the focus of this brief, although I give some background on that issue as motivation. Past literature has yielded suggestive results, but more recent literature employs modern research designs that plausibly conclude RTW diminishes union membership and union power in states after it is enacted.

Keywords: Unions, Policy Analysis, Economic History, Right-to-Work Legislation

1. Background

1.1. Union Decline

Labor organizations have been around in the US since the 1780s, but union membership as a proportion of the non-agricultural workforce fluctuated greatly before the 1940s, growing in intense spurts and falling just as quickly (Rosenbloom 2006). At its peak in 1945, over one third of non-agricultural workers were union represented (Rosenbloom 2006). After remaining strong in the 1950s, union percentage in the United States has been declining and sits now at around 12.1% of the workforce (Bureau of Labor Statistics). Unions have been a staple institution in the blue-collar workforce in America, but if the trend continues, union existence is at risk.

Figure 1: Union Membership Rate, Non-Agricultural Workers, 1880-1998, from Farber and Western (2001)

1.2. Why Should Policymakers Care? The Value (or Disvalue) of Unions

In a theoretical framework viewing unions as merely a monopolist of labor supply, union organizations raise wages above the economically efficient level, creating market distortions that lower productivity and output (Freeman and Medoff 1979). This view centres around a competitive labor market and firms operating at a perfectly competitive equilibrium. However, very few firms in the United States operate at a perfectly competitive equilibrium. Most firms accrue some economic profit that is larger than their operating costs. By requiring higher wages and benefits for employees, unions can take a larger slice of the firm's pie, but at the expense of upper management. According to price theorists from the '50s, firms may simply hire fewer employees in response to the unions' demands for higher wages (Meyers 1959).

Since the key tenet of union demands is wages, labor economists often examine wage effects, particularly inequality. In their paper, "Unions, Norms and the Rise in U.S. Wage Inequality," Western and Rosenfeld document that from 1937 to 2007, private sector union membership declined from 34% to 8% for men and 16% to 6% for women, while inequality in hourly wages increased by over 40% during this period. Western and Rosenfeld claim that the decline in organized labor explains 1/5th to 1/3rd of the growth in inequality in the US, and this claim is supported by other works which have found that unions historically reduce inequality (e.g., Freeman and Medoff 1984, Collins and Niemesh 2019, Farber et al. 2021). If policymakers are concerned about rising income inequality, bolstering unions is a natural answer. In the 1980s, labor economists developed more nuanced

views of organized labor institutions, rather than just focusing on theoretical market distortions. In their seminal book published in 1984, "What do Unions do?" Richard Freeman and James Medoff look further than just the "monopoly face" of unions and describe social benefits due to the "collective voice" face, including more fringe benefits, less employee turnover, and higher economic efficiency within a firm. According to them, "On balance, unionization appears to improve rather than to harm the social and economic system" (pg. 19). If Freeman and Medoff are to be believed, the decline in unions and union power is certainly cause for concern in the 21st century.

1.3. Right-to-Work (RTW)

In 1935, Congress passed the National Labor Relations Act (also known as the Wagner Act), establishing rules for which employees of a firm can unionize and how they engage with their firm in collective bargaining (Herrick 1946). Collective bargaining is the process through which union organizations negotiate wages, benefits, and workplace conditions that apply to all covered employees. The NLRA also gave protections to unions and union-seeking employees from interference by employers, such as employment termination because of union activities (Herrick 1946). A key component of the NLRA was that it institutionalized the legality of closed shops, where being a union member is required for employment within a firm. This changed with the passage of the Taft-Hartley Act in 1947, which outlawed closed shops and gave states the power to pass RTW laws (Ellwood and Fine 1987). RTW legislation outlaws the existence of so-called union shops within a state, allowing workers to decline union membership in all settings if they choose. Union shop arrangements are similar to closed shops, requiring that nonsupervisory workers must join (and pay dues to) the representing union within a specified period of time after employment (Carroll 1983). After Taft-Hartley, the union shop arrangement became a tool for unions to finance their activities and strengthen their negotiating power by increasing membership. With more union members, a local organization's threat to strike or picket their workplace becomes more dangerous to the firm. RTW laws abolish the union shop arrangement, removing an important tool for union organizations to maintain power.

The details of RTW implementation fall to the states that pass it and how they structure legislation. Generally, state RTW laws cover collective bargaining agreements (CBAs) that are negotiated, re-negotiated, or extended after the law is enacted (see National Conference of State Legislatures for a database of bill language). CBAs can vary in length and are typically multi-year contracts, so some union shops may stick around after RTW is passed because the law applies only to new negotiations. Recent research on a sample of CBAs from 1988 to 2016 found that the typical contract length is three years (Chava et al. 2020). Thus, the opportunity to leave an individual's union organization and stop paying union dues may not come until sometime after RTW passage. Additionally, if a worker is already a union member, the responsibility falls on that individual to formally leave the union. RTW does not automatically strip union membership from workers, that decision to leave must be undertaken by the worker. Estimates on the number of union members who then leave their union after the passage of RTW is a gap in the existing literature and remains an open question.

Nicole Fortin, Neil Lloyd, and Thomas Lemieux describe RTW as a "profoundly partisan policy", and this is an accurate description (Fortin et al. 2022, pg. 5). Most of the states that passed RTW after 2000 passed it immediately after Republicans took control of the state legislature, the state senate, and the governorship, giving them the ability to pass legislation without any approval from state-elected Democrats (Fortin et al. 2022). This is not surprising considering organized labor in the US has staunchly opposed RTW efforts, especially in recent years. Since the New Deal period (1933-1939), organized labor has been closely tied to the Democratic Party, directing campaign contributions overwhelmingly to Democrats as well as providing volunteers for grassroots campaigning efforts (Francia, 2010).

Currently, 27 states have active RTW laws. Most of these states passed their legislation shortly after Taft-Hartley legalized it, in the period 1947-1960. RTW is not just an antiquity of the 20th century though, it is still a prevalent policy debate at the state level today. Kentucky passed RTW in 2017, West Virginia in 2016, and the Missouri state legislature passed RTW in 2017 before it was overturned via ballot referendum in 2018. Proponents of RTW cite increased freedom for employees and job creation, while opponents believe that it inherently undermines union power and leads to lower wages (Eren and Ozbeklik 2016).

Figure 2: A map of current RTW states. Source: National Right to Work Legal Defense Foundation

2. Theories on RTW Effects

2.1. The Free-Rider Problem

By outlawing union shops, RTW has the potential to increase union organizations' free-rider problem (Moore and Newman 1985). The free-rider problem occurs when individuals receive all the benefits associated with joining a group while bearing none of the associated costs. In the case of union membership, benefits include higher wages and fringe benefits on average, while the main cost is union dues (Freeman and Medoff 1984). A portion of a union member's paycheck goes to the union organization representing them to keep the organization operational, while non-members don't contribute to the union's finances. Union shops limit free-riding by forcing employees to officially join the union and pay member dues as a condition of employment, therefore bearing their individual costs and eliminating free-riders (Moore and Newman 1985). Under RTW laws, employees can join a unionized firm and be covered by the negotiated CBA while simultaneously not paying union dues. Organizing employees and bargaining on behalf of them takes time, effort, and money on the part of a union organization. With more free-riders, the strain on finite union resources increases, potentially diminishing the quantity of union services offered (Moore and Newman 1985). The free-rider hypothesis maintains that due to RTW, the opportunity to free-ride on union benefits arises, leading to a lower equilibrium level of unionization in RTW states (Moore and Newman 1985). If the free-rider hypothesis is correct, we should expect to see fewer union services and lower unionization rates in states that pass RTW due to RTW implementation (Moore and Newman 1985).

2.2. The Taste Hypothesis

A large problem that researchers face when investigating the effects of RTW is that RTW laws are not randomly distributed across the US. For a state to pass RTW, voters must elect politicians that will support RTW. Workers, and thus voters, might be predisposed to favoring RTW because of underlying anti-union preferences, creating a strong correlation between other factors that lead to anti-union preferences and the presence of RTW (Moore and Newman 1985). Looking back at *Figure 2*, RTW laws dominate the South, and the South has historically had smaller union membership compared to the rest of the country (Friedman 2000). This could be due to institutional and social factors that lead to anti-union sentiment among a majority of workers. A strict interpretation of the taste hypothesis would suggest that the passage of RTW merely reflects worker preferences and will provide no substantive change to union membership or wages after it is implemented in any state, given that it has been passed by that state (Moore and Newman 1985). However, the taste hypothesis could be at play to varying degrees in different states. If RTW is implemented in a state with high levels of pro-union preferences, we would expect to see a larger impact on

unionization rates and union wages in the pro-union state than a state in the South, where anti-union preferences are probably high.

2.3. The Bargaining Power Hypothesis

The bargaining power hypothesis maintains that passing RTW legislation directly reduces a union organization's bargaining power, lowering the union sector's ability to negotiate wages and benefits, therefore lowering union wages and also lowering the benefits of becoming a union member compared to a state without RTW (Chava et al. 2020). The bargaining power hypothesis predicts a similar outcome to the free-rider problem in which the passage of RTW would reduce unionization rates and union benefits in a state (Moore and Newman 1985). While still a predicted treatment effect of RTW, the bargaining power argument operates through a different channel than the free-rider problem. The key difference being that this is a direct impact on bargaining power rather than a result of individual workers not wanting to bear individual costs. Both effects would change the individual decision making for a worker, leading more workers to choose not to become a union member, but the manner in which these effects enter a worker's decision making are different. Under the bargaining power hypothesis, union bargaining power drops, reducing the worker's expected benefit of joining a union, leading to a lower unionization rate (Moore and Newman 1985). With the free-rider problem, RTW wouldn't directly reduce union bargaining power and thus wouldn't reduce the worker's expected benefit of joining a union. Instead, the worker can experience the same expected benefit of joining a union without actually joining and paying dues since the worker would still be covered by a union-bargained CBA.

3. Literature Review

3.1. Ellwood and Fine (1987) – The Impact of Right-to-Work Laws on Union Organizing

In their paper, Ellwood and Fine look at RTW's impact on the flow of workers into union membership in the ten years after a state passes RTW legislation. Rather than just looking at aggregate levels of union membership in RTW states, these authors exploit the flow into new membership because it should be more sensitive to changes in the union environment, and it also predicts future membership rates. The authors present a model where existing union workers leave the union sector (through retirement or employment change), forcing unions to organize new members to maintain their relative composition in the labor force. For example, if union members make up 20% of the workers in the auto industry, the union sector must add new members each year to offset workers leaving the union sector. This becomes especially important during times of employment growth. If employment is rising in the auto industry, enough employees must join the union sector to offset workers leaving and the growth of the nonunion sector, and maintain the relative union composition of 20%. Maintaining relative composition is key because any reduction in the proportion of union to nonunion workers decreases the bargaining power of all union organizations. With a higher availability of nonunion workers, it is easier for firms to substitute for nonunion labor, reducing the power of union organizations to negotiate higher wages and benefits. The rate at which union workers leave the workforce may be slow, thus, level changes in union membership will probably be less sensitive to RTW in the short run. Changes in worker expectations and preferences about unions should immediately manifest after RTW laws are passed and can be measured through inflows of new union members. Therefore, Ellwood and Fine's paper benefits from the examination of flows, instead of levels of membership immediately after RTW passage. To measure these flows, the authors use data on the number of workers newly organized through National Labor Relation Board certified elections.

Ellwood and Fine use a state cross-section analysis for all 50 states 1951-1977, with dummy variables for 5-year intervals after RTW passage in a state. They include a variety of state-level controls to account for many other determinants of union membership, such as employment growth rates, proxies for union support/anti-union sentiment, and proxies for business cycles to name a few. Interestingly, after the rest of their controls are added, the region dummy for the South becomes positive and statistically insignificant. There exists large discussion in union literature on market factors and anti-union sentiment in the South, usually producing a negative, statistically coefficient whenever a South region dummy is included in statistical analysis (eg Carroll 1983, Farber 1984). Their South coefficient being positive implies that the authors' model successfully accounts for variation in worker union preferences with other observable state characteristics. In addition to this, the authors conducted a robustness check with seven states in which they had better data availability. Using their previous specification with a leading indicator for RTW passage, they found no evidence of a pre-trend in labor organization that could bias their results. Indiana, which passed then later repealed RTW, offers particularly good evidence that the presence of RTW had a distinct effect on union organizing rates (see Fig. 3).
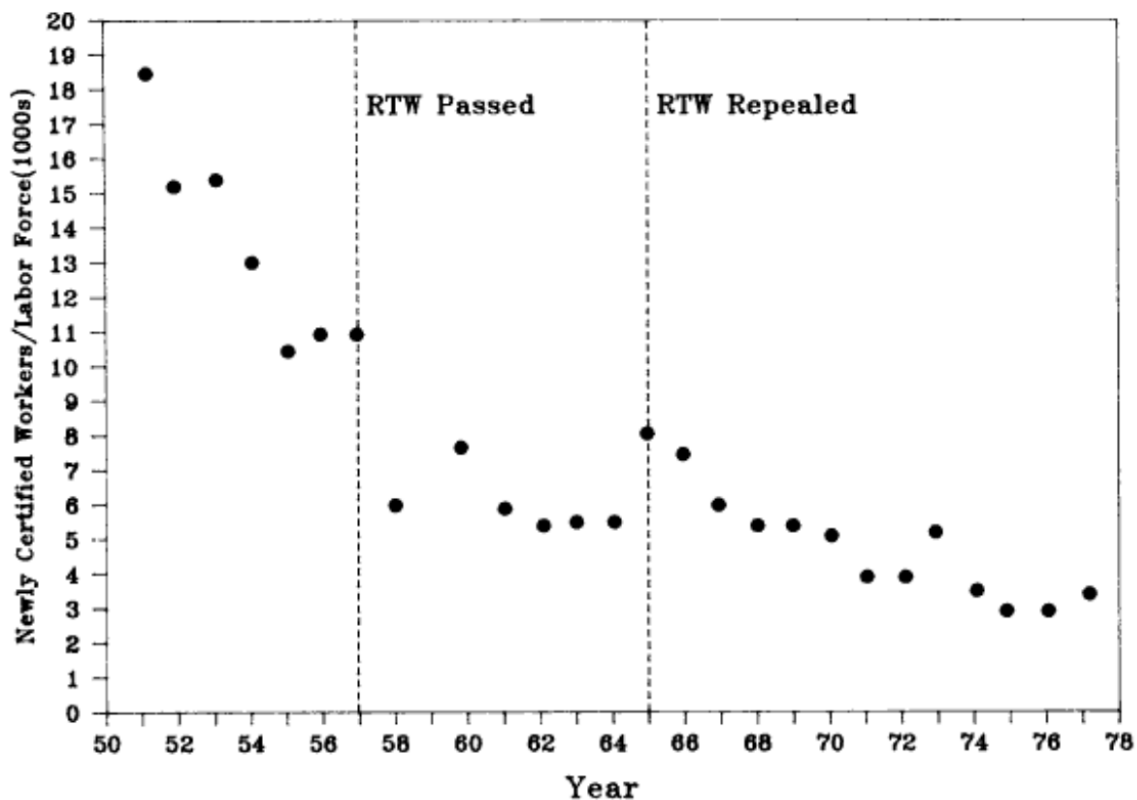
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Figure 3: Organizing in Indiana: 2-Year Moving Averages, from Ellwood and Fine (1987)

Examining all 50 states, Ellwood and Fine found dramatic falls in organizing rates immediately after passage, with more moderate effects in later years. Within the first five years after RTW passage, inflows of union members were reduced by 50%, and between 5-10 years after passage, it was reduced by roughly 25%. After 10 years of passage, the estimates became statistically insignificant. While the long-run levels of union organizing after RTW implementation are unknown, there is a sharp decline in new employees entering union membership in the short-run. This immediate drop could reflect workers' perceived strength of unions after RTW is passed, believing that unions will lose power, thus lowering the benefits of becoming unionized and shifting individual workers' decision-making away from union membership, even if they weren't previously a union member. This drop could also reflect the decision making of previously indifferent workers, who were forced to join a union in a union shop. Now, with RTW outlawing union shops, they join the union firm as a free-rider and don't become a union member. Ellwood and Fine do mention the psychological factor of perceived union strength being important in the willingness of activists and union members to organize, but they do not mention the potential increase in the free-rider problem. Unfortunately, since they measure aggregate inflows at the state level, Ellwood and Fine can't distinguish between these two groups of workers. In either case, RTW states saw a decrease in the inflow of new members. Down the road, this will lead to smaller relative union membership and less bargaining power. Ellwood and Fine predict that this initial shock reduces long-term union membership by 5-10%. Although some other factors could influence this estimate of long-term reduction, states that passed RTW laws experienced a decrease in membership flows in the short run, thereby diminishing union bargaining power and their ability to improve worker welfare. Ellwood and Fine do not employ a research design and their results are merely observational, so their results should be interpreted cautiously. However, these results agree with the view that RTW diminishes union membership.

3.2. Chava et al. (2020) – The Economic Impact of Right-to-Work Laws

Chava, Danis, and Hsu also deviate from using CPS data and instead opt to investigate the effects of RTW on union wages through CBAs. With this data, the researchers only look at effects on union members. Chava and his colleagues look at five states that introduced RTW legislation between 1988 and 2016: OK, IN, MI, WI, and WV. By examining CBAs, the researchers can isolate only union wages and measure the impact of RTW with less noise than aggregate wage data for a state. Although

the researchers cannot observe specific wage levels using the CBAs, they can observe reductions in wage growth, which would decrease future wage levels.

With this data, Chava et al. tests RTW's impact on union organizing efforts with a Difference-in-Difference design to measure the number of CBAs filed per state per year, using the passage of RTW as treatment. They found that on average, the number of CBAs filed per year fell by 7.75 for RTW states compared to non-RTW states. This is half of the average CBAs filed per state per year, which suggests that RTW reduces the number of CBAs by almost half. There could be other factors such as state industry composition that correlates with reduced CBAs and the passage of RTW, but these results still offer convincing evidence that RTW has an effect on union organizing. The CBA data also allows the researchers to look at the free-rider problem by measuring the fraction of workers covered by the CBA and the fraction of union members. While the number of CBAs fell, the proportion of CBA-covered workers to union members increased, implying that RTW legislation exacerbates the free-rider problem for union organizations. Both the reduction in CBAs and the increase in the free-rider problem are consistent with the view that the passage of RTW laws decreases union bargaining power.

Unfortunately, the researchers can't distinguish between workers who left their union after RTW versus workers who were never union members but are then covered by a CBA after RTW. Thus, they can't investigate the question of how RTW changes the individual decision-making of would-be union workers and would-be non-union workers in the absence of RTW. This question is a potential avenue for future research and would further our understanding of who RTW really impacts.

Since Chava et al. find evidence that suggests a potential reduction to union bargaining power, they then turn to findings on union wages and firm response, looking at RTW as a shock to bargaining power. The researchers found an immediate reduction in wage growth, but no long-term effects. This is not surprising, as a year-after-year reduction in wage growth would compound, greatly reducing wage levels and making firms uncompetitive in hiring. The initial shock occurs within a year of passage and reduces wage growth by 0.6 percentage points for RTW states compared to non-RTW states. Although the researchers are limited by their data and can't observe wage levels, the reduced growth for just one year predicts reduced wage levels in the union sector for future years. Using a different data set of firm-level accounting data, the authors turn to another important discussion – how firms respond to the passage of RTW. It is important to note that this firm-level data set also includes nonunion firms. This is beneficial since it provides some indication on how the whole market would react. A classic supply/demand model for the labor market predicts that a decrease in employee wages would increase the number of people employed. Following their earlier findings of reduced union wage growth, Chava et al. supports this framework and found that RTW is associated with a 1.66% increase in a firm's employment growth. In addition to this, they found that RTW is associated with an increase in CEO compensation for all firms and higher profitability for firms with large labor costs. If policymakers are concerned with rising wealth inequality, the increase in CEO compensation is also cause for concern if union workers are simultaneously experiencing decreased wage growth. Supporters of RTW legislation typically argue that by limiting union power, it helps firms maximize their profits and stay competitive. This paper provides evidence that RTW may be beneficial to firms in the state by improving profitability. These effects on the firm also reflect the expected results of RTW undermining union bargaining power. Union members and union organizations lose out on wage growth while executives and firms benefit.

3.3. Farber (2005) – Nonunion Wage Rates and the Threat of Unionization

The labor market is interconnected, and wages and benefits in the union sector impact wages and benefits in the nonunion sector. Like much of the debate around organized labor, researchers have proposed different theoretical frameworks for the effects of unionization on wages of nonunion workers. With the spillover effect, if union organizations raise union wages, firms would reduce employment, then displaced union workers would move to the nonunion sector and depress the equilibrium wage. With the threat effect, nonunion firms must remain competitive in recruiting labor and mitigate desires of employees to unionize. They will respond to union wage gains by offering nonunion employees higher wages. In the real-world, both effects are probably present, but an important question arises as to which has a larger effect. Measuring the threat effect is difficult since researchers can't get into the minds of wage-setting firms, but Farber tries to isolate it through various proxies, including the predicted probability that someone will be a union member, the passage of RTW laws, and industry deregulation. He uses CPS data from 1977 to 2002.

First, Farber creates a predicted probability of an individual being a union member. He uses demographic information, year, industry that an individual works in, and state of residence to create a probability that a person in the data set is a union member. The idea is that employers also observe all this information and can also predict an individual's union probability. If someone

is more likely to be a union member, there is a higher threat effect, and they should see higher wages. Farber compares predicted probability and wages within industry and within states to control for other unobserved factors that could bias his results. Using this proxy, he found no substantial threat effect present.

Next, Farber looked at the passage of RTW in Idaho (1985) and Oklahoma (2001) as policy shocks that reduce the threat effect. As Ellwood and Fine and Chava et al. showed, RTW seems to reduce union bargaining power. After the passage of RTW, nonunion firms should conclude that unions are weaker and reduce their wages because the threat effect is weaker. Compared to other states, the wages of nonunion workers fell by 4.2 percentage points after RTW was passed in Idaho, while union wages saw no significant change. There were no significant findings for Oklahoma, but Farber acknowledges that this could be because he only had one year of data after Oklahoma passed RTW. It is also possible that the taste hypothesis was in play for Oklahoma, which had a lower rate of unionization when RTW was passed than Idaho (6.7% compared to 11.6%). The results from Idaho are suggestive that the threat effect exists and that RTW reduces the union threat, particularly since union wages saw no change in the same time period.

Finally, Farber uses deregulation in the airline (1978), trucking (1979), and telephone (1984) industries during this period as a shock that reduces the threat effect. The CPS collects information on the industry that a person works in, and Farber uses this to compare nonunion wages in an industry that deregulated to other industries, five years before and after deregulation occurred. Regulation adds to union power in an industry by installing higher costs to entry for nonunion firms. After deregulation, it would be easier for nonunion firms to enter, decreasing union power and the power of any unionization threat. Farber found that the wages of nonunion workers fell in trucking and telephone, compared to other industries. Airline nonunion wages did not fall, but they did not keep pace with union wage growth. These results could be due to the threat effect, but they could also be due to other factors associated with deregulation like increased competitiveness, requiring firms to offer lower wages across the board.

3.4. An Interpretive Note on Farber

RTW stands out in Farber's proxies because it was the only selection that yielded results consistent with the threat effect. Passage of RTW is an obvious signal to firms that union power has decreased, making it easy for them to identify a decrease in the threat of unionization. The predicted probability method found no results. From the standpoint of a researcher, it may be easy to predict the likelihood of unionization based on observable characteristics, but this is probably very difficult for a firm. Therefore, firms probably don't realize the changes in threat through small changes in predicted probability and will not adjust their wages. Deregulation provides some evidence that a threat effect exists, but RTW is a clearer signal to firms. From the passage of RTW, nonunion firms believe that union power falls, leading them to not offer higher wages to compete with union firms.

3.5. Other Literature

There is a wide range of other literature which finds no effects of RTW on union membership, but this research relies on changes in levels of union membership, rather than flows into membership (Moore and Newman 1985, Farber 1984). RTW effects on levels of union membership could take a long period of time to materialize, opening the door for market factors and other general trends to dilute the effect. Meanwhile, Ellwood and Fine's findings that flows into union membership immediately change after RTW passage suggest a direct link between future union membership rates and RTW legislation.

Very recently, Nicole Fortin, Neil Lloyd, and Thomas Lemieux began investigating the effects of RTW with more rigorous empirical methodologies. Fortin et al. (2022) focuses on five states that have adopted RTW since 2011. In their working paper "Right-to-Work Laws, Unionization, and Wage Setting," they use an Event Study design paired with a Difference-in-Difference analysis, then confirm their findings using industry unionization rates by state as a measure of differential exposure to RTW. The idea behind the differential exposure design being that RTW will have a larger impact on industries with a higher unionization rate. They support the conclusions of Ellwood and Fine and Chava et al., finding that their research designs "provide evidence that RTW laws reduce unionization rates and wages." (Fortin et al. 2022, pg. 31). Fortin et al. benefits from their use of microdata, allowing the researchers to examine heterogeneity in RTW impact across industries with different union densities. They find that RTW had its largest impact on high-unionization industries, supporting the internal validity of their differential exposure design and providing some insight on state characteristics that could affect the magnitude of RTW's impact (Fortin et al 2022).

4. Conclusion

Since the 1950s, unions have been losing power in the US. Even though Farber and Western, in their paper, "Accounting for the Decline of Unions in the Private Sector, 1973-1988," attribute most of the modern decline to broad market trends like globalization, there is still some hope for a union presence in America. While market trends limit unionization numbers, policymakers can choose to counteract these broader effects or exacerbate them. Ellwood and Fine, Chava et al., and Farber found evidence that RTW laws undermine union bargaining power and increase the free-rider problem, thus diminishing union membership, union wage growth, and even nonunion wage rates. Fortin et al. provides more robust evidence that RTW decreases union membership rates and union power. If you place confidence in the conclusions of Freeman and Medoff and believe that unions improve our social and economic systems, then RTW legislation across the US is certainly cause for concern.

Aside from Fortin et al., most existing research on RTW has examined aggregate effects at the state level, measuring union organizing rates or average changes in worker wages. Theories have been proposed on how RTW can change an individual worker's calculus of whether to be a union member or not, but empirical evidence on rates of compliers (those who decide to leave their union after RTW) is almost nonexistent to my knowledge. Measuring rates of compliers and further investigating how RTW changes individual decision making is an opportunity for future research and would aid in our understanding of how RTW affects a state's labor market. Additionally, the new cluster of states that have passed RTW since 2010 provide an opportunity to examine RTW's effects in states with potentially different levels of union preference among workers. Michigan and Wisconsin, historic union strongholds, passed RTW in 2013 and 2015 respectively and created an opportunity to look at RTW in states with a history of strong union organization.

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Article

Silver Lining in Looming Storm: Examining China's Population Aging Crisis, Expansionary Population Policy, and Alternate Solutions

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Abstract
Home to over 1.4 billion residents, China has been the world's most populous country for centuries. While population growth had been largely natural in China's long history, population policies and controls had become an integral part of Chinese policymaking since the late 19th century. After the Communist Party overtook the regime in 1949, population policies became even more pivotal, if volatile and willful at times. In this essay, I will first show that there is indeed a significant population aging crisis brewing within China, which could mark a fundamental metamorphosis that decimates China's population dividend. I will further state that this belated policy turnaround is already highly unlikely to prepare the Chinese population for the looming population aging crisis, nor is it a promising idea to play this population catch-up game, because it will incur an even heavier burden for the working age population in the next decade. And finally, I will propose alternate solutions to the looming population crisis that look beyond simply boosting birth rates, in the form of a fairer redistribution system and pension system reform that alleviates anxieties and burdens of the working class as well as elderly population.

Keywords: Demographic Crisis, Long-Run Growth, China

Three distinct stages of population policies can be identified in the history of the People's Republic. From the 1950s until his death in 1976, Mao Zedong presided over one of the most significant population explosions in human history, when his expansionary fertility programs added almost 600 million people to China's population. Mao's successor Deng Xiaoping and his cabinet reversed this unsustainable population expansion and adopted the contractionary, if equally controversial, "one-child policy", which mandated the majority of Chinese households to have only one child. Observed as one of the "staunchest attempt[s] of population control" (Lewis, 1987), the one-child policy has been the "fundamental national policy" for over thirty years. However, this fundamental policy[1] to control population growth recently gave way to the third stage of population policy. The first sign of transition came in 2013, when China's National People's Congress broadened the range of exceptions for the one-child policy, before completely replacing the one-child policy with a universal two-children policy in 2015 and expanding again to a three-children policy in 2021. Hence, China's population policy saw another reverse from population control to expansionary policy. It is evident from this rapid U-turn of policy that the Chinese authority had abandoned the "fundamental national policy" amidst growing concerns about an aging society and adopted a new stage of expansionary policy actions to offset downward pressures from a shrinking labor force.

In light of recent policy shifts, what will be China's population outlook? This is a question that concerns not only people in China, but also around the world. Given China's interwoven relations with other global powers, as well as its almost inseverable connections with the global supply chain, any disruption in China's productivity will have considerable ripple effects felt across the globe. China has dominated the global supply chain for the past thirty years with its low labor cost and tremendous population dividend, which is set to diminish as the generation under one-child policy collectively enters the labor market.
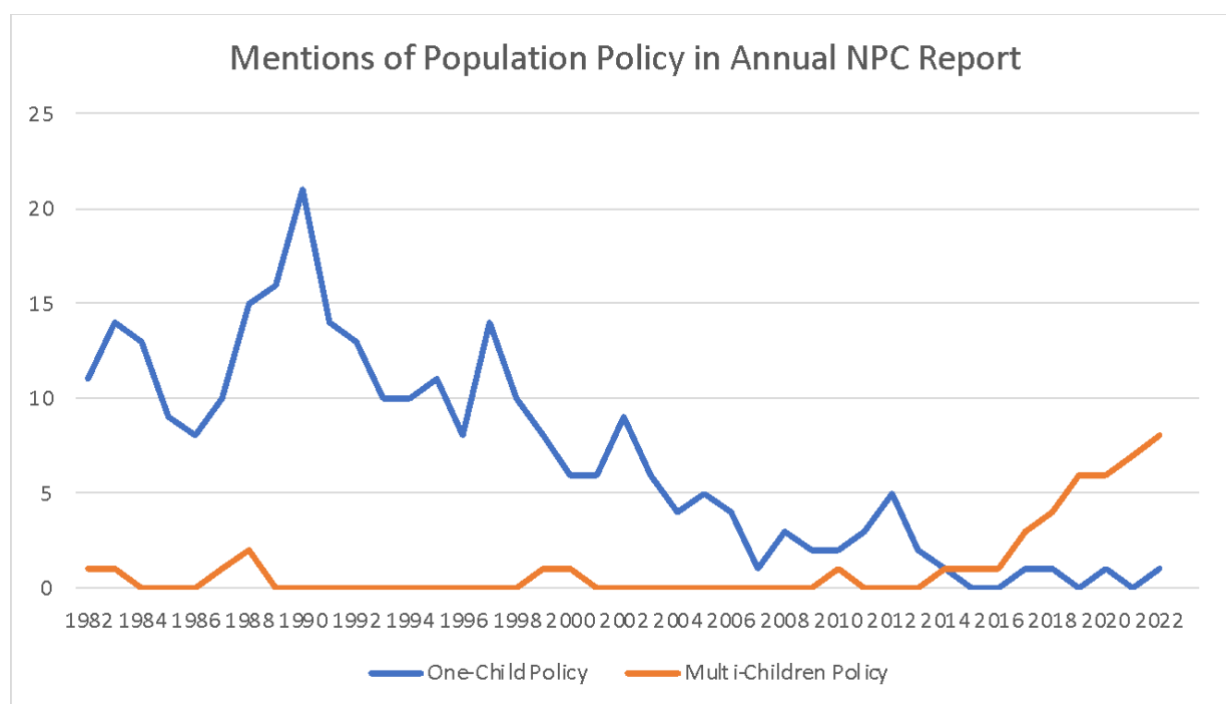
Figure 1: Mentions of population policy in annual NPC reports (*People's Central Government*, 2022)

The graph above signifies the fundamental shift of attitude toward population control among Chinese policymakers, especially after 2013. The National People's Congress holds its plenum annually, where the Chinese premier delivers annual reports to the legislative body, similar to the State of the Union Address in the United States. Tracking the number of mentions of a particular policy is a reasonable approximation of the current administration's policy priority, and arguably one of the best windows to examine the focus of China's top-tier policymakers. As the figures suggest, Chinese policymakers shifted their focus from a one-child policy to a multi-children one after 2013, when the incumbent president Xi Jinping rose to power. However, contrary

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[1] The phrase "fundamental national policy", or "基本国策", is a special designation that is only bestowed upon a handful of policies at the core of Communist Party's platform, like socialism, reform and opening up, and one China policy. Putting one-child policy parallel to these core policies indicates the priority of population control.

to the aims of this new policy, the concerted efforts to expand the Chinese population and boost the fertility rate were met with stony silence from everyday Chinese people, as the fertility rate continues to decline.

It is unmistakable that China does face serious, if not immediate, concerns from population aging. The fertility rate has continued to stall to as low as 1.3 in 2021 (Fu, 2022), which is among the lowest rates for developing countries. In the same year, the nationwide birth rate for China reached a record low (Gao *et al.,* 2022). Two years ago, an investigative report predicted that China could see its first net decline in population in 2027 if birth rate continues its falling trend in the 2010s (Zhang and Cai, 2020), inciting widespread public anxiety. One year later, at the conclusion of China's seventh national population census, that prediction proved to be erring on the cautious side. In the latest press conference by China's Bureau of Statistics, it is estimated now that China may have to witness net population decline – the first since the Great Famine back in the 1960s – as early as this year (Ning, 2022).

As shown in table 2, the working age population (from 15 to 59 years of age) accounted for 63.35% of China's entire population in 2020, which was already 7% less than that reported in the 2010 census. If the fertility rate continues to decrease, the estimated percentage of the population that is of working age will decline to 56.86% by 2035. In other words, in merely 25 years, every working man and woman in China will have gone from supporting 0.43 dependencies to approximately 0.76 on average. In comparison, Japan, the most notable victim of the population aging crisis, reported in 2020 that each Japanese worker is expected to support 0.69 dependents (*World Bank*, 2022). Simply put, in just 15 years, China will inevitably face the worst population challenges ever in the modern world.

普查年份 Census Years	各年龄段人口比重 Proportion of Population by Age Group to National Population			
	0–14	15–59	60+	#65+
1953	36.28	56.40	7.32	4.41
1964	40.69	53.18	6.13	3.56
1982	33.59	58.79	7.62	4.91
1990	27.69	63.74	8.57	5.57
2000	22.89	66.78	10.33	6.96
2010	16.60	70.14	13.26	8.87
2020	17.95	63.35	18.70	13.50

单位：%   (%)

注：“#”表示其中的主要项。
Note："#"indicates a major breakdown of the total.

Table 1: Proportion of Population by Age Group to National Population (*Chinese National Census*, 2021)

It is henceforward clear that Chinese policymakers have every incentive to reverse this concerning trend. However, the multi-children policy bundle will not mitigate the looming crisis, but rather exacerbate population overdependence.

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[2] This comment was trending and gained significant public attention, before being censored by Chinese authority. The original comment is no longer retraceable.
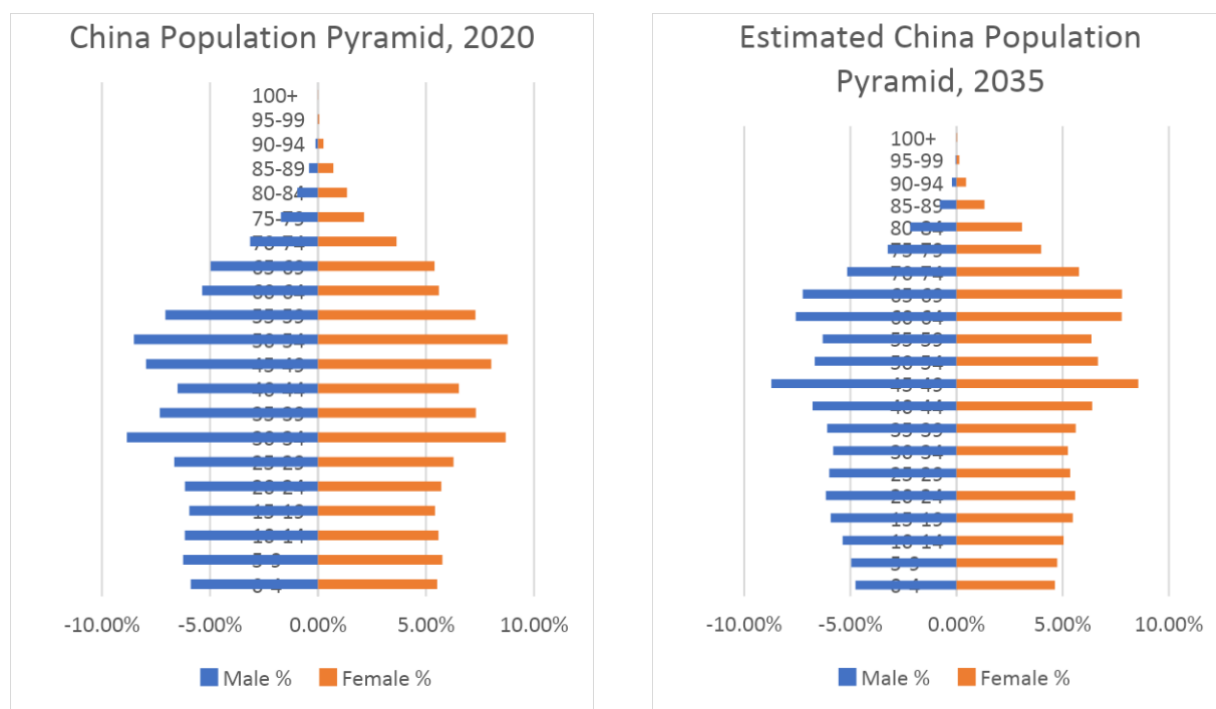
Figure 2: Comparison of China Population Pyramids in 2020 (*Chinese National Census*, 2021) and 2035 (*PopulationPyramid.net*, 2022)

It is clear from the population pyramids that the most concentrated age groups are people born between 1960 and 1975 - at the height of the Great Leap Forward and Cultural Revolution when China adopted ultra-expansionary population policies. Members of these age cohorts will enter retirement *en masse* within the next fifteen years, culminating in the imbalanced age-dependency ratio above-mentioned. However, this fifteen-year timeframe is already too narrow for the expansionary population policy to take its effects. Even if we assume, against all odds, that the progressive "three-children" policy adopted in mid-2021 would substantially increase the birth rate, these newly added age cohorts will not wean from parental support by 2035. Simply put, only the population born before 2017 would alleviate population overdependence and support China's elderly population. Those born after 2017 would not reach adulthood and become productive population elements by 2035, when the population crisis culminates, thereby putting pressure on both ends for the working age cohort. It is a great irony that the progressive population policies will lead to an even greater age-dependency ratio and exacerbate the population crisis.

In this prospect, by 2035 one typical Chinese household will have at most two breadwinners, who will have to support three children in middle school or college and invest heavily on their education due to extreme competitiveness in China's infamous *Gaokao* system; three to four retired parents who earn very limited pension due to flaws in China's pension system; possibly a grandparent born in the 1950s, with constant medical needs but bare minimum insurance; and often must pay for a disproportionately high mortgage or rent, significantly limiting household liquidity or potential for consumption. Indeed, for the vast majority of China's working-class families, having multiple children is simply too luxurious.

The main targets of the three-children policy are people within the ideal reproductive age, namely between 23 and 38 years, who are born between 1980 and 1995. However, it's noteworthy that these age cohorts are coincidentally the first generation born under one-child policy, who are distinctively more independent and self-interested than any previous Chinese generation. Burdened by heightened costs of living, financial insecurity, and a pessimistic outlook for the country's economic future, the new parents-to-be can hardly be persuaded to swallow significant marginal costs just for having another child. Their self-reflection and defiance to the new population policy is embodied by the top trending comment online when China announced the three-children policy: "Having another child is a service to the nation, but a disservice to myself and my kids."[2]

However, all hopes are not lost. Although the current approach can only increase burdens on China's shrinking working population, there are nevertheless other measures that will mitigate the impact of the aging population on everyday households that do not require boosting the fertility rate.

It is noteworthy that although age cohorts born between 1960 and 1975 are the largest cohorts and gradually retiring, they are also the first generation to thrive under China's economic liberalization campaign. They participated in China's primitive accumulation of capital, while acquiring wealth in unprecedented scales in China's history. Of the top 100 richest persons in China, 54 fall within those age cohorts (Hurun Research Institute, 2021). While some scholars characterized China's looming population crisis as "[becoming] old before getting rich" (Wang *et al.*, 2016), citing China's relatively low income per capita, it is imperative to see that this retiring cohort overall is the wealthiest of all generations in China's history (Cai, Garnaut, and Song, 2018). Perhaps a more prominent issue is severe inequality. China's Gini coefficient is estimated at 46.7, ranking as the 26th least egalitarian country in the world (World Bank, 2020). Hence, circumstances call for a more progressive redistribution system, with additional transfer payments in forms of public welfare programs, state-afforded health insurance, and affordable housing. These measures will significantly ease the pressure on China's vast middle-class and working-class families, while creating a reservoir of funding in the national budget that would mitigate the impact of population aging in the coming decade (Zhang, 2017).

A significant part of this comprehensive reform of the redistribution system should be China's pension reform. A modern pension system typically consists of three pillars: government transfer payments, retirement pension from employers, and personal retirement savings and investments. In 2020, China's pension system could provide only 45% of pre-retirement income, whereas the average replacement rate in the U.S. in the same year was 8.
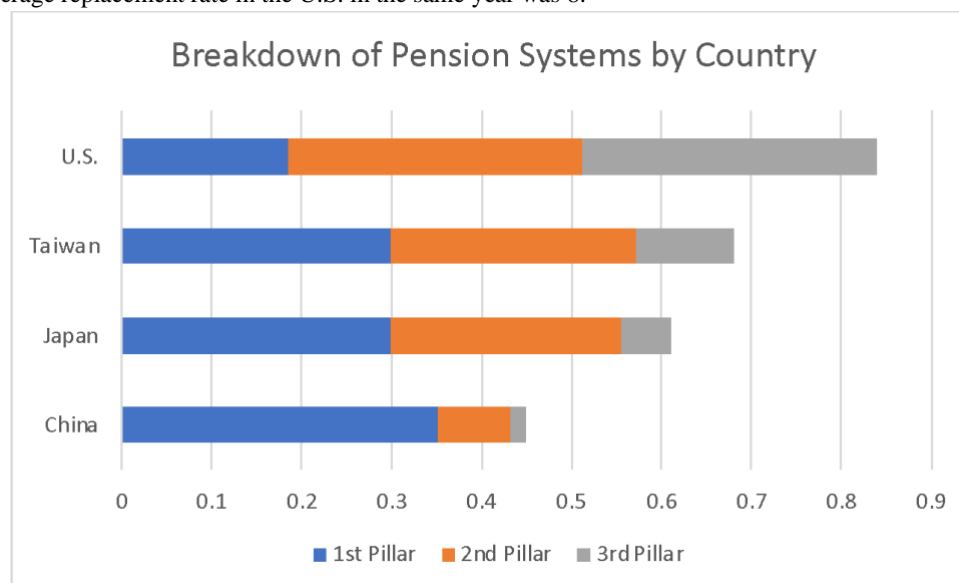
Figure 3: Breakdown of Pension Systems (*OECD*, 2021)

It is evident that China's pension system is lopsided, with government spending accounting for the majority of total pension. It creates the heaviest burden on public finance among the four countries considered, while providing the least coverage for its retired workers. Even compared to Taiwan and Japan, two other East Asian countries with similar culture and even more urgent population crises, China's significant lack of corporate pensions still leaves its retired workers earning 25% less than their Taiwanese or Japanese counterparts. Thus, the necessity and urgency for China to reform its pension system and introduce greater obligations for corporations and employers becomes self-evident.

For centuries, East Asian cultures have put great emphasis on the working-age population's obligation to provide for their retired parents. Modernized East Asian countries like Japan and South Korea had successfully transitioned to more granularized household units. With a secure pension system that takes the burden off from the working-age population, Chinese society may also embark on similar household "granularization" (You and Niño-Zarazúa, 2019), further stimulating consumption and social productivity. A steady stream of income after retirement significantly contributes to the financial security and sustainability of

average Chinese households, which in turn stimulates household consumptions that fuel economic growth and alleviate the impact of population aging.

Boosting productivity and supporting China's increasingly broad base of retired workers are the two main objectives for China to adopt expansionary population policies. While I have argued that the time has passed for such policies to take effect, a progressive redistributive system and improved pension scheme accomplishes the same goals. By mandating corporations and businesses who made significant profits from China's economic liberalization to shoulder their proportional responsibility, the population aging crisis can be ameliorated without having to play the "catch-up" game.

All in all, it's beyond doubt that there do exist systemic challenges from the broad base of the rapidly aging population in China. However, instead of pursuing belated expansionary population policies, Chinese policymakers should consider indirect approaches including a more progressive redistribution system and pension reform, which takes full advantage of the immense wealth the country had aggregated over the past few decades to ameliorate the aging crisis. So that, despite the inevitability of China's entrance into an aging society, the retired workers who dedicated their entire career to one of the most staggering economic miracles the world has seen, may sleep a bit sounder at night, knowing that their retired lives are secure and well-supported.

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Article

Institutions and Economic Growth in Democratic Europe: France's 1958 Transition From Fourth to Fifth Republic

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Abstract

This paper studies the impact of France's 1958 constitutional transition from the French Fourth Republic to the French Fifth Republic. A difference-in-differences regression analysis compared the effect of France's 1958 institutional change on French economic growth against a control group of 12 democratic European countries in the period 1948 – 1969. The regression analysis conducted suggested that the 1958 French constitutional change contributed an additional 2.73% GDP growth per year to French GDP growth in the period 1959 – 1969.

Keywords: Institutional Economics, Economic History, Difference-in-Differences, France

1. Literature Review and Historical Background

1.1. Introduction and Literature Review

This paper seeks to further study the relationship between institutions and economic growth. The relationship between institutions and economic growth is a well-developed field of scholarship, with substantial literature and discussion on this topic in economics and other social sciences. This literature review will discuss several important papers which have explored the relationship between institutions and economic growth.

North (1989)'s paper titled "Institutions and Economic Growth: An Historical Introduction" explores the role of political and economic institutions in economic growth. North (1989) argues that institutional differences produce economic consequences. Examining the development of "institutional frameworks" from England's tradition of common law into the United States Constitution in contrast with more rigid Spanish colonial institutions which produced less institutional change, North (1989) argues that the radically different consequences in Latin America and the United States can be attributed in part to an observed difference in institutions. Diversity and flexibility, in the English and American case, allowed for a consistent pattern of change for institutions. In the Spanish case, rule by heavy handed colonial bureaucracy meant that institutional change was less consistent. North (1989) observes that no post-independence regime in Latin America survived, while the United States did. As North (1989) observes, there remains an enormous economic disparity between the economies of Latin America and that of the United States. The conclusion drawn from North's paper is relatively simple: institutions play some role in economic growth. Simply put: institutions matter.

Barro (1991), in "Economic Growth in a Cross Section of Countries," examined the relationship between economic growth and institutions in a more quantitative manner than North (1989). Using data from the United Nations, the World Bank, and other sources, Barro (1991) attempted to make a general account for the per capita GDP growth of 98 countries in the period 1960 – 1985. In Barro (1991)'s analysis, the number of revolutions and coups per year in addition to the number per million persons of political assassinations per year was regressed on per capita GDP growth for the period. Barro (1991) found that the coefficients for both 'number of revolutions and coups per year' and 'number per million persons of political assassinations per year' were negative for economic growth. This negative relationship was sustained when other factors were accounted for in the regression model. The relationship indicated in Barro (1991)'s research, however, does not suggest a causal interaction between institutions and economic growth. Indeed, as Barro (1991) notes, a reverse causal interpretation may be offered: negative economic growth has a positive influence on the frequency of coups and political assassinations. In other words, Barro (1991) acknowledges the alternative argument that economic growth has some causal influence on institutions. From a wider point of view, Barro (1991)'s seminal paper serves as a key link to understanding the connection between political institutions and economic growth.

A similar paper by Fatás and Mihov (2013) titled "Policy Volatility, Institutions, and Economic Growth" sought to examine the connection between political institutions and economic growth as did Barro (1991). Using data from 93 countries, Fatás and Mihov (2013) measured policy volatility in these countries (derived from country-specific regressions of government consumption on real GDP) and regressed this individual measure on the average growth of real GDP per capita in the period 1970 – 2007 for each of the 93 countries. Fatás and Mihov (2013) found that increases in policy volatility reduced long-term economic growth. More specifically, Fatás and Mihov (2013) found that an increase in policy volatility by 1 standard deviation reduced economic growth by some 0.74% (in panel regressions) and greater than 1% in cross-sectional regressions. Fatás and Mihov (2013) clearly show an empirical relationship between institutions (specifically institutional stability) and economic growth. In further analysis and discussion, Fatás and Mihov (2013) found that stability in government policy had greater impacts on growth when there existed less constraints on executive power, compared to countries where there existed more constraints on executive power. Thus, in countries where leaders have greater executive power, a good leader can play a larger role in bringing about strong economic growth. In this relationship, however, the converse is also true: a bad leader with great executive power can cause worse economic performance than would be possible with less executive power. Much like how North (1989) concluded that the quality of institutions matters for economic growth, Fatás and Mihov (2013) show an empirical relationship between the quality of institutions (in respect to the strength of the executive) and economic growth.

However, research investigating the relationship between institutions and economic growth like Barro (1991) and Fatás and Mihov (2013) are not without their critiques. De Haan (2007) argues that the methods used in these papers to measure items like democracy and freedom in various countries are highly suspect. Indeed, de Haan (2007) points out that many models attempting to measure democracy, liberty, or other measures of political institutions do so through indirect means: Barro (1991), for example, attempted to indirectly measure political instability through the number of coups and political assassinations per

year. Many models attempting to measure the relationship between institutions and economic growth, de Haan (2007) observes, suffer from issues in the use of the time dimension: small timespans (less than ten years) are unable to properly distinguish between the effects of long-term growth and the effects of business cycles. Constructing a model that seeks to estimate the effect of institutions on economic growth, then, must heed de Haan (2006)'s warnings about potential pitfalls which other models have fallen for.

Research on the relationship between institutions and economic growth has also been undertaken in more focused areas than the papers from Barro (1991) and Fatás and Mihov (2013), which broadly examined nearly 100 countries. A recent paper by Dittmar and Meisenzahl (2016) titled "State Capacity and Public Goods: Institutional Change, Human Capital and Growth in Early Modern Germany" examined the relationship between institutions and economic growth in a unique setting: the Protestant Reformation in Germany. The Protestant Reformation in Germany provided Dittmar and Meisenzahl (2016) a unique natural experiment: when cities in Germany adopted Protestantism in the sixteenth century, some cities (less than 55% of all Protestant cities in Germany) adopted formal laws providing for the provision of public goods such as education and social services. Observing variation across neighboring cities within the same territory, Dittmar and Meisenzahl (2016) hypothesized that cities that implemented these new public goods laws by the year 1600 grew relatively quickly. Dittmar and Meisenzahl (2016) later concluded that cities that adopted the new institutions by 1600 grew to be at least 25% larger in the year 1800, compared to similar cities. Dittmar and Meisenzahl (2016) further found that an outbreak of plague during the early Reformation (early fifteenth century) increased the likelihood that a city eventually adopted the new institutions by some 10-25%. Quite similar to research from Barro (1991), North (1989), and Fatás and Mihov (2013), Dittmar and Meisenzahl (2016)'s research also draws a causal connection between institutions and economic growth—the adoption of the new institutions in Protestant cities saw more growth over the period 1600 – 1800 than cities that did not adopt the new public goods institutions.

Similar research to that of Dittmar and Meisenzahl (2016) was undertaken in the context of post-World War II Europe by Eichengreen and Vasquez (2000) in an article titled "Institutions and Economic Growth in Postwar Europe: Evidence and Conjectures." Eichengreen and Vasquez (2000) assert that the 'golden age' of growth in post-World War II Europe was due to institutions inherited by post-war Europe from pre-war Europe being particularly well-suited to the needs of economic growth in post-World War II economies. Eichengreen and Vasquez (2000) observe that corporatist labor relations in post-war Europe encouraged (i) the moderation of wages and (ii) increased investment necessary to recreate large scale industrial production as was performed in the contemporary United States. Centralized European institutions and global integration, moreover, lent themselves well towards adapting American technologies in the European context while creating the markets necessary to support these imported innovations. Eichengreen and Vasquez (2000) further argue that the economic boom, which ended in 1971, can be ascribed to Europe's exhaustion of further technologies to adapt to European circumstances—simply put, Europe had caught up to the frontier of technology. It was here, Eichengreen and Vasquez (2000) conclude, that Europe's institutions became a double-edged sword—the institutions which had helped to drive the post-World War II miracle later became stumbling blocks to further innovation and growth. Just as in North (1989) and Fatás and Mihov (2013), institutions in Eichengreen and Vasquez (2000) have been shown to play an important role in economic growth—for better or for worse.

The current literature on the relationship between institutions and economic growth motivates further research. This research paper, following the example of Dittmar and Meisenzahl (2016), will use a natural experiment in order to estimate the effect of institutional change on economic growth in a particular country. To estimate this effect, this research paper will examine France's 1958 adoption of a new constitution, which replaced the French Fourth Republic with the French Fifth Republic.

1.2. Historical Background: A Troubled Post-War France

The post-World War II years 1945 – 1975 are remembered in France as *Les Trente Glorieuses* (the Glorious Thirty). The French economy, much like the other post-war European economies described by Eichengreen and Vasquez (2000), experienced unprecedented growth and prosperity during these thirty years. Economic prosperity, however, did not mean that all was well in France.

France possessed an expansive colonial empire stretching from Algeria (then regarded as an integral part of France) to then Indochina. Despite the so-called *mission civilisatrice* (civilizing mission) of the French in their colonial empire, assimilation and the acquisition of French citizenship was very difficult. Many local peoples were driven over time to nationalist movements calling for independence. The rapid fall of France to German invasion in 1940 during the Second World War served as an accelerant to many nationalist movements, who had faced repression under the French colonial authorities. When French administration was fully restored after the 1944 Liberation of France, colonial authorities faced greater difficulties in

maintaining the colonial empire. Faced with the growing demands of the decolonization movement, France sought to maintain and even reform its colonial empire instead of folding to nationalists' demands.

The most significant of these colonial conflicts occurred in French Algeria, long marred by tension and outright conflict between French settlers, local Jews, and the local Muslim population. Agitation for independence by the Algerian *Front de Libération Nationale* (National Liberation Front, or FLN) exploded into violence directed at French authorities and the French settler population in 1954. French authorities responded with a brutal counter-insurgency campaign against the FLN, led by units of the French military.

What became the Algerian War (1954 – 1962) was marked by an effective campaign led by French military units and security forces against the FLN. The escalating conflict was marked by the torture of detainees at the hands of the French military and other war crimes, in addition to the war crimes and terror tactics practiced by the FLN. Though the French military was successful in prosecuting the war on the ground, political crises wracked the weak government and gave rise to weakness in political support for the war. Fearing another loss, as had occurred several years earlier in Indochina, units of the French military launched a successful coup d'état against the French government in May 1958. What became known as the May 1958 Crisis marked the fall of the French Fourth Republic.

The extraordinary crisis was resolved with the return of General Charles de Gaulle to the government, with the support of the parliament and coup leaders. De Gaulle was granted extraordinary powers and the task to draft a new constitution in order to redress the weaknesses of the previous republic. In order to redress the political weakness of the old republic and its parliamentary system, De Gaulle introduced a powerful sole executive in the constitution: the French President. Ratified in September 1958, the new constitution formed the basis of the French Fifth Republic, with Charles De Gaulle as its first president.

The events of 1958 in France marked a great shift in power in the French Republic—a parliamentary system was replaced with a semi-presidential system, where the executive possessed far greater powers than before.

In the context of the relationship between institutions and economic growth, France's sudden 1958 transition from a parliamentary system to one with a powerful executive stands as an excellent natural experiment to investigate the change in economic growth when the nature of a country's institution changes. More specifically, this natural experiment serves the question 'What is the effect of a more powerful executive on economic growth?'.

2. Description of Data and Model

2.1. Data Overview

In order to examine the relationship between institution and economic growth in the context of France's 1958 constitutional change, yearly Gross Domestic Product (GDP) growth data on the years 1948 – 1969 was obtained from Databank International's Cross-National Time Series (CNTS) Data Archive. The data allowed for the creation of a panel of 13 countries (pictured below in Figure 1): France (excluding colonial possessions), United Kingdom (excluding colonial possessions), Ireland, Italy, West Germany, Switzerland, Luxembourg, Belgium, Netherlands, Denmark, Sweden, Norway, and Iceland.

The criteria for the inclusion of a country aimed to eliminate potential confounding variables in order to focus on the effect of institutional change on economic growth in France. The need to control for regional effects necessitated the exclusion of non-European countries such as the United States. European countries with significant institutional differences at any point in the 1948 – 1969 period from pre-1958 France (e.g. Spain, USSR, Yugoslavia, East Germany, Greece) were also excluded from the dataset in order to exclude the effects of non-democratic institutions. Finally, countries with particularly incomplete data (many years missing) were excluded. This was the case in respect to Austria and Finland only.
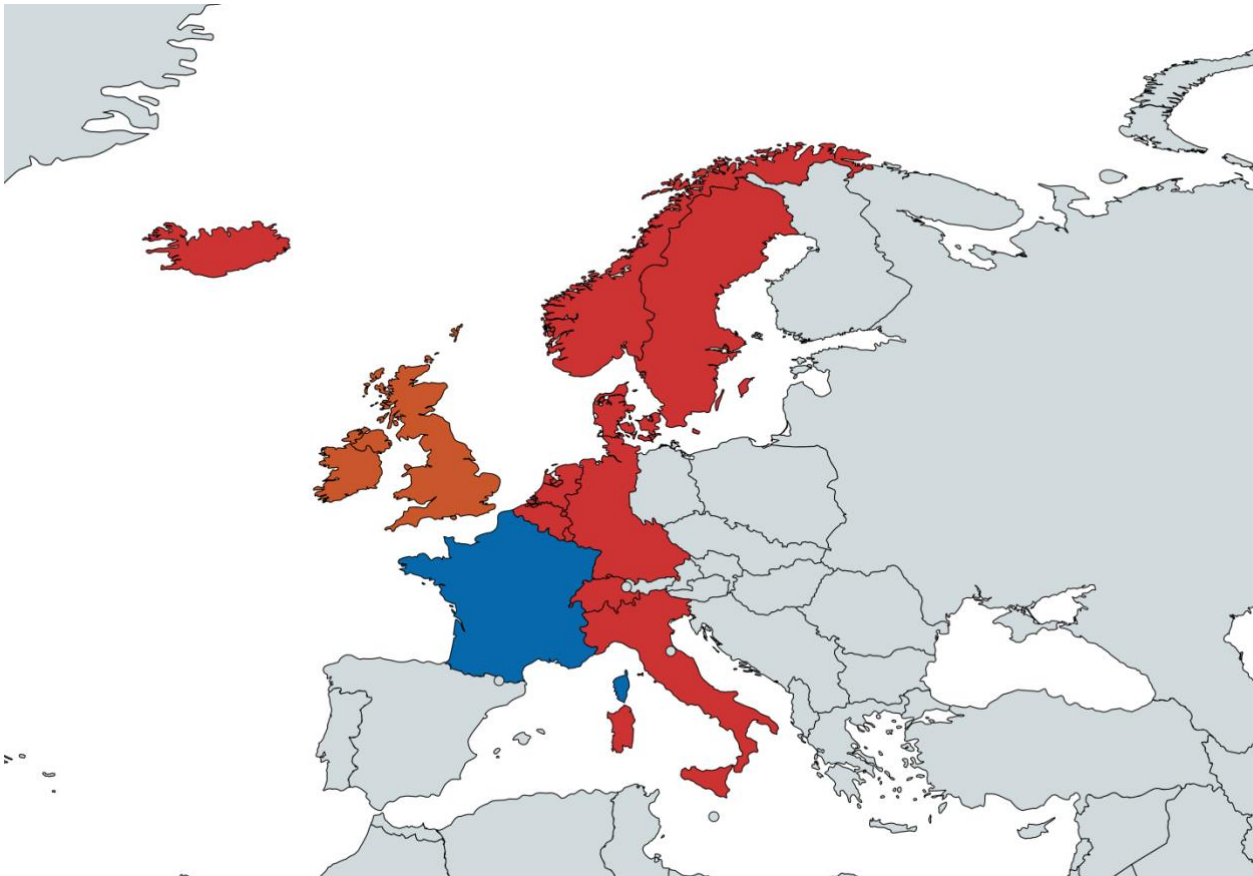
Figure 1: Countries included in Dataset (France in blue, rest in red) (Databank International's CNTS, 2021)

Of the 13 countries included in the panel, all were democracies for the entirety of the period and all but France possessed governments with a less powerful executive for the period (as was the case in pre-1958 France).[1] All countries were materially affected by the Second World War, and all countries included in the panel received Marshall Plan aid. The inclusion of years 1948 – 1969, an approximately twenty-year period, seeks to control for the effects of the business cycle on GDP growth in the panel countries. The careful curation of the dataset has generally sought to control for other effects before analysis in the described model.

2.2. Model and Empirical Strategy

A difference-in-differences strategy was employed in order to estimate the effects of the French constitutional change on GDP growth (depicted graphically below in Figure 2), compared to the GDP growth of all the other countries in the panel (depicted graphically below in Figure 3). The 12 other countries effectively constituted a control group, with France serving as the treatment group.

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[1] For the purpose of this paper, a 'government with a less powerful executive' was construed as a political system in which there are substantial checks on the power of the executive, e.g. a parliamentary system of government.
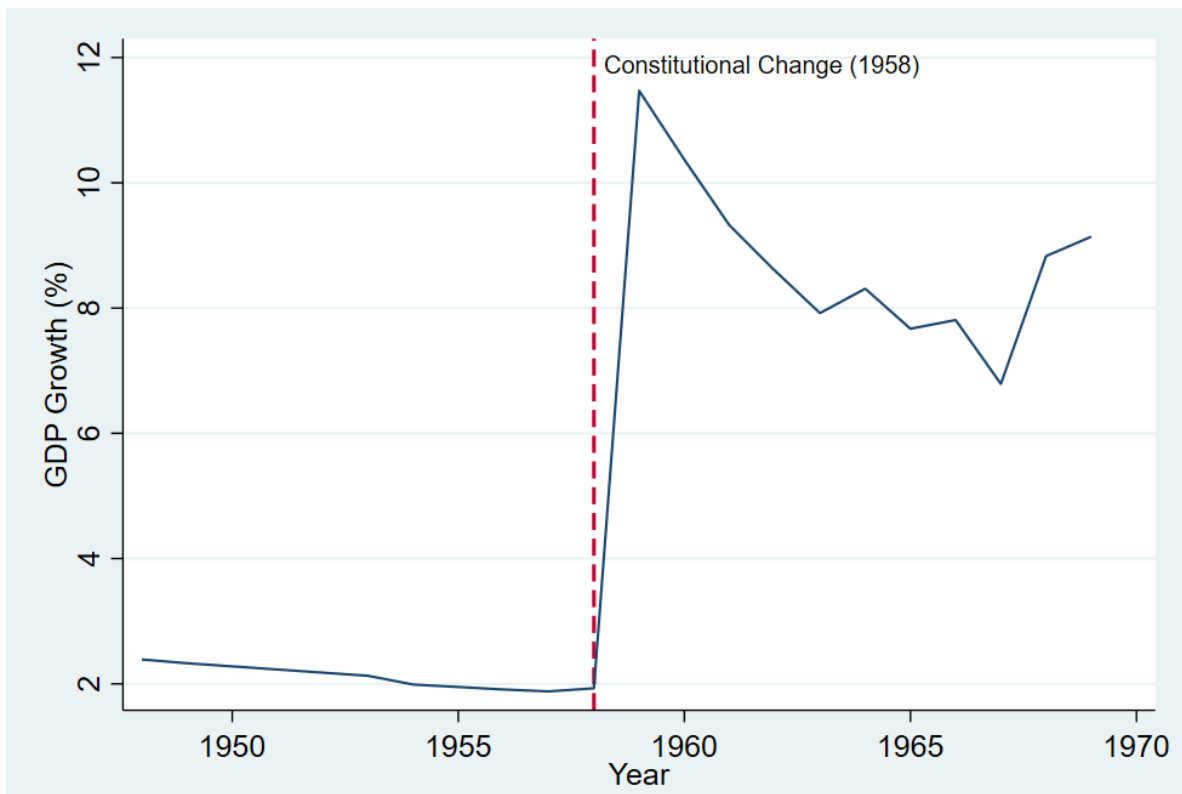
Figure 2: France Yearly GDP Growth (1948 – 1969) (Databank International's CNTS, 2021)
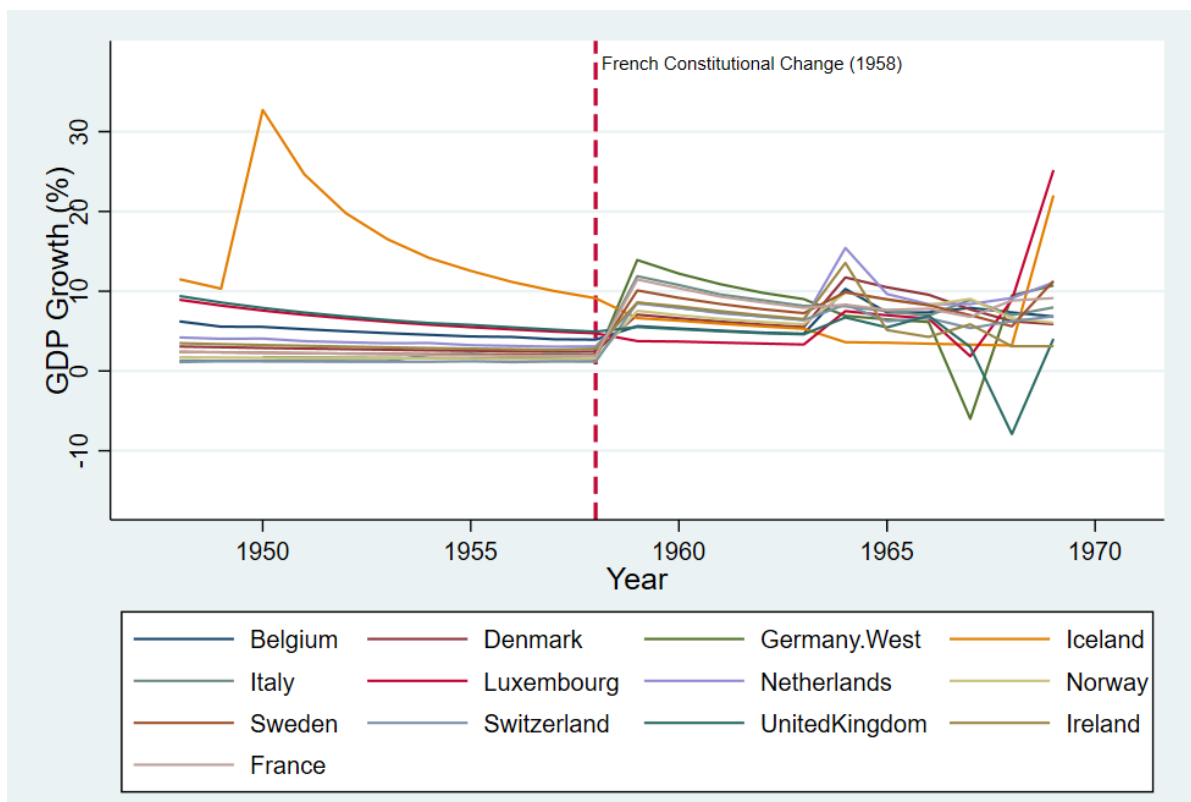
Figure 3: Panel Yearly GDP Growth (1948 – 1969) (Databank International's CNTS, 2021)

In order to successfully achieve a differences-in-differences estimation, a simple regression using a basic differences-in-differences model was used to model the effect of France's institutional change on GDP growth. This is given as the following equation:

$$Y = \beta_0 + \beta_1 Treat + \beta_2 Post + \beta_3(Treat \times Post) + \varepsilon$$

In this model, the key parameter of interest in the model was β_3, the measure of the treatment effect. The treatment effect measured by parameter β_3 was yearly French GDP growth after 1958 (yearly French GDP growth following the institutional change). The treatment (*Treat*) and post-treatment (*Post*) parameters served as dummy variables to (i) indicate the country receiving the treatment (France) and (ii) indicate the period in which the treatment was active (1959 – 1969), respectively. This model was used to achieve the described differences-in-differences estimation.

In order to further control for other effects within the panel group that were not accounted for in the selection of countries, two robustness checks were performed in addition to the original regression analysis, using the same model in the equation above.

2.3 Hypothesis

It was hypothesized, based on Fatás and Mihov (2013), that France's 1958 shift towards a system with a more powerful executive resulted in noticeably greater absolute GDP changes for the French economy in the period 1959 – 1969. Based on Eichengreen and Vasquez (2000), it was further hypothesized that this effect was positive. Thus, in respect to the regression model, parameter β_3 was hypothesized to be positive.

3. Results

3.1. All Countries

Table 1 (pictured below) depicts the results obtained in the regression analysis, where France's economic growth after the 1958 constitutional change was compared with the performance of all the other countries included in the dataset. The variable of interest (the interaction variable, β_3) is 'did', shown on the third line on Table 1.

Independent Variable	(2) Coefficient	(3) Standard Error	(3) t	(4) P > | t |
Time	2.908717	0.4827469	6.03	0.000
Treated	-2.190601	1.226787	-1.79	0.075
did	3.730374	1.734425	2.15	0.032
_cons	4.299692	0.342654	12.55	0.000
Note: $R^2 = 0.1575$, Adjusted $R^2 = 0.1585$				

Table 1: Differences in Differences Results - All Countries

The analysis yielded a positive regression coefficient of 3.73, statistically significant at the 5% level. The positive coefficient indicates a rise of 3.73% GDP growth in France for every 1% of GDP growth among all panel countries in the period 1959 – 1969. Even at the lowest bound of one standard error below the coefficient, this result still indicates a rise of 2% GDP growth in France for every 1% of GDP growth among all panel countries. These results are consistent with the hypothesis that the 1958 French constitutional change had a positive effect on France's GDP growth.

3.2. Robustness Check: EEC Countries

A robustness check was performed to control for the effect of the European Economic Community (EEC) coming into force in the year 1958, the same year that France underwent its constitutional change. All six original EEC members were already included in the original panel: France, Italy, West Germany, Luxembourg, Belgium, and Netherlands. In this robustness check, all original EEC members except for France served as the control group, using the same model as in the original analysis. Table 2 (pictured below) displays the results of this further analysis. The variable of interest (the interaction variable, β_3) is again shown on the third line of Table 2 under the name 'didEEC'.

Independent Variable	(1) Coefficient	(2) Standard Error	(3) t	(4) P >	t	
Time	4.159166	0.5675132	7.33	0.000
TreatedEEC	-1.578834	0.9768752	-1.62	0.109
didEEC	2.479925	1.37935	1.80	0.075
_cons	3.687925	0.4049911	9.11	0.000
Note: R^2 = 0.3939, Adjusted R^2 = 0.3795				

Table 2: Differences in Differences Results: EEC Countries

This robustness check yielded a positive regression coefficient of 2.47, but unlike the original analysis this analysis is statistically significant at the 10% level. The positive coefficient indicates a modest rise of 2.47% GDP growth in France for every 1% of GDP growth among all other EEC countries in the period after the treatment. At the bound of one standard error below the coefficient, the result indicates a far more modest rise of 1.1% growth in France for every 1% of GDP growth among all other EEC countries in the period after the treatment. Nevertheless, the positive regression coefficient of 2.47 is consistent with the proposed hypothesis that the 1958 French constitutional change had a positive effect on French GDP growth in the period 1959 – 1969.

3.3. Robustness Check: Major Economies

A further robustness check was performed in order to control for the potential differences between panel countries with larger and smaller economies. Larger economies are generally more complex than smaller economies and therefore a larger economy's growth could be more difficult to influence through institutions compared to smaller economies. Thus in this analysis, only four countries (defined as Major Economies) of the thirteen countries included in the panel were included: France, United Kingdom, Italy, and West Germany (the latter three countries serving as the control group). Utilizing the same model which was used in the previous robustness check and original analysis, Table 3 depicts the results of the regression analysis.

Independent Variable	(1) Coefficient	(2) Standard Error	(3) t	(4) P >	t	
Time	3.503402	0.801493	4.37	0.000
TreatedMajors	-1.31478	1.124592	-1.17	0.246
didMajors	3.135689	1.58409	1.98	0.051
_cons	3.423871	0.5755284	5.95	0.000
Note: R^2 = 0.3428, Adjusted R^2 =0.3188				

Table 3: Differences in Differences Results: Major Economies

The variable of interest (again, the interaction variable, β_3) is again found on the third line of Table 3. In this case the variable was named 'didMajors'. The analysis yielded a higher regression coefficient than the first robustness check: 3.13. Similar to the first robustness check and unlike the original analysis, this coefficient is significant at the 10% level. In this case, the positive coefficient indicates a rise of 3.13% GDP growth in France for every 1% of GDP growth among all other EEC countries in the period after the treatment. And at the bound of one standard error below the coefficient, the analysis suggests a more modest rise of 1.58% GDP growth in France for every 1% of GDP growth among all other EEC countries in the period after the treatment. Like the other results in the original analysis and first robustness check, the results of this robustness check are also consistent with the hypothesis that the 1958 French constitutional change had a positive effect on French GDP growth in the period 1959 – 1969.

4. Discussion

The difference-in-differences regression model employed yielded results consistent with the hypothesized results. Compared to all countries in the panel, the model indicates that France's constitutional change was associated with an additional 2.73% GDP growth per year in the French economy. Controlling separately for the effects of the EEC coming into force and the size of panel countries' economies, France's constitutional change was associated with 1.47% and 2.13% additional annual GDP growth in France, respectively. Even when accounting for a full standard error in the negative direction, the associated increase in annual GDP growth for France holds across both the original analysis and the two robustness checks, albeit more modestly. At a full two standard deviations in the negative direction, however, the predicted positive economic effects associated with France's 1958 constitutional change do not seem to manifest when compared to other countries.

These findings are nevertheless consistent with that of Fatás and Mihov (2013), who found that greater executive powers were associated with larger changes (both positive and negative) in economic growth rates. In this case, the replacement of the French Fourth Republic (a parliamentary centered government) with the French Fifth Republic (a government with greater executive power than in the Fourth Republic) was generally associated with an increase in France's economic growth rates in the decade after 1958. More broadly, these findings reinforce the connection established by Fatás and Mihov (2013) on the relationship between greater executive power and larger changes in GDP growth. Change in the nature of a country's institutions appears to have a measurable effect on GDP growth.

Though great care was taken during the process of data collection and data analysis to exclude factors that may significantly impact the validity of this analysis, there exist several potential points of contention which can be raised towards this research.

Like other research on periods where the method of collecting and storing data differs from today, the period 1948 – 1969 is no exception. More detailed time series data in the form of monthly or quarterly GDP growth rates, or other figures, was generally not available for the period 1948 – 1969 (France was a notable exception, with quarterly GDP data available for the entire period from the government's statistical agency). In many cases, state-run statistical agencies and international organizations possessed either partial yearly data on GDP figures for the period 1948 – 1969 or possessed no data on the period altogether. Indeed, the CNTS data archive was a critical factor in the success of this research. However, the availability of only yearly GDP growth rate data for the period 1948 – 1969 leaves much to be desired. In the case of the two robustness checks, the lack of many points of data meant that the obtained regression coefficients were only significant at the higher 10% level. The constraints imposed by the amount of available data similarly impacted the size of the standard error, thereby impacting the potential estimated size of the measured effect of the 1958 French constitutional change.

The strong efforts made during data collection and analysis towards controlling for other confounding factors like the EEC and regional effects do not preclude the existence of other effects. It must be acknowledged that other factors could potentially account for the apparent rise in French GDP growth rates in the period 1958 – 1969 compared to other countries. For example, the end of the Algerian War in 1962 or Charles de Gaulle's individual success and policies as president during this same period (de Gaulle served as president from 1959 – 1969) could serve as alternative explanations for this growth. France's 1958 constitutional change alone may not account for the observed effect of higher French GDP growth rates in the decade after.

Nevertheless, the results of this research are compelling. Despite the constraints of the panel data, the results of the difference-in-differences regression analysis are both sizeable and statistically significant. These results are in line with the expectations outlined in both the stated hypothesis and existing literature such as that of Fatás and Mihov (2013).

5. Conclusion

The results obtained in this research are supportive of current mainstream scholarship: when it comes to growth, institutions matter and can often have a measurable impact. This regression analysis employing a difference-in-differences method on the effect of France's 1958 constitutional change suggests that the shift from power centered in a parliament towards a stronger executive (president) was associated with a meaningful rise in French economic growth (an additional 2.73% annual GDP growth), compared to other democratic European countries. This result was the case when major economies alone served as comparison countries (here the constitutional change was associated with an additional 2.13% annual GDP growth), and also when attempting to control for the EEC coming into effect in 1958 (in this case, the constitutional change was associated with an additional 1.47% annual GDP growth).

 The success of this empirical analysis points towards the continued potential for further research into the relationship between institutions and economic growth. This examination of a natural experiment, similar to that of Dittmar and Meisenzahl (2016), suggests that further empirical research concerning the relationship between institutions and economic growth through the use of other natural experiments is viable—particularly ones where institutions changed rapidly, as was the case in France during the year 1958. These types of natural experiments neither present themselves regularly nor are always accompanied with substantial amounts of useful data. Future researchers must consider this hurdle with regards to potential projects—this is particularly true regarding natural experiments occurring particularly long ago. Future researchers seeking natural experiments with the most detailed data would do well to seek out the more recent past (1970 – 2022). Nevertheless, further scholarship on the relationship between institutions and economic growth is welcome — institutions are an important piece of the puzzle that is economic growth.

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Article

Do Wealthy States in the USA Have a Disproportionate Advantage in Generating Renewable Energy?

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Abstract

This paper tries to establish some causal connection between per capita income and the percentage of renewable energy generated by a state in the US, through the course of 2000-2018. The literature on relations between different macroeconomic factors and renewable energy indicate reverse causality. Moreover, there is not much consensus on whether wealthier states and countries truly have an edge over other countries other than financial and investment ability. Hence, this paper tries to establish a relation between per capita income and renewable energy generation in the context of the USA. Granger Causality was used to establish causal links between the per capita income and the percentage of energy generated by different states that is derived from renewable sources. For states without bidirectional causality, fixed effects regression indicated a statistically significant positive relation between Per Capita Income and renewable energy – a $100 increase in per capita income was associated with a 0.04% increase in the percentage of total energy of a state derived from renewable sources. This points at potential disparities between wealthy and poorer states and adds to the argument of providing more regulatory, financial, and technological aid to poorer states in order to reduce their reliance on non-renewables.

Keywords: Renewable energy, Fixed-Effects Regression, Time-series, Macroeconomics, Sustainability

1. Introduction

With the appointment of Brian Deese as the Director of the National Economic Council and President Joe Biden setting a goal of getting America to net-zero carbon emissions by 2050, the USA is moving rapidly towards a greener future and confronting the climate crisis with ambitious solutions. Currently, over 40% of carbon emissions are generated through power plants using fossil fuels (DOE, 2021). Therefore, electricity generation is a very big part of the push to a greener economy.

However, there is a lot of capital required to build the infrastructure to generate renewable energy – whether it's solar panels, massive wind farms, or geothermal plants – and also R&D to develop better, more efficient technology. Over the past few decades, the efficiency of such technology has improved and capital required has decreased, but it's interesting to ask whether over the past 20 odd years, richer states have been able to adopt renewable energy at a higher rate than poorer states.

Figure 1: REG% time series for each state

In Figure 1, REG% refers to the total percentage of energy generated in each state from renewable sources. As seen in this chart, over the course of 18 years, clearly some states have consistently maintained a high share of their total energy generation from renewable sources. The top states include Idaho, Washington, Oregon, South Dakota, and Montana. If we look closely, we can almost cluster these lines into a few states with high REG%, a few between 20-40 REG% and a lot of states under the 20 REG% mark. The four states mentioned above are not the richest states in terms of per capita income, but there definitely seem to be certain factors that allow certain states to consistently outperform others.

This paper tries to build on Uzar (2020) to identify whether per capita income has had any significant causal effect on REG% for US states from 2000-2018. As such, this paper is divided into four main sections:

- Literature Review: developing some background on the literature behind this study and what other scholars believe to be the connection between macroeconomic factors and renewable energy generation
- Data and Methodology: discussing details about the data, the time series analysis, the regression equation, model, fixed-effects methodology, and robustness checks that are conducted for heteroskedasticity and fixed effects
- Results: describing the results of the regression, and the empirical implications
- Discussion: a brief discussion of next steps, pitfalls, and potential policy implications

2. Literature Review

The electric energy industry has high costs of capital. As such, the switch to a greener economy requires substantial amounts of capital for investment. However, there are a lot of other factors that also contribute to renewable energy. A rich country that has limited land and is surrounded by water might find it difficult to tap into solar power or wind power. On the other hand, a country with vast swathes of open land and sunshine might be cash-strapped. Hence, there is not a lot of consensus on whether richer countries actually have a disproportionate advantage in tapping into green energy. In order to understand the relationship between macroeconomic factors like wealth and the ability to generate renewable energy, I decided to conduct an investigation in the context of the United States of America, examining whether richer states have found it easier to generate more renewable energy.

There is some literature discussing renewable energy consumption and generation in OECD countries like Apergis and Payne (2009). This study examines the relationship between renewable energy consumption and economic growth for a panel of twenty OECD countries over the period 1985–2005 within a multivariate framework. Given the relatively short span of the time series data, a panel cointegration and error correction model is employed to infer the causal relationship. The results for the heterogeneous panel cointegration test reveal there is a long-run equilibrium relationship between real GDP, renewable energy consumption, real gross fixed capital formation, and the labor force. This long-run relationship indicates that a 1 percent increase in renewable energy consumption increases real GDP by 0.76 percent. This long-run relationship also suggests that there might also exist some sort of reverse causality. Economies that are growing may find it easier to invest in renewable energy. Other papers like Sinha (2017) use various measures like Thiel's inequality index to demonstrate that although inequality in renewable energy generation exists within OECD countries, it is gradually diminishing.

Another similar paper is by Chien and Hu (2006). Because economies signing the Kyoto Protocol are CO2-emission conscious, many of them will increase their renewable energy intensity. It is thus quite important to confirm if the increasing usage of renewable energy improves energy efficiency, i.e., the amount of energy required to perform a certain task.

According to the paper, the share of renewable energy in the total energy supply is higher in nonOECD (developing) economies than in OECD (developed) economies. OECD economies with lower renewable energy shares have higher technical efficiency (higher effectiveness of converting resources into goods and services), and thus renewable energy has a negative effect on technical efficiency. This paper indicated the need to include some measures of not only technical efficiency but also technical limitations and innovation that might affect the ability of a state in the US to generate renewable energy.

Most of the regression variables in this paper are based on Uzar (2020). As far as is known, the study is the first attempt to discover the relationship between income inequality and renewable energy consumption. The impact of income inequality on renewable energy consumption is examined theoretically and empirically in 43 developed and developing countries for 2000-2015. The results demonstrate that the decline in income inequality will enhance renewable energy consumption. In other words, policymakers have the opportunity to reduce income inequality and environmental degradation at the same time.

The time-series analysis done in this paper to deduce causality is a framework I have tried to imitate. Moreover, the premise of finding causal links between macroeconomic factors and renewable energy is what made this paper important to my research.

Energy cost is an important aspect that can also impact the ability of a state to generate renewable energy and invest in this technology. A paper discussing a similar concept is Schilling and Esmundo (2009). Plotting the performance of a technology against the money or effort invested in it most often yields an S-shaped curve: slow initial improvement, then accelerated

improvement, then diminishing improvement. Analyzing renewable energies using S-curves can show us the payoff for investment in these technologies. The paper suggests that government R&D investments in fossil fuels are still excessive. Secondly, results suggest that renewable energy sources (particularly wind and geothermal) have been significantly under-funded relative to their potential payoffs. Thirdly, the strategic commitments firms have to fossil fuels may still make this more profitable. This prompted me to include cost and institutional factors in my regression model. Institutional factors might indicate strategic commitments to fossil fuel suppliers, and due to the high costs of renewable energy, we should observe the higher generation of renewable energy from richer, larger states.

Mourmouras (1991) is another paper relevant to this study that shows the impact of conservationist government policies on intergenerational equity based on renewable resources. The overlapping generations model is a very fundamental framework that also can be loosely employed in the time series data. Moreover, I also introduce similar variables that indicate the political affiliation of the governor of a state in order to factor in any governmental aspects that also affect policies and incentives given to the renewables sector.

An important tool used in this paper's analysis is Granger causality. The theory behind Granger causality is based on Shojaie and Fox (2021). According to this paper, Granger causality finds whether one time series is predictive of another time series. A time series X is deemed to be 'causal' of another time series Y if utilizing the history of series X reduces the variance of the prediction of series Y. X is then said to 'Granger cause' Y. The way it has been applied in this paper is loosely based on Uzar (2020) and Dumitrescu and Hurlin's (2012) panel causality test. In the next few sections, we will essentially demonstrate how per capita income and renewable energy generation can have bidirectional causality, and then use Granger causality to isolate only those states in the US where only a unidirectional relationship exists, i.e., per capita income Granger causing renewable energy generation and not vice versa.

Finally, a range of papers and review papers, including Toman (1994), Grubb et al. (2015), Pezzey and Toman (2002), and Howell (2007) give a great overview of the field of sustainability economics and the role of energy in making our economy greener. These papers helped me understand the concept of sustainability, the ongoing issues in the field, and the way economic analysis can help shed light on important environmental conundrums.

3. Data and Methodology

3.1. Main Idea & Hypotheses

The main hypothesis I intend to test is whether Per Capita Income (PCI) has any causal effect on the percentage of total energy in a state derived from renewable sources (REG). Therefore, the null and alternative hypotheses are:

- *H_0: PCI has no effect on REG*
- *H_A: PCI has a statistically significant effect on REG*

This paper investigates whether wealthier states in the USA over 2000-2018 have had a higher percentage of their total energy generated through renewable sources. I chose to leave out 2019 and 2020. 2019 had incomplete data and the COVID-19 pandemic in 2020 induced an aberrant shock that can skew the analysis in this paper. I have represented the per capita income of a state through PCI, and the dependent variable is Percent of Renewable Energy generated through renewables (REG), along with other controls as discussed below.

3.2. Empirical Strategy

The general equation to be estimated is:

$$REG_{it} = \beta_0 + \beta_1 GDP_{it} + \beta_2 Growth_{it} + \beta_3 PerCapitaIncome_{it} + \beta_4 CO2\_Emissions_{it} + \beta_6 Nameplate\_Capacity_{it} + \beta_7 AvgEnergyPrice_{it} + \beta_8 Energy\_Revenue_{it} + \beta_9 Governor\_Party_{it} + \beta_{10} Crude\_Oil_{it} + \alpha_i + \gamma_t + \varepsilon_{it}$$

Where:
- *REG:* Renewable energy as a percent of total energy generated by the state
- *GDP:* Gross Domestic Product of the state (Millions of chained 2012 dollars)
- *PerCapitaIncome:* Per capita personal income of the state (Dollars)
- *CO2_Emissions:* Carbon Dioxide emissions of the state (Metric Tons)
- *Nameplate_Capacity:* Total energy generating capacity of the state (Megawatts)
- *AvgEnergyPrice:* Price of energy as Dollars/Megawatthour
- *Energy_revenue:* Total electric industry revenue from sales to ultimate customers (Thousand dollars)
- *Governor_Party:* Binary variable which is 1 if the Governor of the state is Democrat, 0 when Republican
- *Crude_oil:* Crude oil production (Thousand Barrels)
- α: State dummies for fixed effect
- γ: Year dummies for fixed effect
- ε: Error terms

The general empirical strategy is to control for all these factors and confounding variables and use fixed effects regression to isolate any causal effect of PCI on REG. However, a simple fixed effect regression like this may potentially have endogeneity issues. PCI may have an effect on REG, but Renewable energy sources, consumption, and generation may also effect welfare and wealth of a region according to Makešová and Valentová (2021).

Such reverse causalities are depicted by double-sided arrows in Figure 2.
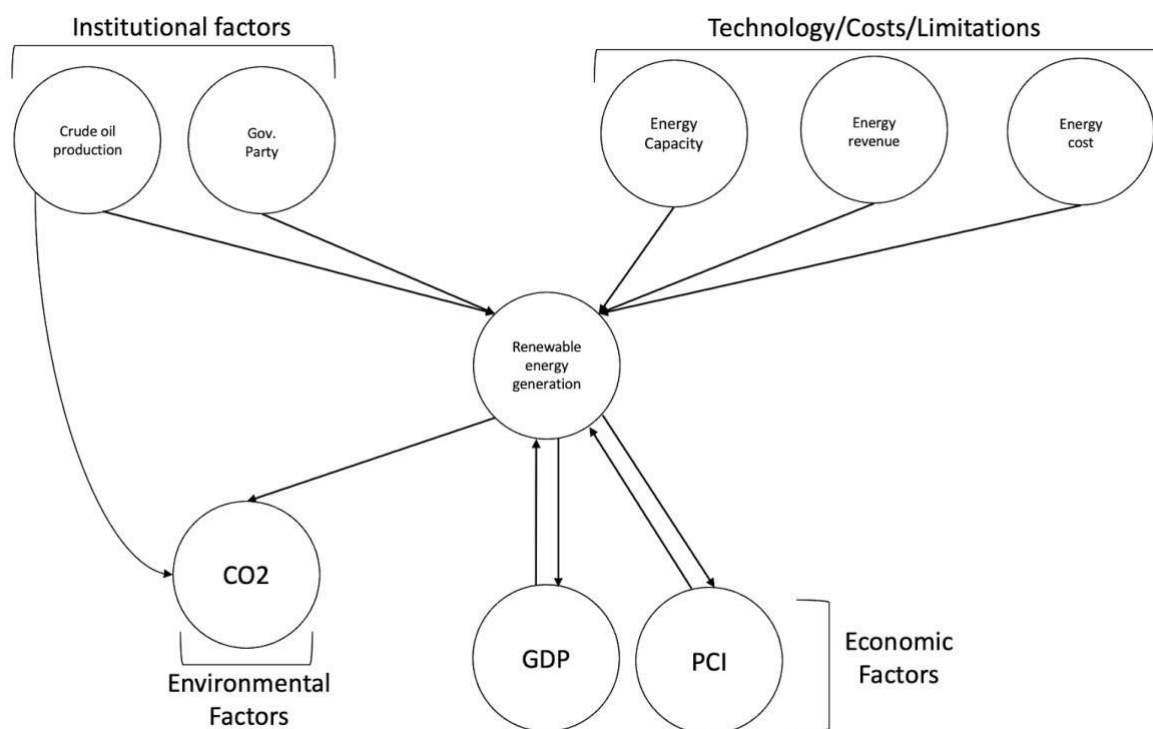
Figure 2: Causal Graph

Therefore, the general framework I use is as follows:
1. Use the Augmented Dickey-Fuller (ADF) Test to see if the time series for each variable is stationary
2. Use Vector Auto Regression (VAR) to find the maximum lag order based on the smallest Akaike Information Criterion (AIC)
3. Use the Granger causality test to map causal links between all variables
4. Check for heteroskedasticity
5. Use step (3) to filter out states that have a unidirectional causal relation between PCI and REG
6. For these states, use fixed effects regression to find the potential causal impact of PCI on REG

3.3. Data

In order to understand renewable energy generation, there are four main factors to consider – institutional, technology, economic, and environmental – as seen in Figure 2. This is loosely based on Uzar (2020).

Institutional factors like the government, regulation, subsidies, and tax breaks can directly affect REG in a state. While it was difficult to compile data on all such factors, I decided to include a dummy variable that is 1 when the governor of the state at a point in time was Democrat and 0 when Republican. This data on governors has been taken from the open ICPSR database and the National Conference of State Legislatures dataset. I also included a variable for crude oil production since some states may have long-term contractual obligations regarding fossil fuels that may prohibit increased funding of renewable fuels, so I hope to represent that using this variable. This data has been taken from the US Energy Information Administration (EIA) website.

The Technology variables are other confounding factors that affect the REG of a state. The total energy generation capacity, the cost to generate a megawatt-hour, and the revenue collected from electricity generation affect how much percentage of the state's energy comes from renewable sources and how much money the state may have to invest into this technology. If a state's energy generation costs a lot of money with not much revenue pulled in, then it is likely the state might not use expensive renewable energy technology and might resort to more polluting fuels. Hence, I included these factors. All these variables have been compiled from the US EIA database.

The main Economic factors included are the GDP of the state and the Per capita income (PCI). These variables have been compiled from the St. Louis Federal Reserve database for each of the 50 states.

The environmental factors included are CO_2 emissions. Now, although I have included CO_2 emissions in one of the fixed effects regression, the causal graph shows that crude oil production might potentially have an effect on CO_2 emissions as well. This makes the CO_2 emissions variable a possible 'collider variable' and including it in the regression procedure might induce bias and make causal relations more difficult to interpret. Hence, I will do two regressions, one with and one without CO_2 emissions. This data has also been taken from the US EIA online database.

Finally, REG represents the percentage of total energy generated that was derived from renewable sources. This is the dependent variable. The data has been taken from the US EIA as well.

The final regression will have dummies for 47 states (leaving the states of Arkansas, Maine, and Georgia out because of insufficient data).

3.4. Robustness Checks

Two main robustness checks have been conducted to check for heteroskedasticity and stationarity of the panel data.

3.4.1. Heteroskedasticity

There are two main robustness checks I did – the Hausman test for Fixed and Random Effects and a graphical test for heteroskedasticity.

The p-value in the Hausman test was very small (around 0.009), so we can reject the null hypothesis and Fixed effects seems like the most suitable framework.

I then performed a simple Pooled OLS regression and graphed the fitted values and residuals.
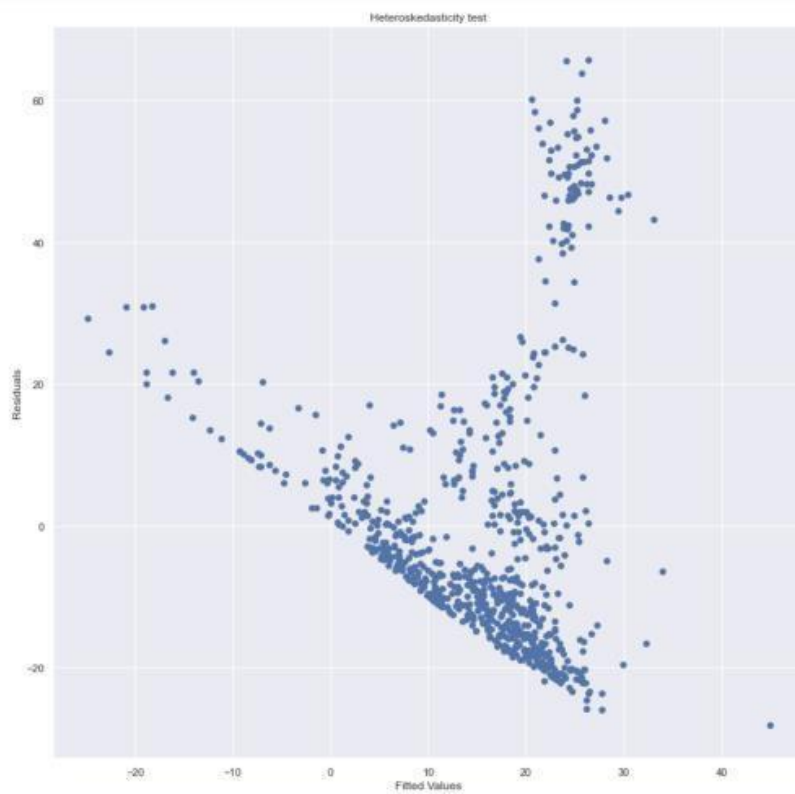
Figure 3: Fitted Values vs Residuals

It can be clearly seen that the errors are heteroskedastic, and so we will adjust for heteroskedasticity in our fixed effects regression model.

3.4.2. Augmented Dickey-Fuller Test

The ADF test was conducted in order to check if each variable was stationary. Stationarity is important for the subsequent VAR model and Granger causality analysis. The results for this test are shown in Table 1.

Variables	ADF Statistic	P-value
GDP	-5.117798	0.000013***
PCI	-6.200680	0.000000***
Capacity(Megawatts)	-4.863828	0.000041***
Cost($/Megawatts)	-5.549901	0.000002***
Total Revenue	-5.064636	0.000017***
Governor Party	-7.480971	0.000000***
Crude Oil	-5.159224	0.000011***

*** shows statistical significance at the 1% level

Table 1: ADF Test results

As seen in Table 1, all the values prove to be stationary according to this test. Hence, we can proceed with the next steps without imposing stationarity by taking first differences.

4. Empirical Findings

As described above, the empirical findings are based on the idea of isolating states, which exhibit a unidirectional Granger causality between PCI and REG, and then performing Fixed Effects Regression. However, we will discuss the differences of a general fixed effects regression bypassing the Granger causality step (using and not using CO2 emissions) and then see if there is any difference in the relation between PCI and REG for states that do exhibit this unidirectional relation.

4.1. Granger Causality

The VAR model's results for each of the different lag orders tried are shown in the following table.

Lag Order	AIC
1	108.52030855000051
2	108.53460269859967
3	108.54648025368468
4	108.53285247862898
5	108.56448431444772
6	108.59517963174751
7	108.58395479398328
8	108.58620547821113
9	108.56173546993985
10	108.57793337952569
11	108.57347193659378
12	108.63151357477724
13	108.65786965128076
14	108.71383205731456
15	108.71206323638484

Table 2: Lag Order and AIC

Lag orders for the Granger causality are generally chosen in an empirical fashion, but it is advised that the lag order with the smallest AIC value is chosen. As seen in Table 2, the lag order with the smallest AIC is 1. Hence, this will be chosen as the 'max lag' parameter in the Granger causality model.

Next, the Granger causality model is fitted to the whole compiled dataset for every state.

Note that Table 2 does not contain CO2 per capita since it is potentially a collider variable.

	GDP_x	PCI_x	Nameplate Capacity (Megawatts)_x	$/Megawatthour_x	Total Revenue_x	Gov_Party_Dummy_x	Crude Oil_x	REG_x
GDP_y	1.0000	0.0239	0.5393	0.7466	0.6236	0.3875	0.2225	0.4059
PCI_y	0.9949	1.0000	0.3965	0.1106	0.7991	0.5529	0.2499	0.2067
Nameplate Capacity (Megawatts)_y	0.6215	0.0080	1.0000	0.4681	0.4554	0.7278	0.0005	0.2729
$/Megawatthour_y	0.7392	0.0000	0.3905	1.0000	0.5782	0.4813	0.4083	0.0474
Total Revenue_y	0.7029	0.0006	0.1827	0.3389	1.0000	0.5987	0.0512	0.7159
Gov_Party_Dummy_y	0.1771	0.7203	0.8036	0.5570	0.5461	1.0000	0.1340	0.5910
Crude Oil_y	0.2357	0.7086	0.0057	0.6734	0.0634	0.1840	1.0000	0.8997
REG_y	0.2957	0.0992	0.4548	0.5980	0.4077	0.4388	0.7890	1.0000

Table 3: Granger causality for each time series

In Table 3, the rows can be considered the response variables (y) and the columns are predictors (x). If the value in the corresponding cell is below the 0.05 p-value threshold, then we reject the null hypothesis and can conclude that column_x

Granger causes row_y. However, here we see that the value for PCI causing REG is 0.0992 and the value for REG causing PCI is 0.2067. This implies that neither variable Granger causes each other.

However, it is important to consider the limitations of this model:

1. The data on which the Granger causality model is fitted contains data for each state in each column. Checking Granger causality between time series values like GDP and dummy variables like Gov_Party_Dummy calculates a p-value that is difficult to interpret and may skew results.
2. The lag order chosen through the VAR model is an assumption based on the AIC values, so it might not be the ideal lag order to calculate Granger causality. As such, I decided to fit the Granger causality model for the data of each state, as this will give us a better understanding of each time series. On doing this, contrary to Table 4, most states individually exhibited statistical causality between PCI and REG. However, it was found that there are only 23 states where PCI Granger causes REG, but not vice versa. For most other states, there exists bidirectional causality. Hence, it is important to acknowledge that the endogeneity issue of reverse causality is true and may be a hindrance in trying to figure out a one-way causal relationship between PCI and REG.

Based on these results, the following states exhibit a one-way Granger causal link:

State	PCI causing REG	REG causing PCI
AZ	0.0164	0.1526
CO	0.0385	0.2682
CT	0.0006	0.9674
FL	0.0000	0.4880
HI	0.0000	0.3912
IN	0.0264	0.0982
IA	0.0006	0.5485
KS	0.0074	0.9266
MD	0.0010	0.6338
MA	0.0000	0.4329
MI	0.0019	0.3316
MN	0.0202	0.6837
MT	0.0000	0.4566
NE	0.0179	0.9773
NV	0.0196	0.0940
NH	0.0000	0.3357
NJ	0.0000	0.4007
NY	0.0000	0.3794
OH	0.0086	0.8563
RI	0.0175	0.8374
SD	0.0075	0.5708
UT	0.0144	0.1102
VT	0.0294	0.7615

Table 4: P-values for unidirectional Granger causality

I decided to filter the main dataset to contain only these 23 states and then conduct a fixed effects regression. It is difficult to provide an economic reason behind why some states portray this unidirectional relationship and some do not, as this result was derived merely by checking time series metrics like p-values and AIC. However, one reason may be that some states have had a lot more funding provided by state governments for renewable energy generation according to Geier (2021). States like North Carolina and California have provided billions in funding to develop the renewable energy sector, which may have in turn resulted in economic growth, resulting in renewable energy generation actually having some causal impact on per capita income growth. On the other hand, some states that have had lesser government incentives to develop this sector might have to rely more on consumers choosing to use renewable energy, thus resulting in a different direction of causation. This disparity in government support will also be discussed in more detail in the final Policy

Implications section. Hence, we filter for the latter case, making our framework more robust in trying to estimate how much per capita income impacts renewable energy generation. However, I also conducted fixed effects regression for the entire dataset to see if there was any marked difference in the coefficient for PCI relative to REG.

4.2. Fixed Effects Regression Results

There are three main fixed effects models computed. The first two can be seen in Table 5, computed on the entire dataset without filtering for the 23 states. Regression (A) contains CO2 per capita but Regression (B) does not.

Variables	(A)	(B)
GDP	-1.434e-05***	-1.409e-05***
	(6.99e-06)	(7e-06)
PCI	0.0005***	0.0005***
	(8.12e-05)	(8.01e-05)
Capacity(Megawatts)	0.0006***	0.0006***
	(0.000)	(0.000)
Cost($/Megawatthour)	0.0199***	0.0187
	(0.010)	(0.009)
Total_Revenue	-6.909e-07***	-6.913e-07***
	(1.88e-07)	(1.87e-07)
Governor Party	-1.0627***	-1.0272***
	(0.491)	(0.491)
Crude Oil	4.304e-06	4.38e-06
	(2.9e-06)	(2.89e-06)
CO2 Per Capita	0.0728	
	(0.085)	
State Fixed Effect	Yes	Yes
Year Fixed Effect	Yes	Yes
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Number of observations	792	792
R^2	0.947	0.947

Note: Arkansas, Maine, and Georgia have been left out of this because their GDP data before 2005 was missing.

Table 5: Fixed Effect Regression – whole dataset

Here, we can see that in regression (A), all the coefficients other than those for Crude Oil and CO2 emissions per capita are statistically significant. In regression (B), except for the Cost and Crude Oil coefficients, others are significant.

When using normal pooled regression, the GDP coefficient was positive, but using fixed effects the GDP coefficient becomes negative. This shows that a $1 million increase in Real GDP correlates strongly with a 0.000014% decrease in REG (the percent of the total energy of a state derived from renewable sources). However, a $100 increase in PCI correlates with a 0.05% increase in REG. This indicates that over 20002018, really rich states might have relied more on non-renewables but states with high amounts of individual wealth have had higher REG. Income inequality perhaps also plays an important role in this as seen in Uzar (2020).

The Governor Party coefficient shows that if the Governor is a Democrat, there is a nearly 1% decrease in the total energy of the state derived from renewables. This is an interesting result as we would generally tend to believe that Democrats lean more towards environmental action and favour the renewables industry. We must take into account the fact that this result may be because of some sort of bias, endogeneity, or there might be some lagged effects of previous Republican governors that cause this negative coefficient. In order to try and remedy the problem of bidirectionality, the following fixed effect regression table is only for the 23 states that have a unidirectional Granger causal relation between PCI and REG.

As seen in Table 6, the coefficient for PCI is still statistically significant. However, it seems to have changed slightly. In this regression, a $100 increase in PCI is associated with a 0.04% increase in REG. However, taking into account Granger

causality, this estimate can be considered to have lesser endogeneity than the regression in Table 5. Moreover, some variables like Cost, and Governor's Party lose their statistical significance in this regression model.

Variables	Coefficient
GDP	-3.9e-05**
	(1.16e-05)
PCI	0.0004***
	(0.000)
Capacity(Megawatts)	0.0009***
	(0.000)
Cost($/Megawatthour)	0.0019
	(0.011)
Total Revenue	-1.144e-06**
	(2.38e-07)
Governor Party	-1.3325
	(0.741)
Crude Oil	3.217e-05**
	(1.46e-05)
State Fixed Effect	Yes
Year Fixed Effect	Yes
------------------------	-----------
Number of observations	437
R^2	0.878

`** indicates statistical significance`

Table 6: Fixed Effect Regression – Granger filtered

5. Conclusion and Policy Implications

Based on the Granger causality and Fixed Effects Regression, there is definitely a strong relationship between PCI and REG, which is most likely a positive one. As found in the regressions, a $100 increase in PCI possibly causes a 0.04% - 0.05% increase in the total percentage of energy derived from renewable sources in a state in the US. However, it is important to be cognizant of the problem of bidirectional causality as shown in the Granger tests.

There are a few limitations to this analysis. Obviously, endogeneity and reverse causality is one of them as explained above. However, there may be other variables that I have included that may be colliders, or there might be some important variables that I have left out that may be confounders. Aspects like land area, natural resources already possessed by a certain region, the amount of money devoted to investment in renewable energy technology, and the number of policies and incentives offered by a state over the years might be important confounders that have been left out due to lack of readily available data. In addition, per capita income may not be the best indicator of 'wealth' differences between states. Using other indicators of wealth might yield more holistic results.

There are definitely many ways to improve upon this research in the future. One of the most fundamental aspects to improve is randomization. By finding a programme, event, shock, or policy, it may be possible to employ a more robust method like Difference-in-Difference or Regression Discontinuity to find stronger causal links between wealth and renewable energy generation. Also, using time-series techniques other than Granger causality can exploit the nature of the data and illuminate more endogeneity biases. Finally, conducting a similar study in the context of other countries or multiple countries at once may expose more interesting relationships.

Although this research was conducted only in the context of the US, this perhaps sheds light on a similar relation between PCI and REG for other regions of the world too. With countries announcing ambitious net-zero carbon emission goals and

concentrating on more sustainable methods, illuminating such macroeconomic relations can have important policy implications. For example, there is definitely a need for more regulatory policies and incentives to help poorer states invest more and develop renewables.

Currently, there is a large difference in the number of policies and incentives some states offer for renewable energy growth. According to the Database of State Incentives for Renewables and Efficiency (DSIRE), California (169), Texas (123), Minnesota (140), and New York (115) are a few of the top states with the greatest number of policies and incentives directed towards renewables development and energy sustainability. There are many countries with a lesser number and magnitude of policies directed towards renewable energy generation. Hence, we need more such policies.

However, bidirectional causality implies both wealth and renewable energy probably impact each other in a cycle that can be exploited for sustainability and green growth. Policies (in the US and other countries) that help improve wealth, income inequality, and economic differences in groups of people can also help boost demand and consumption of renewable energy, which will increase renewable energy generation.

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Article

From Preference to Policy: Wealth, Institutions of Government, and the Search for Democracy

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Abstract

What is the nature of substantive representation within American institutions of government, and to what extent do constituents' preferences turn into adopted policy? To answer these questions, I analyze data on federal policies proposed between 1964 and 2006 and constituents' support for them by running a series of linear probability models to estimate the chance of policy adoption as a function of constituent support. I find the president is more responsive to constituents than Congress, and high-income constituents' preferences – but not those of median- and low-income constituents – are significantly correlated with policies adopted by both Congress and the president.

Keywords: Democracy, Representation, Income Inequality, Linear Probability Models, USA

"I assume that a key characteristic of a democracy is the continued responsiveness of the government to the preferences of its citizens, considered as political equals."

–Robert Dahl, 1971 (p. 1)

1. Introduction

What is the nature of substantive representation in the American government? The U.S. democracy seems quite simple: citizens form policy preferences and elect representatives to turn our preferences into policy, but it sometimes feels like that preference-to-policy pipeline goes unfulfilled (e.g., Carnes, 2013; Tavernise, 2016).

The question of who is represented in the U.S.' representative democracy is highly debated, with some purporting or implying that all who vote or participate politically are represented and others claiming only certain groups of the American public are represented. These contrasting ideas leave us with questions about representatives' responsiveness to their constituents: to what extent do our preferences become policy? Are the institutions of government responsible for adopting policies differentially responsive to constituents' preferences? Has this preference-policy relation changed in the context of elections or polarization-caused challenges to governing?

The standard account provides one model of the policymaking process: constituents elect legislators who turn our preferences into policy. In this thesis, I test implications from the standard account across institutions of government; I estimate policy adoption as functions of constituent support for proposed policies. My data contain information about policies proposed between 1964 and 2006, their support from constituents, the institutions responsible for enacting them, and whether the policies were adopted within two years of being proposed.

My results show the president is more responsive to constituents' policy preferences than Congress. Furthermore, my findings align with the existing literature about the American government's differential responsiveness to constituents: like other scholars, I find higher-income constituents are most likely to have their preferences significantly correlate with adopted policy while median- and lower-income constituents are rarely likely to have their preferences significantly correlate with policy. When analyzing election years, I show the presidency remains more responsive than Congress and find there remains differential responsiveness on the basis of constituent income. These results are robust to a variety of different specifications.

Overall, my results contribute uniquely to the literature about the American government by analyzing and comparing policy responsiveness for our different institutions. The rest of this paper is organized as follows: section two summarizes the existing literature surrounding the nature of democracy, focusing on the standard account model of political representation. Sections three through five outline my hypotheses then the data and empirical strategies I'll use to test them. Sections six and seven report my results and their potential confounders. Section eight concludes my research and pivots toward larger questions of American democracy. The appendix checks the robustness of my findings.

2. The Standard Account of Political Representation

Gilens & Page (2014) identify four "theoretical traditions in the study of American politics": Majoritarian Electoral Democracy, Economic-Elite Domination, Majoritarian Pluralism, and Biased Pluralism. In Majoritarian Electoral Democracies, "the collective will of average citizens, seen as empowered by democratic elections," drives policy. Thus, under this theory, the median voter has the most political power (see Downs, 1957); (s)he has "the capacity … to produce intended and foreseen effects on others" (Wrong, 1995, p. 2) and meets Domhoff's "four power indicators" (2005):

> (1) *who benefits* in terms of having the things that are valued in the society? (2) *who governs* (i.e., sits in the seats that are considered to be powerful)? (3) *who wins* when there are arguments over issues? and (4) who has a *reputation for power* (i.e., who stands out in the eyes of their peers)?

In comparison, the Economic-Elite Domination Theory places policymaking power in the hands of the wealthy, potentially as a result of their ability to "finance election campaigns, bribe supporters and opponents, and purchase other political advantages such as a good education" (Ball & Peters, 2005, pp. 37–38); the theory includes "a class that rules and a class that is ruled" (Mosca, 1939, p. 50). Gilens & Page's remaining two theories of democracy are forms of interest group pluralism, giving

political power to interest groups rather than constituents: Majoritarian Pluralism purports interest groups representing all citizens compete to make policy, and Biased Pluralism restricts Majoritarian Pluralism to corporate, business, and professional interest groups. Notably, none of these four theories give low-income constituents any political power, and by focusing on interest groups, the latter two diminish all constituents' power.

According to Urbinati & Warren (2008), Majoritarian Electoral Democracies – the traditional view of American democracy – see citizens form preferences and then elect representatives to turn those preferences into policy. The standard account has four central features: (1) there is a principal-agent relationship between constituents and representatives, (2) representation is determined by geography, (3) representatives are responsive to their constituents, and (4) representation is politically equal. Central to the idea of the standard account is the belief citizens can voice policy preferences, aligning with Gilens & Page (2014) claiming democratic proceedings empower citizens to voice their desires. Existing literature shows our democracy meets this condition: constituents can express preferences by voting (Franko, 2013), staging riots or protests (Enos et al., 2019; Gillion, 2013), and lobbying (Kollman, 1998). Therefore, because citizens can express our preferences to policymakers, the foundation of the standard account holds true.

Just because we can express our preferences, however, does not mean they necessarily will become policy. Starting with the account's first tenet, if representatives do not follow the wishes of their constituents, they violate the model. Notably, the trustee model of representation – where representatives are elected and trusted to enact the policies they deem best, regardless of their constituents' beliefs (Burke, 1774) – allows for such violations. Next, the nationalization of American politics (Abramowitz & Webster, 2016; Caughey et al., 2018; Morgenstern et al., 2009; Sievert & McKee, 2018) may violate the account's second tenet by leading legislators to widen their foci to constituents outside their districts or states, as compared to keeping legislators closest to the constituents with whom they connect geographically. Additionally, the electoral college (Edwards, 2011) and the equal – not equitable – representation of states in the Senate (Lee & Oppenheimer, 1999) violate the account's third tenet by virtue of taking away aspects of citizens' abilities to hold our representatives accountable. Finally, governmental descriptive representation – when "a representative body is distinguished by an accurate correspondence or resemblance to what it represents, by reflecting without distortion" (Pitkin, 1967, p. 60) – does not always match the breakdown of America itself: representatives are not always similar to their constituents on the bases of race (Crenshaw, 1989; Grofman et al., 1992; Hardy-Fanta et al., 2008; Hawkesworth, 2003; Lee & Oppenheimer, 1999; Lublin, 2021), gender (Crenshaw, 1989; Hardy-Fanta et al., 2008; Hawkesworth, 2003; Rosenthal, 2002; Tate, 2004), religion (Sandstrom, 2019; Stone, 2010), income or class (Carnes, 2013, 2018), ethnicity (Grofman et al., 1992; Lublin, 2021; Welch & Hibbing, 1984), or sexuality (Reynolds, 2013). Furthermore, disenfranchisement (such as felony disenfranchisement (Clegg, 2001)) and other barriers to political participation (such as voter ID laws (Alvarez et al., 2008; Barreto et al., 2009; Hajnal et al., 2017; Vercellotti & Anderson, 2006)) diminish the participation and representation of minority, low-income, less-educated, older, and immigrant constituents; these things violate the account's fourth tenet. In summary, the standard account's philosophical underpinning does not hold up as well as we'd like – American democracy appears to be not so responsive to average constituents after all.

The empirical literature has proposed several tests of the standard account. My analysis draws from Bartels (2008, 2016), Gilens (2012), and Gilens & Page (2014), who also studied the relationship between constituents' preferences and adopted policies and further showed violations of the account. Bartels (2008, 2016) analyzes Senators' policy responsiveness during the late 1980s and the 1990s, finding American democracy does not treat all citizens' preferences equally. Specifically, Bartels (2008) finds Senators weighed the views of those in the upper third of the income distribution 50% more than the views of those in the middle third, with that trend of decreasing wealth correlating with decreasing policy influence continuing to the extent that constituents in the bottom third of the income distribution were "entirely *un*considered in the policymaking process" (254). These findings violate the standard account's fourth tenet.

Gilens (2012) shows even when 100% of Americans support a proposed policy, there is only approximately a 65% chance of it being adopted within four years, and high-income constituents' preferences are more strongly correlated with adopted policy than those of median- and low-income constituents. This overall policy unresponsiveness violates the third tenet of the standard account, and this differential responsiveness on the basis of income violates the fourth.

Gilens (2012) also shows citizens' preferences are more likely to become policy during presidential election years, though there remain "differential impacts on responsiveness to more- and less-well-off Americans" (170). This suggests elections' high salience increases representatives' responsiveness to their constituents' preferences. Ultimately, though, he concludes that "under most circumstances, the preferences of the vast majority of Americans appear to have essentially no impact on which

policies the government does or doesn't adopt" (Gilens, 2012, p. 1); despite the relative increase in responsiveness due to elections, absolute responsiveness remains low.

Gilens & Page (2014) share the results of a similar study regarding citizens' preferences and policy adoption, though this time also accounting for interest groups' preferences. Accounting for interest groups' preferences reveals that "[e]mpirical support for Majoritarian Pluralism looks very shaky, indeed. We also know that the composition of the U.S. interest-group universe is heavily tilted toward corporations and business and professional associations." Ultimately, their analysis provides evidence for the theory of Biased Pluralism, and when focusing more on constituents' preferences, they also find evidence for the Economic-Elite Domination theory.

In sum, Bartels, Gilens, and Page provide further evidence showing that American governance follows the Economic-Elite Domination theory of democracy. Whether from wealth (in the case of economic elites) or lobbying (in the case of interest groups), power may be a necessary condition to relate one's preferences to policy. However, both these scholars and other researchers leave open questions about how policy responsiveness varies across governmental institutions; by conducting such an analysis, my research fills a gap in the literature.

3. Hypotheses

Mayhew (1974) advances a view of representatives as single-minded seekers of re-election – i.e., individuals who maximize utility by doing whatever will maximize their vote shares in future elections – and scholars like Fenno (1978), Murray (2010), and Weingast (1997) offer similar understandings of legislators. I apply this view to the president as well, facilitating a comparison of his responsiveness to that of Congress; this view follows a line of reasoning pioneered in political economy by Buchanan and Tullock (1962) and sometimes referred to as the "Virginia School" (Amadae, 2003; Levy & Peart, 2018, 2020; Mitchell, 1988). Because re-election incentives lead to responsiveness according to Mayhew, I predict responsiveness will decrease alongside election frequency; as Congresspeople are up for re-election every 2.75 years (averaged across both houses), the president is up for re-election every 4 years, and Supreme Court (SCOTUS) justices are never up for re-election (by virtue of being appointed for life), I make the following hypothesis:

> *H1.* **Congress is more responsive than the president.**

Note that I account for existing research about SCOTUS while formulating my hypotheses, but because my dataset does not include enough observations about policies routed to the Court for adoption, my hypotheses and empirical analyses themselves do not ultimately analyze SCOTUS.

In line with Bartels (2008, 2016), Gilens (2012), and Gilens & Page (2014), however, I predict Congress and the president will have differential responsiveness on the basis of constituents' incomes, with both Congresspeople and the president preferring to maximize responsiveness to those most able to contribute to their re-election efforts: economic elites. As compared to members of those two institutions, SCOTUS justices are appointed for life and therefore never need to seek re-election, protecting the Court from Mayhew's re-election-motivated incentive. Existing research offers conflicting accounts of how SCOTUS makes its decisions, however, with some claiming the Court is responsive to outside – e.g., citizen – influences (Ball & Peters, 2005; Bentley, 1949; Flemming & Wood, 1997; Gillion, 2013; Link, 1995; Mishler & Sheehan, 1993, 1996) and others claiming it is isolated from such pressures (Hagle & Spaeth, 1993; Segal & Spaeth, 1993, 2002). My second hypothesis thus is as follows:

> *H2.* **Within Congress and the presidency, there will be differential responsiveness to constituents' preferences: the two institutions will be most responsive to the preferences of economic elites, moderately responsive to median-income constituents, and least responsive to low-income constituents. For the aforementioned reasons, I predict the ordinal rankings of responsiveness by institution will be the same as for H1.**

Testing this hypothesis will allow me to examine the first two theories of democracy with finer resolution; rather than focusing on American government at large, I will be able to determine whether our institutions follow the theories of Majoritarian Electoral Democracy or Economic-Elite Domination.

Furthermore, the presence of an impending election can lead legislators to enact policies they would not otherwise enact (Arnold, 1990; Fenno, 1978), temporarily increasing responsiveness (Gilens, 2012). This makes sense in the context of the retrospective voting model (Bartels, 2016; Cheibub & Przeworski, 1999; Fiorina, 1978, 1981; Fisher & Hobolt, 2010; Healy & Malhotra, 2013; Kiewiet & Rivers, 1984; Kramer, 1971; Plescia & Kritzinger, 2017): constituents decide whether to re-elect legislators based on their prior policy positions, so these prior positions are of increased saliences during election years. In fact, due to it being easier to recall more-recent policy positions, legislators' election-year positions can serve as heuristics for their earlier performances (Fiske & Taylor, 1991; Tversky & Kahneman, 1974), further increasing the salience of positions leading up to elections. My third hypothesis thus is as follows:

> *H3.* **Cardinal measures of Congressional (resp. presidential) responsiveness will increase during Congressional (presidential) election years, with Congress being most responsive and the president being moderately responsive (similar to the ordinal rankings of responsiveness from H1).**

In the context of existing literature showing differential responsiveness on the basis of constituent income, I predict each institution will retain its ordinal ranking of responsiveness across levels of income, leading my fourth hypothesis to be similar to my second hypothesis:

> *H4.* **Though measures of responsiveness during election years will be cardinally larger than measures during non-election years, within Congress and the presidency, there still will be differential responsiveness to constituents' preferences.**

Testing these hypotheses will let me test the theories of democracy within an institution-specific context.

4. Data

To test these hypotheses, I analyze the microdata Gilens (2012) obtained from several nationally representative public opinion surveys and by tracking federally-adopted policies. The dataset's unit of analysis is one proposed policy, with the policies' topics including economic policy, social welfare policy, moral or religious policy, foreign policy, and gun control policy. My data's survey questions range from whether we should allow motorized vehicles in federal wilderness areas to how we could reform the U.S. healthcare system; each question asks for a dichotomous pro or con response, focused on a specific policy, related to federal policy decisions, and used categorical rather than conditional phrasing. For each proposal, the data contains information about support from all constituents, support from constituents of specific income percentiles, when the policy was proposed, whether the policy was adopted within two years of being proposed, and which institution of government could enact it (e.g., Congress alone, the president alone, a combination of Congress and the president). The data comes from a combination of the iPOLL database maintained by the University of Connecticut's Roper Center, the Public Opinion Poll Question database maintained by the University of North Carolina's Odum Institute, other pollsters as described in Gilens (2012), and Gilens and his team directly. Overall, the dataset contains 2,355 policies proposed between 1964 and 2006, though some years in that window do not have any observations due to Gilens' data collection methods. For more information, see Gilens (2012) and Gilens & Page (2014).

Figure 1 illustrates the percent of proposed policy changes by year, with color indicating whether the policy was adopted, opaqueness indicating the timeline of adoption, and each bar's height representing the percent of all policies which were proposed during that year (e.g., 5.4% of all policies I analyze were proposed in 2006, the last year included in my dataset).
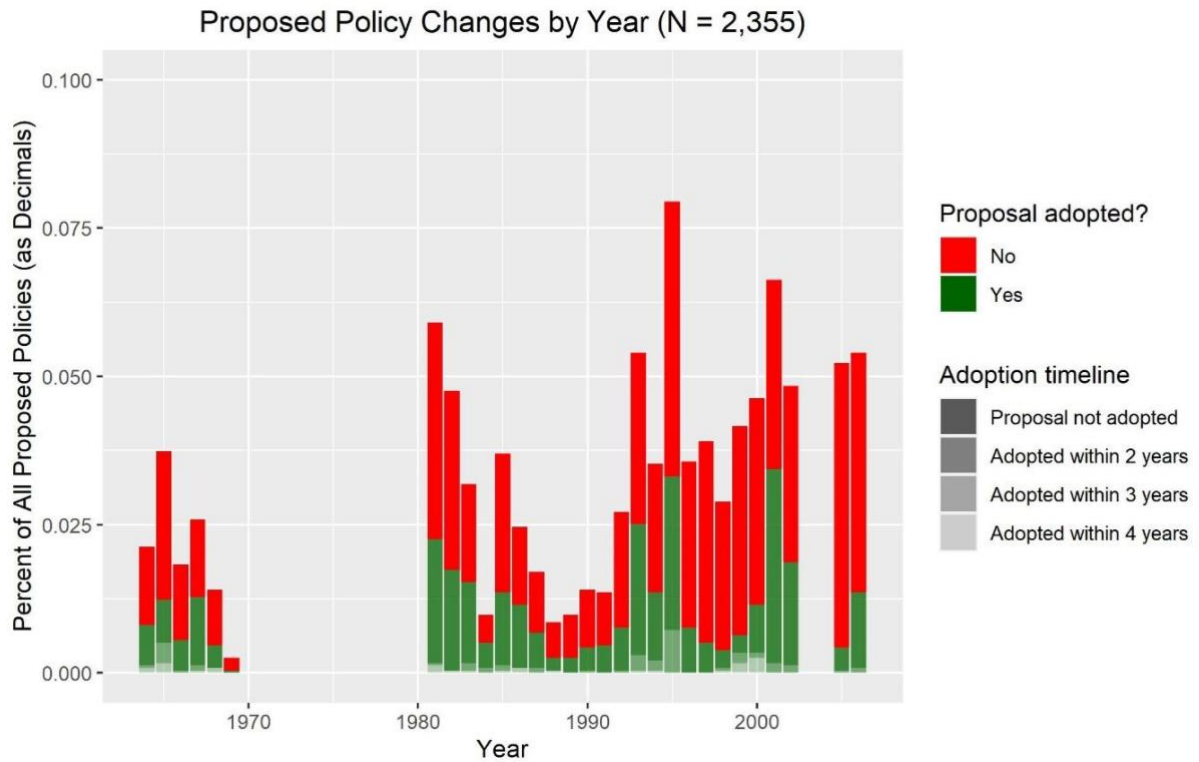
Figure 1

Most adopted policies were adopted within two years, and there appears to be an increasing trend over time for the number of policies proposed in a given year.

The following table illustrates the number of proposed policies by the institution of government able to enact them and what percent of these proposals were adopted:

Institution	Proposal count	Share of proposals	Adoption rate
Congress	1932	0.82	0.307
President	427	0.181	0.522
SCOTUS	10	0.004	0.5
Total	2369	–	–

Table 1

In my analysis, I classify proposed policies as routed through institutions of government – i.e., up for adoption by those institutions of government – by whether that institution needed to play a role in enacting it. For example, a policy routed through Congress could be enacted by Congress alone or a combination of Congress and the president. Because I classify policies this way, I double-count those which can be adopted by either Congress or the president, leading the row of totals to be larger than they would be without any double-counting. As a result, because they exceed 100%, I removed the two totals reported in percentages ("Share of proposals" and "Adoption rate").

The following table summarizes the key variables for my analysis:

Statistic	N	Mean	St. Dev.
Adoption indicator	2355	0.335	0.472
Percent of constituent support: all	2349	0.546	0.206
Percent of constituent support: 10th income percentile	2349	0.539	0.209
Percent of constituent support: 50th income percentile	2349	0.548	0.214
Percent of constituent support: 90th income percentile	2349	0.550	0.207
Percent not knowing their preferences	1259	0.072	0.066

Table 2: Summary Statistics

NOTE: 'Adoption indicator' equaling 1 signifies the proposed policy was adopted. The four 'Percent of constituents supporting' variables are the percent support proposed policies received from that group of constituents (by income percentile). 'Percent not knowing their preferences' is the percent of respondents who said they didn't know what their preferences were for that specific policy.

In the appendix, I interpret the "Percent not knowing their preferences" variable – *DK_PERCENT*, which I will describe in more detail in that section – as a measure of policy salience (with a higher percent of constituents not having a preference indicating the policy is of lower salience and vice versa).

Figure 2 illustrates the distribution of poll respondents saying they "don't know" their preferences for proposed policies:
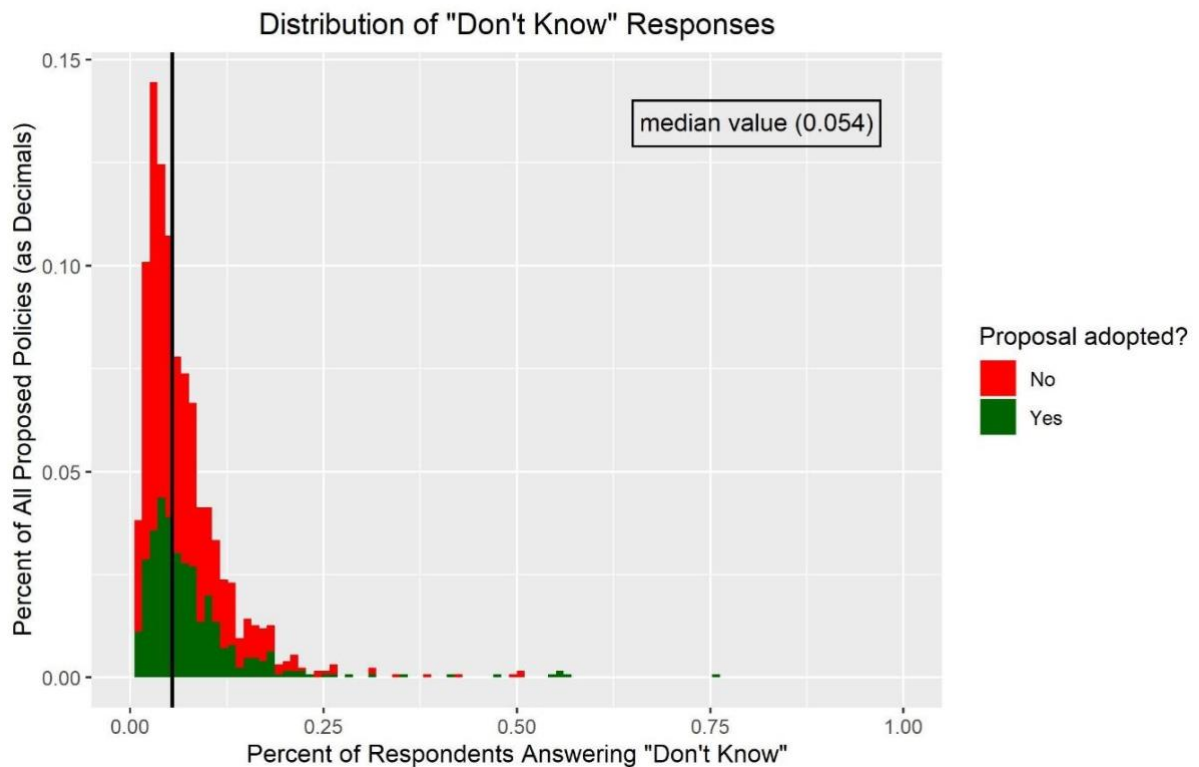
Figure 2

The vertical black line falls at the median value of *Don't know percent*, 0.054. Clearly, the data is right-skewed, suggesting constituents have preferences most of the time and cluster on the same policies when they don't know their preferences (e.g., on a lower-salience policy). This aligns with the literature: by forming their own beliefs internally or picking up positions externally through processes such as heuristics, constituents come to hold policy positions (Carpini & Keeter, 1996; Krosnick, 1990; Kuklinski & Quirk, 2000; Popkin, 1993).

5. Empirical Strategies

To test my first hypothesis (H1), I estimate the following linear probability model:

$$ADOPTION_i = \beta_0 + \beta_1 * PCT\_SUPPORT\_ALL_i + \epsilon_i,$$

where *ADOPTION* is an indicator variable measuring whether a policy was adopted within two years of being proposed (and taking the value 1 if the policy was adopted and 0 otherwise), *i* subsets the proposed policies by the institutions of government responsible for enacting them (Congress, president, SCOTUS), *PCT_SUPPORT_ALL* is the percent of all constituents in favor of each policy, and ϵ is an error term. Note that I pool data across all years of observations to examine the institutions as wholes (like Bartels (2008, 2016), Gilens (2012), and Gilens & Page (2014)); I do this for subsequent analyses as well. I use a linear probability model for its ease of interpretation, which allows me to compare the magnitudes of the calculated coefficient estimates.

To test my second hypothesis (H2), I estimate the following regression:

$$ADOPTION_i = \beta_0 + \beta_1 * PCT\_SUPPORT\_10_i + \beta_2 * PCT\_SUPPORT\_50_i + \beta_3 * PCT\_SUPPORT\_90_i + \epsilon_i,$$

where *ADOPTION* and *i* maintain their prior meanings. My specification is similar to that of Gilens (2012) and Gilens & Page (2014): I represent low-income constituents' preferences by the percent support a policy receives from constituents at the tenth income percentile, median-income constituents' preferences by support from the fiftieth percentile, and economic elites' preferences by support from the ninetieth percentile, with *PCT_SUPPORT_##* being a decimal of the percent of constituents at the ##th income percentile who support each policy (e.g., if 40% of constituents at the tenth income percentile supported a policy, *PCT_SUPPORT_10* would equal 0.4). Though those at the ninetieth percentile may not truly be societal economic elites, the ninetieth percentile's preferences are likely more similar to those of the economic elites than those of median-income constituents, making the ninetieth percentile a satisfactory proxy for economic elites (Gilens & Page, 2014).

To test my third hypothesis (H3), I estimate the following regression:

$$ADOPTION_i = \beta_0 + \beta_1 * PCT\_SUPPORT\_ALL_i + \epsilon_i,$$

where terms defined earlier retain their meanings. I run this specification three separate times: on policies proposed during Congressional election years, presidential election years, and non-election years.

While testing my third hypothesis, it easily makes sense why I should focus on the responsiveness of Congress (resp. the president) during Congressional (resp. presidential) election years – the years when that institution faces re-election incentives – though it is also worth focusing on the intersections of institutions and election years. First, it's possible the president may increase responsiveness during Congress-only election years; given the president takes on the role of the party leader (Cotter, 1983; Klinghard, 2005; Savage, 2014; Seligman, 1956), evaluations of his party's candidates may be somewhat dependent on evaluations of the president himself (i.e., a modification of the coattail voting theory (Calvert & Ferejohn, 1983; Ferejohn & Calvert, 1984; Mondak, 1990; Zudenkova, 2011)), so increasing his responsiveness may yield benefits for Congressional candidates from his party. Second, because presidential elections are of higher salience than Congressional elections (to equate turnout with salience, e.g., Arseneau & Wolfinger, 1973; Campbell, 1960; Converse & Niemi, 1971; Milbrath & Goel, 1977), they pull focus away from Congressional elections and therefore may allow Congresspeople to decrease their responsiveness and still win re-election (with that potential decrease in responsiveness being relative to Congress-only election years). Hence, I will analyze Congress (resp. the president) during Congress-only (presidential-only) election years as well as Congress (the president) during presidential (Congress-only) election years. Furthermore, for a baseline reference, I will also analyze the institutions during non-election years.

To test my fourth hypothesis (H4), I estimate the following regression:

$$ADOPTION_i = \beta_0 + \beta_1 * PCT\_SUPPORT\_10_i + \beta_2 * PCT\_SUPPORT\_50_i + \beta_3 * PCT\_SUPPORT\_90_i + \epsilon_i,$$

where terms defined earlier retain their meanings. I run this specification the same three times as for my test of H3.

Similar to the aforementioned literature, these specifications include as explanatory variables only terms capturing percent support of policies. Though my analysis omits potential controls or a causal specification, it still reveals correlations in governmental responsiveness to constituents of various incomes and aligns with the established literature. Possible control variables for future analysis include measures of political participation regarding proposed policies (e.g., the number of protesters at a rally, the number of emails a legislator receives about a proposed policy) or support among interest groups; future

researchers may need to collect additional data to measure these things. In section seven, I discuss questions similar to these in greater depth.

6. Results and Discussion

The following table contains the results of my test of H1, that the order of institutional responsiveness is Congress, the president, then SCOTUS:

Institution	ADOPTION	
	Congress	**President**
PCT_SUPPORT_ALL	0.378***	0.838***
	(0.050)	(0.117)
Constant	0.098***	0.102
	(0.030)	(0.062)
N	1932	421
R-squared	0.029	0.109
Predicted probability	0.307	0.567

Table 3: Policy Adoption by Institution (standard errors in brackets)
* significant at 10%, ** significant at 5%, *** significant at 1%

My dataset lacks a large number of policy observations routed to SCOTUS for enactment; as a result, I cannot analyze SCOTUS' responsiveness. Future research could expand the timeframe of observations in the hopes of tracking enough proposed policies to facilitate an analysis of the Court.

Notably, the preferences of all constituents are significantly correlated with policy adoption at the 1% level for both Congress and the president, and as *PCT_SUPPORT_ALL* is the percent of all constituents supporting a proposed policy and my models are linear probability models, the coefficients indicate the percent change in the likelihood a policy is adopted given a one hundred percentage point (one-unit) increase in support for the policy by all constituents (e.g., for Congress, a one-unit increase in support for a policy is correlated with a thirty-eight percentage point increase in its chance of adoption).

These results provide evidence against my first hypothesis: the president appears more responsive to constituents than Congress. This may be due to the president serving a larger constituency, therefore making him accountable to the preferences of all Americans and emphasizing incentives to pursue policies aligned with a majority of constituents' interests. Some have argued that the president has more autonomy over his agenda (Baumgartner & Jones, 2010; Cohen, 1995, 1999; Downs, 1972; Kingdon & Stano, 1984; Light, 1999) than Congresspeople have over theirs (Edwards III & Barrett, 2000; Krehbiel, 1988, 2010; Rutledge & Larsen Price, 2014), with one reason for Congresspeople not having ultimate authority over their agendas being the president's ability to affect the Congressional agenda. As a result, it's possible the president would enact policies strongly aligned with constituents' preferences and add to the Congressional agenda policies he supports but that contradict constituents' preferences. This would increase my measure of presidential responsiveness relative to Congressional responsiveness; future research could examine this in greater depth.

Additionally, I include a row at the bottom of the table to report the predicted probabilities of *ADOPTION* given the estimated model coefficients and the average value of *PCT_SUPPORT_ALL*. I will include similar rows in all my regression tables (though using the means of those tables' respective independent variables) as a robustness check to ensure all predicted probabilities fall between 0 and 1, the only reasonable range for *ADOPTION* given it is an indicator variable. Ultimately, all my specifications' predicted probabilities fall inside that interval, marking my models as robust in this respect.

The following table contains the results of my test of H2, that (1) there exists differential responsiveness on the basis of income within our institutions and (2) institutions retain the same ordinal levels of responsiveness I predicted in H1:

Institution	ADOPTION	
	Congress	**President**
PCT_SUPPORT_10	-0.246*	-0.131
	(0.136)	(0.294)
PCT_SUPPORT_50	-0.120	-0.030
	(0.202)	(0.455)
PCT_SUPPORT_90	0.785***	0.985***
	(0.143)	(0.329)
Constant	0.068**	0.105*
	(0.031)	(0.064)
N	1932	421
R-squared	0.047	0.126
Predicted probability	0.307	0.518

Table 4: Policy Adoption by Institution and Income (standard errors in brackets)
* significant at 10%, ** significant at 5%, *** significant at 1%

Again, there is not enough data to analyze SCOTUS.

For neither Congress nor the president is the median-income voter's preference significantly correlated with policy adoption, aligning with the findings of existing research that provide evidence against the median voter theorem and show the U.S. is not a Majoritarian Electoral Democracy (e.g., Bartels, 2008, 2016; Drezner, 2015; Fraenkel, 2016; Gilens & Page, 2014; Gilens, 2012; Romer & Rosenthal, 1978; Rowley, 1984). In fact, for both institutions, the preferences of median- and low-income voters are insignificant at the 5% level and beyond, aligning with the findings of existing literature referenced earlier and aligning with the part of my hypothesis purporting there will exist differential responsiveness within the institutions. The last part of my hypothesis is incorrect, however, as Congress remains less responsive to constituents than the president (or, more precisely, less responsive to high-income constituents, those at the ninetieth percentile who I use to understand responsiveness to economic elites).

A quick search of my dataset reveals one example of this pattern: in 1966, respondents were asked whether they "favor or oppose a plan such as medicare for older people which would cover all members of [their] famil[ies]," with 74.7% of low-income constituents (three-fourths of them) favoring the proposal and 53.7% of median-income constituents (just over half) favoring it. In comparison, only 37.5% of economic elites (well under half) favored it, and despite the support of so many low- and median-income constituents, the proposal ultimately was not adopted by Congress.

The following table contains the results of my test of H3, that (1) elections increase policy responsiveness and (2) the ordinal rankings of responsiveness from H1 will remain constant:

Institution	ADOPTION					
	Congress	**Congress**	**Congress**	**President**	**President**	**President**
Election year?	**Pres.**	**Cong.**	**None**	**Pres.**	**Cong.**	**None**
PCT_SUPPORT_ALL	0.405***	0.405***	0.374***	1.653***	0.871***	0.738***
	(0.125)	(0.095)	(0.067)	(0.328)	(0.246)	(0.144)
Constant	0.023	0.087	0.116***	-0.289*	-0.028	0.198**
	(0.077)	(0.056)	(0.039)	(0.161)	(0.139)	(0.077)
N	319	521	1092	65	99	257
R-squared	0.032	0.034	0.028	0.288	0.114	0.093
Predicted probability	0.26	0.311	0.32	0.477	0.434	0.56

Table 5: Policy adoption by institution and income, by election year type (standard errors in brackets)
* significant at 10%, ** significant at 5%, *** significant at 1%

For each specification, the preferences of all constituents are significantly and positively correlated with policy, but because of the overlap between the confidence intervals of the coefficients within institutions (e.g., Congress during presidential election years, Congressional election years, and non-election years), I cannot definitively confirm the first part of H3 despite the

coefficients' point estimates being larger during election years than non-election years (which would support my hypothesis if not for the overlapping confidence intervals).

As for the second part of my hypothesis, similar to the first part, comparing the confidence intervals of the coefficients across institutions (e.g., Congress during presidential election years and the president during presidential election years) reveals an overlap for the responsiveness estimates during Congressional and non-election years, making it so I cannot definitively confirm the second part of H3 despite the coefficients' point estimates being larger for the presidency than Congress (which would support my hypothesis, similar to what I observe for my test of the first part of H3). For presidential election years, however, the confidence intervals do not overlap, and because the coefficient for the president is larger than the coefficient for Congress, my results provide strong supportive evidence for the second part of H3. Since the sample size for presidential adoption is so small, future research with an expanded dataset may shed more light on our understanding of the president's responsiveness.

The following table contains the results of my test of H4, that (1) election years increase policy responsiveness yet (2) still contain differential responsiveness by constituents' income:

	ADOPTION					
Institution	**Congress**	**Congress**	**Congress**	**President**	**President**	**President**
Election year?	**Pres.**	**Cong.**	**None**	**Pres.**	**Cong.**	**None**
PCT_SUPPORT_10	-0.087	-0.568**	-0.179	-0.748	-0.051	-0.118
	(0.346)	(0.282)	(0.175)	(0.799)	(0.707)	(0.358)
PCT_SUPPORT_50	0.459	0.151	-0.374	1.092	1.576	-0.585
	(0.538)	(0.411)	(0.259)	(1.304)	(1.014)	(0.547)
PCT_SUPPORT_90	0.018	0.829***	0.986***	1.318*	-0.708	1.465***
	(0.360)	(0.279)	(0.191)	(0.770)	(0.739)	(0.413)
Constant	0.031	0.084	0.069*	-0.310*	0.006	0.183**
	(0.082)	(0.057)	(0.040)	(0.157)	(0.163)	(0.076)
N	319	521	1092	65	99	257
R-squared	0.033	0.063	0.052	0.358	0.129	0.131
Predicted probability	0.26	0.311	0.32	0.477	0.434	0.56

Table 6: Policy adoption by institution and income, by election year type (standard errors in brackets)
* significant at 10%, ** significant at 5%, *** significant at 1%

As can be seen, there exists differential responsiveness, with economic elites' preferences being more likely to correlate significantly with adopted policy and median- and low-income constituents' preferences rarely significantly correlating with adopted policy (thus aligning with the second part of H4). Furthermore, during Congressional (resp. presidential) election years, economic elites' preferences are – with varying levels – significant to Congresspeople (the president) as expected due to re-election incentives. The coefficients for responsiveness to economic elites during each institution's respective election years are not significantly different from the corresponding coefficients during non-election years, however, so I cannot definitively accept or reject the first part of H4, consistent with the result of my test of H3.

Interestingly, low-income constituents' preferences are negatively and significantly (at the 5% level) correlated with Congressional policymaking during Congressional election years. Though the negative value may merely be a result of my using a linear probability model, the takeaway that low-income constituents' preferences are not positively and significantly correlated with adopted policy is most likely indicative of reality. Additionally, as compared to my test of H3, this test shows that during years with presidential and Congressional (resp. Congressional) elections, economic elites' preferences are insignificant to Congress (resp. the president) – i.e., economic elites' preferences are insignificant in the first and fifth columns. This may result from presidential elections pulling focus from Congressional elections during presidential election years (first column) and Congress pulling focus from the president during years when Congress is up for election and the president is not. Put another way, presidential elections' higher saliences than Congressional elections (see section five for more information) and Congressional elections' higher saliences than non-election years for the president (see sections two and three for more information) may divert attention from each respective institution, thereby decreasing re-election incentives and explaining the results of the first and fifth columns (respectively). Future research could study these questions in greater depth.

Putting aside the overlaps of confidence intervals, the coefficients' point estimates show responsiveness to economic elites' preferences decreases during election years, contrasting with my test of H3 (and when similarly putting aside confidence interval overlaps). For Congress, one possible explanation is the fact that House members' terms are only two years, so even during non-election years, the next election is always within sight. As a result, House members could always try to maximize their responsiveness to elites during non-election years in preparation to maximize their funding for upcoming elections (which will increase their chances of re-election, once again making my results align with Mayhew's theory). In sum, holding constant the preferences of median- and low-income constituents – i.e., those least able to fund legislators' re-election campaigns and therefore those more likely to be marginalized – House members may not distinguish between election and non-election years when trying to secure campaign funds from potential donors. Furthermore, because House members constitute the majority of Congress, it's possible this lack of difference between election and non-election years' responsiveness for Congress is a result of the effects of House responsiveness "beating out" increased Senate responsiveness during election years. Future research could expand my data to examine legislators' roll call votes and whether they align with their constituents' preferences – rather than simply looking at the blunt instrument of non/adoption – to test responsiveness by chamber and non/election years.

A similar effect may explain the lack of significant difference between presidential responsiveness during election and non-election years: the president may try to remain as responsive as possible given he has fewer opportunities to adopt a policy, making every policy of higher importance. Per the summary statistics in my *Data* section above, 1,932 policies were routed through Congress for adoption, whereas only 427 policies were routed through the president. Hence, a one-policy increase in the share of non-enactments of supported policies or enactments of unsupported policies will decrease the president's responsiveness by more than such an act would decrease Congress' responsiveness. Future research could expand my dataset and test this potential explanation.

To ensure my findings are robust, I re-test them a few different ways in the appendix to this paper.

7. Discussion of Potential Confounders

7.1. Constituents' Agenda-Setting Power (or Lack Thereof)

One potential issue with my analysis is selection bias arising because some constituent-supported ideas never make it onto the agenda. If constituents were to support a policy that never goes up for adoption, that non-policy should diminish my measures of policy responsiveness, but my analysis assumes every policy with constituent support was added to the agenda, potentially biasing upward my measures of responsiveness.

One reason a policy may not make an agenda despite constituent support could be due to more-powerful constituents, interest groups, or policymakers opposing it and quietly expressing their preference not to have that policy go up for adoption (e.g., Bachrach & Baratz, 1962; Crenson, 1971; Lukes, 1974). In effect, it's possible every proposed policy included in my analysis was – by some hidden mechanism – approved by elites and then added to the government's agenda. As a result, my analysis does not account for the probability of a policy being proposed in the first place. Addressing this bias would require data on constituents' preferences for ideas that never made it onto the agenda; this analysis (e.g., with an instrumental variable proxying policy proposal but not adoption) would facilitate an examination of whether and how agenda-formation itself might be biased toward the more powerful.

7.2. On Constituents Expressing Preferences

As I described earlier, constituents have tried-and-true ways to express our preferences to legislators (e.g., voting, lobbying, protesting), yet if we refrain from political participation, legislators may not learn our policy preferences. It's possible the unresponsiveness of the American government disincentivizes constituents from expressing preferences (e.g., Tavernise, 2016) – after all, if political participation won't amount to policy changes, constituents will be less inclined to incur participation's costs (Riker & Ordeshook, 1968) – but it's also possible the American government is unresponsive because a small share of constituents incurs those participation-caused costs in the first place. Relatedly, if lower-income constituents are less likely to express their preferences in the face of political-participation-caused costs, wealthier constituents may be more likely to have their preferences significantly correlated with policy from the get-go (e.g., during a rainy election day, a wealthier car owner may be more likely to vote than a less-wealthy person without a car because the wealthier constituent will be better able to stay

dry on the way to polls, thereby mitigating the cost of getting wet). Future research could examine the potential general equilibrium linking unresponsive government with the likelihood of political participation.

7.3. The State's Emergent Preferences(?)

Another potential issue with my analysis is endogeneity bias: while policy adoption may be determined by constituents' preferences, so too may constituents' preferences be determined by policy proposals. If we define "the state" as "an interrelated set of governing institutions" that serves as a neutral arbitrator between low-, median-, and high-income citizens' preferences (Cudworth et al., 2007, p. 2), we view proposed policies as manifestations of constituents' preferences (Latham, 1952). On the other hand, however, if we define "the state" as "a set of institutions which pursue certain objectives" (Cudworth et al., 2007, p. 2), the American government could be an emergent phenomenon; rather than an instrument devoted to serving its constituents by organizing our preferences, "the state" could propose policies that shape our preferences by virtue of entering political discourse. Through this lens, it's possible our government has a policy agenda of its own (Latham, 1952), in which case proposed policies may originate within the state and constituents' preferences about them may follow.

My analysis assumes all proposed policies begin with constituents' preferences, opening up my findings to this potential threat to their validity. Future research could examine whether the state passes any policies largely inconsistent with constituents' preferences; such policies could be signs there is a non-constituent-based mechanism at play within our government.

On a similar note, there exists a potential endogeneity bias resulting from the timing of the polling which forms the foundation of my data. Though none of the policies I analyzed had been adopted at the time constituents were polled about them, if the respondents were able to make predictions regarding whether the policies would pass or if respondents were able to identify large swings in public opinion and didn't want to be left out (i.e., if they want to "jump on the bandwagon" of public opinion), they may have changed their opinions of the policies (Morton et al., 2015; Rothschild & Malhotra, 2014; van der Meer et al., 2016). As a result, proposals' chances of being passed may affect constituents' support for them, constituents' support for them may affect their chances of being passed, and the cycle may repeat. This potential general equilibrium could serve as a mechanism through which "the state" having preferences for or against certain policies may impact whether constituents support policies and thereby whether the policies are ultimately adopted.

7.4. Interest Groups

Though my analysis – driven by democratic theory purporting constituents steer policy – does not control for interest groups, future research seeking a more robust model for the correlates of adopted policy could account for them (Ball & Peters, 2005; Bartels, 2008, 2016; Gilens & Page, 2014; Gilens, 2012; Grossman & Helpman, 2001). Interest groups being a potential confounder for my models merely highlights one more aspect of America's political system which manifests differently than the ideal, theoretical democracy driven by constituents; while I show the preferences of the wealthiest constituents matter most for policy adoption, future research could analyze policy adoption while also controlling for interest group support, thereby testing the theories of Majoritarian Pluralism and Biased Pluralism (the theories I did not test) in addition to Majoritarian Electoral Democracy and Economic-Elite Domination (the theories I did test).

8. Conclusion

Overall, my results suggest the president is more responsive to constituents' policy preferences than Congress – potentially due to the president having more power over his agenda than Congresspeople have over theirs (see section six) – but due to limitations in data availability, I am unable to compare SCOTUS' responsiveness with those of the other two institutions of American government. Moreover, I find differential representation on the basis of wealth within both Congress and the presidency, and my results suggest elections increase policy responsiveness. All these findings align with the existing literature. My analysis of Congressional responsiveness is slightly limited by my data, however: as my dataset's unit of observation is aggregated across individual policies (and lacks the resolution of policy support within individual legislators' constituencies), I am unable to analyze the responsiveness of individual Congresspeople, and as my data does not differentiate between policies routed primarily or first through the House or Senate, I cannot analyze the responsiveness of the chambers individually. Future research with an expanded dataset could conduct these analyses.

My analyses of Congress and the presidency join existing literature by showing there exists differential responsiveness to constituents, with economic elites having their preferences most strongly correlated with adopted policy and median- and low-

income constituents having their preferences correlate less – i.e., showing American democracy follows the theory of Economic-Elite Domination and not Majoritarian Electoral Democracy. Overall, my research aligns with the literature - nuancing the simplistic, "romanticized" view that the American government exists solely to serve its constituents equally and that individual constituents can significantly impact policy (Pildes, 2014).

In light of my findings, we're left wondering where the disconnect regarding views of American democracy is: why do we continue thinking of our government as an equally accessible conduit for societal improvement despite it being unresponsive to the majority of constituents' preferences? Ralph Miliband phrases this issue rather nicely:

> *"The act of voting is part of a much larger political process, characterised, as I have argued, by marked inequality of influence. Concentration on the act of voting itself, in which formal equality does prevail, helps to obscure that inequality, and serves a crucially important legitimating function."* (1969, p. 194)

In other words, "All animals are equal, but some animals are more equal than others," (Orwell, 1946); at the voting booth – or, more broadly, when we have preferences – we're the same, but at the meetings to formulate real policy, we're far from it.

Perhaps the answer lies in the way we view democracy itself. William H. Hastie, the first Black federal judge, offered the following definition of the term: "Democracy is a process, not a static condition. It is becoming, rather than being. It can be easily lost, but is never finally won," (*Quotes*, n.d.). Academics have weighed in as well, claiming active participation in our political system can make us better citizens and better people (Adams, 1994; Tolbert & Smith, 2005). So, perhaps a better view of American democracy focuses on our perpetual effort to improve the status quo one step at a time, gradually transforming what *is* into what *could be*, not *despite* the challenges in our political system but rather *because of* them. In all, because wealth differentially correlates with access to institutions of government, the search for democracy continues.

Acknowledgements

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