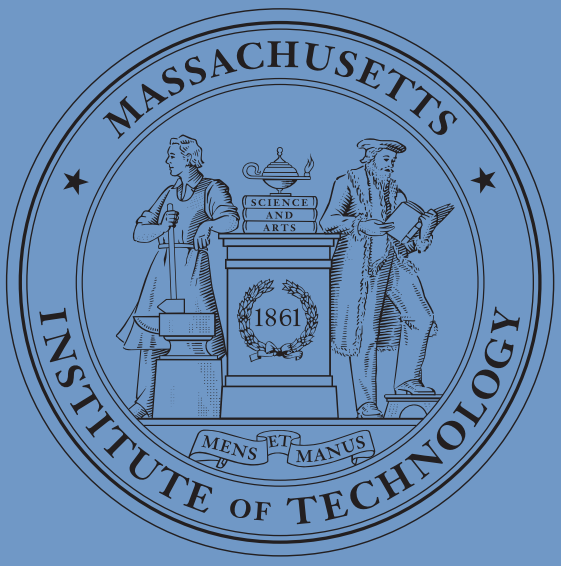


# The MIT Undergraduate Journal of Economics

**Volume XIX**

**2019-2020**

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# Foreword

"Money… must always be scarce with those who have neither wherewithal to buy it, nor credit to borrow it."

*- Adam Smith*

As MIT undergraduate economics students progress through their coursework, they are continuously introduced to new economic topics, constantly learning the ideas and models of established economists, and relentlessly being challenged to think differently about the observable phenomena around them. It is this enthusiasm for learning that led undergraduates at MIT to proceed in their own research—to experience the excitement of asking a question and striving to answer it. We hope that this year's papers highlight the vigor with which our undergraduate students pursue economic research and the rigor with which they present their ideas.

The publication of this Journal is made possible by the support of many people. We especially thank Professor Dave Donaldson for selecting the articles for this year's publication.

These relevant student papers demonstrate the enduring importance of rigorous economic research in the days ahead.

# The MIT Undergraduate Journal of Economics Volume XIX

## 2019-2020

Contents

# Forming Immigration Opinions in a Low Fertility Rate Country

Erin Grela *

December 11, 2019

## Introduction

The issue of immigration is polarizing and dominates many policy debates in a number of developed countries, including the United States. As with most polarizing topics, such debate is subject to sensationalizing by politicians and the media. It is well-documented that even false immigration statistics considerably influence opinion-forming. This not only makes it difficult for the population to craft informed opinions but also obscures what public opinion actually is. In response to concerns of sensationalizing, many economists have worked to shed light on the realities of immigration. However, as long as the environment is one plagued by sensationalizing and non-rational behavior, even the correct facts will struggle to right the situation (Banerjee and Duflo 2019).

Indeed, in a recent randomized online experiment, a group of economists demonstrated the long-lasting effects of President of the French National Front Marine Le Pen's sensationalized and false statements about immigration on immigration opinions, effects which persisted even after the facts were corrected. When respondents were presented with Le Pen's entirely false and negative statistics about immigrants in France, their opinions on immigration were predictably more anti-immigration. However, even after these statistics were corrected and knowledge updated, the negative opinions persisted, relative to control-group opinions: the impressions made

*Thank you to David Atkin, Sara Fisher Ellison, and Ryan Hill for their advice and guidance on the paper, as well as the MIT Department of Economics for funding the survey. This survey experiment was approved by the MIT Institutional Review Board Committee on the Use of Humans as Experimental Subjects.





by the initial facts lingered (Barrera et al. 2018). So with a topic where irrationality clearly holds ground, presenting the correct facts alone will not stabilize the debate. It is also necessary to attempt to understand what public opinion on the matter is and why that opinion is formed as it is.

A realm of intersection with immigration for which there may be interest in understanding how people think is that related to fertility rate, specifically low fertility rates. The fertility rate in a country needs to be approximately 2.1 children per woman, the "replacement rate," in order for that country to maintain a stable population, absent immigration. Most developed countries today, particularly in Asia and Europe, have fertility rates well below this replacement rate. The U.S. has a sub-replacement fertility rate of 1.80 children per woman, slightly higher than that of many European and Asian countries, but a number that has been declining over the past decade (The World Bank 2019). Many countries, like Canada and Singapore, have implemented immigration-friendly policies with the hope of curbing their declining populations and labor markets, and this idea has been central to much of the immgiration discourse in such countries (*The Economist* 2015). However, the same notion is relatively unexplored in the U.S., particularly with respect to what ordinary citizens think of the matter.

I aim to characterize whether those living in the U.S. respond to such low-fertility-rate concerns when forming opinions on immigration and, if so, in which way opinions are affected. It is plausible that opinions would become more pro-immigrant if the risk of population decline were made salient; in other words, I aim to test whether ordinary people exhibit a sort of population loss aversion. To do this, I implement a randomized survey on Amazon Mechanical Turk, a crowd-sourcing website where it possible to hire individuals to complete short human-intelligence tasks. I randomize the survey by presenting respondents living in the U.S. with one of three randomly-chosen true facts about immigration to the United states. The three facts portray immigration as

i. staving off population decline,
ii. helping maintain population stability, or
iii. being a net influx of people.

I then ask respondents to rate the favorability of high and low skilled immigration and the current volume of such immigration types, to then compare how favorability changes based on the fact given. Across analyses, there is a consistent but very small association between having received the immigration-as-

preventing-population-decline fact and pro low-skill immigration opinions and pro high-immigration-volume opinions. The opposite association is seen for opinions on high-skill immigration. However, such results are statistically non-significant and therefore cannot be taken to support any conclusions about how individuals in the U.S. think about immigration with respect to fertility rates and population size.

This experiment fits in with two subsets of existing literature. First, there is recent work that investigates attitudes towards immigration and what shapes these attitudes. The Pew Research Center's extensive work characterizing immigration attitudes in the U.S. and globally reports that favorability towards immigration has increased in recent years but that feelings on the matter have also grown more polarized, especially along party lines (Gonzalez-Barrera and Connor 2019). Hainmueller and Hopkins work at the intersection of political economy and political psychology, documenting that fact that sentiment towards immigrants is motivated by sociotropic concerns, rather than by personal economic circumstances (2014). A second subset of literature builds off of the ideas of behavioral economics to determine how individuals process facts and then form opinions on policy questions related to those facts. As mentioned, Barrera et al. do so with respect to immigration opinions and false facts in France, documenting that individuals do not change opinions made based on false statistics, even after those satistics are corrected (Barrera et al. 2018). Di Tella and Rodrik carry out a randomized survey, prompting respondents with news headlines reporting trade shocks and then recording opinions on trade. The document that support for protectionist trade policies rises significantly when respondents are given such trade-shock news (2019). Similarly, Alfaro, Chen, and Chor use a randomized-survey framework to present respondents with a summary of economic evidence on the effect of trade on inequality and labor market outcomes. They find that being presented negative effects of trade increases respondents' propensity to support policy measures that would limit imports, while seeing positive effects of trade has no effect on responses (2019). This paper looks at an intersection of those two strands of literature, applying the behavioral lens of how opinions on policy matters change in response to randomized facts with the idea of immigration attitudes, specifically with respect to low fertility rates.





# Data

## Amazon Mechanical Turk

To conduct this survey, I use Amazon Mechanical Turk (MTurk), a crowd-sourcing website that allows "requesters" to submit short, human-intelligence tasks to "workers" to complete for a pre-specified amount of money. Surveys are one such popular task. The requester releases a preset number of surveys which can only be completed by a worker once. Upon finishing the survey, the worker receives a survey completion code to submit to the requester, who then verifies with the code that the worker did indeed complete the survey. The requester approves the work, and the worker is paid. For this survey, I restricted the respondent sample geographically to those in the U.S. Workers were paid 35 cents for this 14-question multiple-choice survey.

## Respondent Demographics

Research has shown that MTurk's average worker demographics do differ from those of the U.S. population as a whole. In particular, respondents are younger and more likely to hold a college degree than the general population. However, it has been shown that these differences nearly disappear when demographic observables are controlled for; that is, MTurk workers do not demonstrate significantly different unmeasurable qualities (Walters et al. 2018). This demographic concern is relevant to this survey, but the concern is mitigated by the fact that this survey looks for a change in response levels across respondents, not at the levels themselves. That is, since I am not interested in the response levels themselves, the fact that the sample may not be nationally representative matters less. However, it could still be the case that the magnitude of any change in response levels, given a certain fact, would be different for different subsets of the population, and for that reason, the non-representative demographic composition of this sample is a shortcoming of generating the data from MTurk. I do control for demographic bins in order to correct for any discrepancies between my MTurk sample and the larger U.S. population of interest.

The demographic breakdown of my respondents does coincide with the characterization of MTurk workers described above. As shown below in Table 1, when compared to a nationally-representative sample, my survey respondents are more

likely to be male, younger, and significantly more likely to hold a 4-year college degree and be employed full time. Respondents are also significantly poorer, on average, as well as more likely to be born in the U.S. The proportion of whites is comparable to that of the U.S. population. The representative U.S. population values in column 2 were calculated from the IPUMS American Community Survey from 2017.

Table 1: Demographic Breakdown of Survey Respondents Versus U.S. Population

| | (1) Share in Survey Sample | (2) Share in U.S. Population |
|---|---|---|
| Female | 45.6 | 51.1 |
| Under age 36 | 48.5 | 42.6 |
| White | 76.2 | 76.4 |
| Born outside of the U.S. | 6.3 | 12.8 |
| At least 4-year college degree | 59.2 | 24.2 |
| Employed full-time | 60.6 | 30.5 |
| Household income less than $50,000 | 48.0 | 35.5 |

The demographic breakdown of the U.S. population was obtained from the Integrated Public Use Microdata Series (IPUMS) American Community Surveys (ACS) from 2017, the most recent year available to date. Employed full-time excludes those workers who indicated that they were self-employed. Household income is annual household income.

### Survey Structure and Questions

The survey was conducted as a randomized survey to ensure that differences in responses could be attributed only to the randomized fact presented to the respondent. Upon beginning the survey, each respondent was assigned to one of three treatment groups by a random number generator. Each treatment group received a true fact about the U.S. population. The fact for the first group presented immigration as preventing population decline by citing the sub-replacement birth rate in the United States (Figure A.1.1) (World Bank 2019). I will subsequently refer to this fact as the "loss fact." The second fact reflected population stability in the U.S., referencing the fact that the U.S. population will be in 2080 what it is today, by some population projections (Figure A.1.2) (U.S. Census Bureau 2014). I refer to this fact





as the "stability fact." The third group received a fact reporting the positive net immigration to the U.S. each year; that fact is referred to as the "gain fact" (Figure A.1.3) (World Bank 2019). Following presentation of these facts, with the facts still in view, respondents were asked to answer a simple question about what the fact said, specifically whether it reflected loss, stability, or gain. Respondents were told they needed to answer the question correctly, and if they failed to do so, they were removed from the survey. This comprehension check ensured both that respondents were reading the survey carefully and that they had processed the fact.

On the next page, respondents were asked to rate the favorability of high and low-skilled immigration to the United States on a scale from 1 (= Very Unfavorable) to 7 (= Very Favorable) (Figure A.2.1). Another attention check question, a common MTurk practice, was used on this page as well, with respondents being asked to mark 2 as the response to a question. Failure to do so resulted in the respondent being removed from the survey, again an attempt to reduce potential noise from inattentive respondents clicking random answers to the survey. All responses from any respondents who failed either the comprehension check or this attention check were dropped from the sample before analysis. There is of course a risk that respondents, randomly selecting responses, did pass both attention checks by chance. However, to do so, they would have needed to select the correct answer from both check questions, the first having three possible responses and the second having seven possible responses. Statistically then, it can be expected that just under five percent of respondents who should have failed both attention checks passed by chance. Given the number who failed the check, this corresponds to just over 30 respondents in the pool of purportedly-attentive responses who were actually inattentive workers, out of just over 1200 purportedly-attentive workers, a rather small fraction. Given that attention and comprehension checks were extremely well-disguised in the survey, it can be assumed that respondents applied the same level of attention to questions, regardless of whether they were attention-check questions.

Respondents were next asked to rate what they thought of the current flow of immigration, both high and low-skilled, to the U.S., again on a scale of 1 (= Too Low) to 7 (= Too High) (Figure A.2.2). For analysis purposes, throughout the rest of the paper, I have reversed the order of values so that 1 = Too High and 7 = Too Low, so that the direction of pro-immigration opinions in these questions is the same as that of pro-immigration in the favorability questions (towards 7 be-

ing more pro-immigration). This is to prevent confusion with coefficients reported in the results. Finally, respondents were asked basic demographic questions about their gender, age, race, country of birth, educational attainment, employment status, and annual household income (Figure A.3). All questions were required, and so my dataset consists of values corresponding to each question mentioned above, for each respondent, at the respondent level.

### Stability treatment group concern

As described, there were three randomly-assigned treatment groups: the loss fact group, the stability fact group, and the gain fact group. There was also attrition in each group due to the comprehension and attention checks (all survey respondents who completed those checks also completed the entire survey). However, attrition was not the same across treatment groups, which brings to light a concern with the data gathered. Specifically, as shown in Table 2, while the same number of respondents were assigned to each treatment group, the stability fact treatment group had a significantly higher attrition rate than the other treatment groups. Upon further investigation, this was due to a larger fraction of this group failing the comprehension check. It is very likely that this was because of the vague language (intentionally) used in the stability fact: "by some estimates." This language was necessary to ensure that the fact was true, as only a subset of estimates (those which rely on low immigration) do project the U.S. population being the same in 2080 as it is today. While I mirrored this language exactly in the comprehension check question, the relatively greater confusion it caused is cause for concern (Figure A.1.2). To account for this, I do include that group when reporting the main results but then remove it from all secondary analyses, looking only at the difference between the loss and gain treatment groups.

## Methods and Results

### Summary of Responses

The survey gathered 1205 complete responses. As shown in Table 3, responses to all four questions received the full range of answers (1-7) and were rather dispersed, per the standard deviation values. Of the two question types, questions that asked about the favorability of immigration received more pro-immigration responses than ques-





Table 2: Treatment Group Assignment

| | (1) Number assigned to Treatment Group | (2) Number in Treatment Group That Completed Survey |
|---|---|---|
| Loss fact | 570 | 433 |
| Stability fact | 575 | 347 |
| Gain fact | 577 | 425 |

Those that did not complete the survey were removed for failing the comprehension, attention, or completion checks.

tions that asked about volume of immigration. Further, across the two question types, high-skill immigration questions received more pro-immigration responses than questions pertaining to low-skill immigration. There was also a slightly narrower range of responses for the high-skill versus low-skill immigration questions.

These baseline levels of immigration favorability are generally in accordance with national averages, based on nationally-representative polls. A recent Gallup poll showed that a majority of Americans do support and view immigration in a positive light, but that there is less support for immigrants who are likely to rely on U.S. welfare systems. This is consistent with the fact that the high-skilled favorability score of 5.6 is above the neutral point of 4, as shown in column 1, as well as the fact that the favorability score is lower for low-skilled immigration (4.1, shown in column 2). This reasoning of course relies on the assumption that most Americans believe that it is the low-skill immigrants who would rely on welfare more probably than high-skill immigrants, but this assumption is not unreasonable. Further, Gallup also finds that, on average, Americans feel that levels of immigration should stay the same, consistent with the neutral score of 4.0 (column 3) for high-skilled immigration volumes. That average over high and low-skill immigration of views on immigration volumes falls slightly below 4.0 is perhaps indicative of the fact that this sample is slightly less in favor of high immigration volumes than the population average, but not considerably so.

### Main Results

To determine how the randomized fact presented affected opinions on the favorability of high and low-skill immigration and immigration flows, I regress each outcome of

Table 3: Summary of Responses

| | (1) How favorably do you view the following immigration to the U.S. (1-7, 7=Very Favorably) | | (3) Is the current inflow of the following immigrants to the U.S. (1-7, 7=Too Low) | |
|---|---|---|---|---|
| | High-Skilled | Low-Skilled | High-Skilled | Low-Skilled |
| Mean | 5.6 | 4.1 | 4.0 | 3.2 |
| Std. Dev. | 1.4 | 1.8 | 1.4 | 1.5 |
| Min | 1 | 1 | 1 | 1 |
| Max | 7 | 7 | 7 | 7 |
| Observations | 1205 | 1205 | 1205 | 1205 |

Immigration flow questions were actually asked in with 1=Too Low and 7=Too High, but that ordering has been reversed here so that the ordering and coefficient interpretation go in the same direction as those of the other question category.

interest on a dummy variable for being in a certain treatment group

$$Y_i = \alpha + \beta_1 T_i^{stability} + \beta_2 T_i^{loss} + \epsilon_i$$

Each observation is at the individual-respondent level, $i$, and each $T_i$ is a dummy for whether the individual was in the treatment group specified by that dummy. Since the gain fact treatment group is the omitted dummy, $\alpha$ corresponds to the average response for members of that treatment group. The results are reported in Table 4. On the whole, there are no outcomes of statistical significance. The coefficients in column 1, corresponding to opinions on the favorability of high-skilled immigration are furthest from significance and very close to zero as well, marking no effect of the fact received on recorded opinions. That is true for all responses, as none are statistically significant. The coefficients in columns 2 through 4 are all positive, however, some weaker than others. Those on the immigration volume questions are larger than those on the immigration favorability questions, however, which may coincide with intuition. That is, it may be reasonable that facts about fertility rate and population sizes would not change opinions on immigration as a concept but rather the volume of immigration that people believe should occur. Of course, none of these coefficients are statistically different from zero, but the magnitudes





of these "zeroes" are of considerable enough magnitude that there may indeed be an effect a more powerful experiment could detect. Thinking comparatively, a loss fact seems to increase immigration favorability by about 10-20 percent of what the gap in favorability between high and low skill immigration opinions is, a potentially considerable measure. So there is potential that a future survey, done with a larger sample size and looking more carefully at the question of the optimal volume of immigration in response to low fertility rates, would find non-zero results of interest. In particular, such a survey, with more statistical power, would test whether increasing the salience of the low fertility rate in the U.S. and thus its would-be declining population, absent immigration, would raise what individuals consider to be the optimal number of immigrants. As for the sample size needed for such a test, standard errors approximately half of what they are in this current study would have resulted in such outcomes holding statistical significance. Therefore, a sample size approximately four times that which was used for this study would be needed to pick up statistical significance, should there be any. This would mean a sample size of approximately 1300 per treatment group, which would require beginning with 2000 per group, given that many fail the attention check and comprehension check questions.

Looking further at the coefficients on the demographic indicators, we see that there are significantly positive coefficients on the favorability of high-skill immigration from those who were born outside of the U.S., presumably immigrants as well as on both high and low-skill immigration for those who have four-year degrees. The other coefficient of note is the fact that those under 36 are significantly more likely to think the current volumes of high-skill immigrants are too high compared to those over 36. The fact that those with college degrees are more likely to view all types of immigration more favorably is consistent with past findings, which overwhelmingly assign education levels to be one of the biggest predictors of pro-immigration attitudes (Cottrell et al. 2016). Further, past survey results have found that young people are more likely to take personal and personal economic concerns into account when thinking about immigration, in contrast to more general anti-sociotropic findings. Given that most respondents hold a four-year degree and thus are likely high-skilled, this force could explain the negative coefficient on high-skill immigrant volumes for young people (under 36) in my sample (Cohen et al. 2018).

Table 4: Main Regressions

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | How favorably do you view the following immigration to the U.S. (1-7, 7=Very Favorably) | | Is the current inflow of the following immigrants to the U.S. (1-7, 7=Too Low) | |
| | High-Skilled | Low-Skilled | High-Skilled | Low-Skilled |
| Stability fact | 0.00248 | 0.0584 | 0.132 | 0.111 |
| | (0.102) | (0.130) | (0.103) | (0.111) |
| Loss fact | -0.0183 | 0.153 | 0.0753 | 0.136 |
| | (0.0925) | (0.121) | (0.0948) | (0.101) |
| Female | 0.0388 | 0.187 | -0.188* | 0.170 |
| | (0.0806) | (0.106) | (0.0824) | (0.0892) |
| Under 36 | 0.107 | 0.199 | -0.223** | 0.0767 |
| | (0.0812) | (0.106) | (0.0819) | (0.0890) |
| White | 0.0244 | -0.0660 | 0.227* | -0.260* |
| | (0.0953) | (0.122) | (0.0954) | (0.104) |
| Born outside U.S. | 0.415** | -0.148 | 0.307* | 0.00547 |
| | (0.136) | (0.226) | (0.135) | (0.173) |
| Has four-year degree | 0.381*** | 0.573*** | -0.117 | 0.229* |
| | (0.0922) | (0.114) | (0.0878) | (0.0961) |
| Full-time | -0.0314 | -0.0772 | -0.0953 | -0.201* |
| | (0.0892) | (0.112) | (0.0846) | (0.0952) |
| Income under $50,000 | -0.134 | 0.0462 | -0.116 | -0.0314 |
| | (0.0864) | (0.111) | (0.0865) | (0.0928) |
| Constant | 5.306*** | 3.588*** | 4.096*** | 3.206*** |
| | (0.154) | (0.191) | (0.146) | (0.159) |
| Observations | 1205 | 1205 | 1205 | 1205 |

* p<0.10, ** p<0.05, *** p<0.01 Standard errors in parentheses. Immigration flow questions were actually asked in with 1=Too Low and 7=Too High, but that ordering has been reversed here so that the ordering and coefficient interpretation go in the same direction as those of the other question category.





### Secondary Results

I now extend my analysis to examine how responses change across both treatment groups and demographic groups, per the demographic information I collected from respondents. For each of the seven demographic questions asked (Figure A.3), I group respondents into one of two bins for each demographic, based on their response. These binary bins correspond to the demographic descriptions used in Table 1. For example, for the age demographic, Table 1 reports that 48.5 percent of survey respondents were under age 36. This corresponds to the fact that I have a demographic age bin for those under 36 as well as one for those aged 36 and over. I created the bins by, as in the case of age, finding the approximate cutoff such that resultant bins would be as close to equal as possible. Of course, my ability to do so was constrained by the demographic distribution in the bins from which respondents could choose. For certain demographics, particularly race and country of birth, a significant majority were white and born in the U.S., respectively.

I then analyze how treatment effects vary across both treatment groups and demographic groups. While doing so, I remove all respondents from the stability group, on account of the potential selection bias into that group due to the attrition issue mentioned previously. I carry out the following regression, comparing question responses of those in the loss and gain treatment groups, but across the binary demographic bins I constructed

$$Y_i = \alpha + \beta_1 G_i + \beta_2 T_i^{loss} + \beta_3 (G_i * T_i^{loss}) + \epsilon_i$$

$Y_i$ again marks response values to each of the four immigration-opinion questions. $T_i^{loss}$ is again a dummy variable for belonging to the loss fact treatment group (the gain fact is again the excluded dummy). $G_i$ is a dummy for belonging to a demographic bin, specified for each demographic category in the corresponding regression table. The final term is an interaction term, defining those who belong to both the loss fact treatment group as well as the specified demographic group. $\alpha$ is now the average response for those in the gain treatment group who are not in the specified demographic group.

Carrying out this analysis, I again find that the vast majority of effects are insignificant. Tables A.1 to A.6 in the Appendix detail the results of these regressions for the gender, race, country of birth, educational attainment, employment status, and income level demographics, respectively. Notes of interest include that

fact that for the educational attainment demographic, as shown in Table A.4, those who hold at least a four-year college degree are much more likely, and statistically significantly so, to view both high and low-skilled immigration more positively than those without four-year degrees. This is particularly true for low-skilled immigration favorability. The same difference does not hold when looking at immigration flow, however, which means it it would likely not have implications for the question of immigration with respect to fertility rate and population size, and, indeed, being in the loss versus gain treatment group has no effect on responses across these educational attainment bins. Interestingly, though, the more pro-immigration attitudes of respondents with 4-year degrees, particularly for low-skilled immigration, seems to contradict the previously mentioned finding by Hainmueller and Hopkins that immigration opinions are informed by sociotropic concerns rather than personal economic situation (2014). It may be the case, however, that there is no contradiction between the two findings, as there are other omitted variables correlated with holding a 4-year degree, like race, political affiliation, and location, that could inform a person's sociotropic concerns, a highly plausible explanation.

The other demographic category that yields an interesting set of conclusions is the age category (Table 5), and one such interesting coefficient is on a treatment-group interaction dummy. Both low-skilled favorability and volume questions bring no significant effects, but there are two interesting coefficients for responses about the favorability of high-skill immigration. First, as shown by the coefficient on the "Under 36" demographic bin in column 1, respondents under the age of 36 are more likely to hold pro-immigration opinions on high-skilled immigration, specifically, perhaps unsurprising, as declining support for immigration with age is a well-documented trend in the United States. More interesting is that this higher favorability entirely disappears, and then some, when interacted with being in the loss fact treatment group, a statistically significant result at the 5 percent level. This negative effect of the loss fact is perhaps surprising, according to intuition. It may however be rationalized by employment-opportunity concerns. That is, the majority of respondents to this survey hold at least a 4-year college degree, or in other words, they are, on-average, high-skilled themselves. However, at the same time, respondents are poorer than the average U.S. household, despite their higher level of education, perhaps suggesting, along with the fact that they are a worker on MTurk to begin with, that respondents on-average, have had sub-optimal employment outcomes. That is not to say they are not working, however, as a much higher





fraction of my respondent pool reports working full time compared to a representative U.S. sample. But that does not exclude the fact that they are not working in well-paying full-time jobs, despite their high education. In fact, the opposite may be reasonable, as they are seeking income on MTurk, which may signal a low-paying job, either on its own, as MTurk wages are hardly at the minimum-wage level, or as a supplemental source of income with a second likely lower-paying job. Given that job insecurity falls more squarely on younger and less-experienced workers, such facts may reasonably be particularly true for younger respondents.

To test this hypothesis, I control for both having a four-year degree as well as for income. If such a mechanism, as suggested, is at play, it would follow that any negative effects would disappear after controlling for income and being a high-skilled worker. I proxy being a high-skill worker as having a four-year degree and add that binary control. I also control roughly for income by using the binary income bin I constructed (income less than or greater than $50,000). The results of this regression with controls are presented in Table 6. The coefficient of interest, that on the Under 36*Loss fact variable in column 1, is still negative, although it is slightly less negative and only statistically significant at the $p < 0.10$ level now. While this does not support my proposed hypothesis, it also does not rule it out, given the controls used. A continuous income control, as opposed to the binary categorization used, would be able to more robustly refute or support such a hypothesis. It would also be useful to control with a variable more directly related to the hypothesis at hand. Such a variable could be be related to the extent to which the respondent feels satisfaction with their current occupation.

It may then be the case that favorability towards immigration disappears when such respondents are reminded of the low fertility rates in the U.S., as it could bring to mind the fact that they themselves are already having difficulty with employment opportunities in this rather favorable employment landscape, and that such opportunities would likely be even less favorable in the presence of high-skilled immigrants, or their employment competitors. Such an interpretation, however, would contradict the Hainmueller and Hopkins finding that personal economic concerns do not affect immigration opinions. It is also highly possible, given the large number of outcomes I examined, that the statistical significance on this coefficient is a false positive, as it is statistically likely that when multiple hypotheses are tested, at least some will be significantly non-zero. It may very well be that such is the case here.

Table 5: Effects by Age

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | How favorably do you view the following immigration to the U.S. (1-7, 7=Very Favorably) | | Is the current inflow of the following immigrants to the U.S. (1-7, 7=Too Low) | |
| | High-Skilled | Low-Skilled | High-Skilled | Low-Skilled |
| Under 36 | 0.321* | 0.230 | -0.156 | 0.0371 |
| | (0.134) | (0.175) | (0.137) | (0.143) |
| Loss fact | 0.218 | 0.185 | 0.171 | 0.150 |
| | (0.137) | (0.174) | (0.130) | (0.149) |
| Under 36*Loss fact | -0.488** | -0.0885 | -0.199 | -0.0252 |
| | (0.186) | (0.244) | (0.190) | (0.202) |
| Constant | 5.415*** | 3.924*** | 3.987*** | 3.107*** |
| | (0.106) | (0.123) | (0.0929) | (0.105) |
| Observations | 858 | 858 | 858 | 858 |

* p<0.10, ** p<0.05, *** p<0.01 Standard errors in parentheses.

## Conclusion

On the whole, being exposed to facts that portrayed immigration in a certain way, as related to fertility rate and population size, did not bring any statistically-detectable, non-zero effects on immigration opinions. This was true for either high or low-skilled immigration questions or questions on immigration volumes. As a result, the only conclusion regarding how individuals in the U.S. think about immigration, with respect to low fertility rates and population size, that can be supported by this data is simply that they don't think about immigration in such terms.

That said, there were statistically-zero but positive (pro-higher immigration) coefficients on questions related to immigration volumes, conditional on having received a loss fact. A future survey, with a greater sample size, that looks more carefully at opinions on immigration volumes, perhaps with an attempt to tease apart sociotropic and personal economic welfare concerns, may yield interesting results. Specifically, the sample would need to be roughly four times that which was used per group, but only the "loss" and "gain" group types would be needed. The study should bring greater specificity to both the randomized prompts, relating the facts to immigration more explicitly, as well as greater specificity to the questions





Table 6: Effects by Age with Controls

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | How favorably do you view the following immigration to the U.S. (1-7, 7=Very Favorably) | | Is the current inflow of the following immigrants to the U.S. (1-7, 7=Too Low) | |
| | High-Skilled | Low-Skilled | High-Skilled | Low-Skilled |
| Under 36 | 0.235* | 0.209 | -0.205* | 0.110 |
| | (0.100) | (0.129) | (0.102) | (0.109) |
| Loss fact | 0.184 | 0.170 | 0.0774 | 0.144 |
| | (0.114) | (0.154) | (0.116) | (0.132) |
| Under 36*Loss fact | -0.395* | -0.0863 | -0.135 | -0.104 |
| | (0.161) | (0.212) | (0.167) | (0.179) |
| Has four-year degree | 0.387*** | 0.549*** | -0.132 | 0.195* |
| | (0.0890) | (0.111) | (0.0860) | (0.0931) |
| Income under $50,000 | -0.131 | 0.0676 | -0.110 | 0.0123 |
| | (0.0852) | (0.109) | (0.0860) | (0.0921) |
| Constant | 5.283*** | 3.593*** | 4.204*** | 2.995*** |
| | (0.109) | (0.130) | (0.104) | (0.110) |
| Observations | 1205 | 1205 | 1205 | 1205 |

* p<0.10, ** p<0.05, *** p<0.01 Standard errors in parentheses.

asked. Questions would need to more directly classify which types of immigration were in question (documented, undocumented, temporary, etc). Another set of question attempting to uncover mechanisms of thought would also be necessary, specifically looking at why individuals feel the way they do about the volume of immigration flows. This would help to tease out whether such concerns were motivated by economic concerns (like labor market competition) or cultural concerns (like crime rate), and the extent to which these concerns are mitigated by receiving a "loss" fact as well as the extent to which these concerns drive overall opinions would help uncover any mechanisms at play.

Such insights into public opinion on immigration questions, and how those opinions are formed, might help pave the way to understanding the tempestuous immigration debates in the U.S. A better understanding of these debates and how individuals think about immigration would then better inform how the true facts should enter the debate so as to help individuals form opinions based on these facts. The ability to for individuals to do so is, of course important today, but will likely hold increasing importance over time, as fertility rates decline further, and the U.S. reaches the state that countries like Singapore and Japan are currently in, where replacement migration is widely discussed, even at the individual level.

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# Appendix

Figure A.1.1: Fact reflecting immigration as staving off population loss and comprehension check

Please read the following true immigration fact about the U.S. carefully and answer a question about it. You must answer the question correctly.

The U.S. birth rate of 1.8 children per women is below the 2.1 children per women needed to keep a constant population.

- The U.S. birth rate is below the birth rate needed to maintain its population.
- The U.S. birth rate is that at which the U.S. maintains a constant population.
- The U.S. birth rate is above the birth rate needed to maintain its population.

Figure A.1.2: Fact reflecting immigration as maintaining stability and comprehension check

Please read the following true fact about the U.S. carefully and answer a question about it. You must answer the question correctly.

By some estimates, the U.S. population is projected to be the same in 2080 as it is today.

- By some estimates, the U.S. population will be smaller in 2080 than in 2019.
- By some estimates, the U.S. population will be the same in 2080 as in 2019.
- By some estimates, the U.S. population will be larger in 2080 than in 2019.

Figure A.1.3: Fact reflecting immigration as a net inflow and comprehension check

Please read the following true immigration fact about the U.S. carefully and answer a question about it. You must answer the question correctly.

In the past decade, net migration (immigration minus emigration) to the U.S. has been about +5 million people per year.

- In the past decade, the U.S. has had negative net migration.
- In the past decade, the U.S. has had zero net migration.
- In the past decade, the U.S. has had positive net migration.





Figure A.2.1: Questions on immigration favorability and attention check

How favorably do you view high-skilled immigration to the United States?

| Very Unfavorably | | | Neutrally | | | Very Favorably |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| ○ | ○ | ○ | ○ | ○ | ○ | ○ |

How carefully are you responding to this questionnaire? Please mark 2 as a response.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ | ○ | ○ |

How favorably do you view low-skilled immigration to the United States?

| Very Unfavorably | | | Neutrally | | | Very Favorably |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| ○ | ○ | ○ | ○ | ○ | ○ | ○ |

Figure A.2.2: Questions on net immigration flow favorability

Do you think the current inflow of high-skilled-worker immigrants to the United States is...

| Too Low | | | Just Right | | | Too High |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| ○ | ○ | ○ | ○ | ○ | ○ | ○ |

Do you think the current inflow of low-skilled-worker immigrants to the United States is...

| Too Low | | | Just Right | | | Too High |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| ○ | ○ | ○ | ○ | ○ | ○ | ○ |

Figure A.3: Demographic Questions

**1. What is your gender?**

- Male
- Female
- Other
- Prefer not to say

**2. What is your age?**

- Under 25
- 25-35
- 36-45
- 46-55
- 56-65
- 66-75
- Over 75

**3. Please enter your ethnicity**

- American Indian or Alaska Native
- Asian
- Black or African American
- Hispanic or Latinx
- Native Hawaiian or Other Pacific Islander
- White
- Prefer not to say

**4. What is your country of birth?**

- United States
- Outside of United States
- Prefer not to say





**5. What is your highest level of completed education?**

- Less than high school diploma
- High school diploma or equivalent (eg. GED)
- Some college, no degree
- Associate degree (e.g. AA, AS)
- Bachelor's degree (e.g. BA, BS)
- Master's degree (e.g. MA, MS, MEd)
- Professional degree (e.g. MD, DDS, DVM)
- Doctorate (e.g. PhD, EdD)
- Prefer not to say

**6. What is your current employment status?**

- Employed full time (40 or more hours per week)
- Employed part time (up to 39 hours per week)
- Unemployed and currently looking for work
- Unemployed and not currently looking for work
- Student
- Retired
- Homemaker
- Self-employed
- Unable to work
- Other
- Prefer not to say

**7. What is your annual household income?**

- Less than $20,000
- $20,000 to $34,999
- $35,000 to $49,999
- $50,000 to $74,999
- $75,000 to $99,999
- Over $100,000

Table A.1: Effects Across Gender

| | (1) How favorably do you view the following immigration to the U.S. (1-7, 7=Very Favorably) | (2) | (3) Is the current inflow of the following immigrants to the U.S. (1-7, 7=Too Low) | (4) |
|---|---|---|---|---|
| | High-Skilled | Low-Skilled | High-Skilled | Low-Skilled |
| Female | -0.117 | 0.117 | -0.1000 | 0.189 |
| | (0.138) | (0.177) | (0.137) | (0.144) |
| Loss fact | -0.127 | 0.104 | 0.113 | 0.167 |
| | (0.127) | (0.161) | (0.132) | (0.139) |
| Female*Loss fact | 0.228 | 0.0994 | -0.113 | -0.0587 |
| | (0.189) | (0.245) | (0.191) | (0.202) |
| Constant | 5.622*** | 3.978*** | 3.960*** | 3.036*** |
| | (0.0881) | (0.113) | (0.0907) | (0.0986) |
| Observations | 858 | 858 | 858 | 858 |

* p<0.10, ** p<0.05, *** p<0.01 Standard errors in parentheses.

Table A.2: Effects Across Race

| | (1) How favorably do you view the following immigration to the U.S. (1-7, 7=Very Favorably) | (2) | (3) Is the current inflow of the following immigrants to the U.S. (1-7, 7=Too Low) | (4) |
|---|---|---|---|---|
| | High-Skilled | Low-Skilled | High-Skilled | Low-Skilled |
| White | -0.267 | -0.345 | 0.301* | -0.279 |
| | (0.139) | (0.202) | (0.153) | (0.169) |
| Loss fact | -0.242 | 0.00192 | 0.205 | 0.173 |
| | (0.172) | (0.232) | (0.181) | (0.198) |
| White*Loss fact | 0.289 | 0.184 | -0.180 | -0.0590 |
| | (0.205) | (0.272) | (0.213) | (0.230) |
| Constant | 5.773*** | 4.299*** | 3.680*** | 3.340*** |
| | (0.113) | (0.175) | (0.131) | (0.148) |
| Observations | 858 | 858 | 858 | 858 |

* p<0.10, ** p<0.05, *** p<0.01 Standard errors in parentheses.





Table A.3: Effects by Country of Birth

| | (1) How favorably do you view the following immigration to the U.S. (1-7, 7=Very Favorably) | (2) | (3) Is the current inflow of the following immigrants to the U.S. (1-7, 7=Too Low) | (4) |
|---|---|---|---|---|
| | High-Skilled | Low-Skilled | High-Skilled | Low-Skilled |
| Born outside U.S. | 0.371 | 0.0976 | 0.00395 | 0.177 |
| | (0.232) | (0.408) | (0.199) | (0.329) |
| Loss fact | -0.0200 | 0.157 | 0.0599 | 0.130 |
| | (0.0985) | (0.126) | (0.101) | (0.105) |
| Born outside U.S.*Loss fact | -0.0842 | -0.126 | 0.0235 | 0.0787 |
| | (0.314) | (0.495) | (0.250) | (0.396) |
| Constant | 5.546*** | 4.027*** | 3.913*** | 3.115*** |
| | (0.0714) | (0.0900) | (0.0716) | (0.0739) |
| Observations | 858 | 858 | 858 | 858 |

* p<0.10, ** p<0.05, *** p<0.01 Standard errors in parentheses.

Table A.4: Effects Across Education Levels

| | (1) How favorably do you view the following immigration to the U.S. (1-7, 7=Very Favorably) | (2) | (3) Is the current inflow of the following immigrants to the U.S. (1-7, 7=Too Low) | (4) |
|---|---|---|---|---|
| | High-Skilled | Low-Skilled | High-Skilled | Low-Skilled |
| Has four-year degree | 0.367** | 0.635*** | -0.203 | 0.246 |
| | (0.142) | (0.176) | (0.137) | (0.146) |
| Loss fact | -0.0827 | 0.312 | 0.0537 | 0.270 |
| | (0.157) | (0.190) | (0.142) | (0.158) |
| Has four-year degree*Loss fact | 0.119 | -0.258 | 0.00734 | -0.216 |
| | (0.194) | (0.246) | (0.191) | (0.205) |
| Constant | 5.345*** | 3.649*** | 4.036*** | 2.976*** |
| | (0.114) | (0.136) | (0.102) | (0.112) |
| Observations | 858 | 858 | 858 | 858 |

* p<0.10, ** p<0.05, *** p<0.01 Standard errors in parentheses. "Has four-year degree" indicates respondents who recorded obtaining either a four-year college degree or any level of education beyond that.

Table A.5: Effects by Employment Status

| | (1) How favorably do you view the following immigration to the U.S. (1-7, 7=Very Favorably) | | (3) Is the current inflow of the following immigrants to the U.S. (1-7, 7=Too Low) | |
|---|---|---|---|---|
| | High-Skilled | Low-Skilled | High-Skilled | Low-Skilled |
| Full-time | -0.0213 | 0.241 | -0.125 | -0.0386 |
| | (0.141) | (0.179) | (0.136) | (0.150) |
| Loss fact | -0.110 | 0.335 | 0.0781 | 0.268 |
| | (0.155) | (0.192) | (0.142) | (0.163) |
| Full-time*Loss fact | 0.147 | -0.307 | -0.0238 | -0.209 |
| | (0.195) | (0.248) | (0.191) | (0.207) |
| Constant | 5.580*** | 3.888*** | 3.988*** | 3.148*** |
| | (0.111) | (0.138) | (0.0999) | (0.120) |
| Observations | 858 | 858 | 858 | 858 |

* p<0.10, ** p<0.05, *** p<0.01 Standard errors in parentheses. "Full-time" refers to those working 40 hours a week or more who are not self-employed.

Table A.6: Effects Across Income

| | (1) How favorably do you view the following immigration to the U.S. (1-7, 7=Very Favorably) | | (3) Is the current inflow of the following immigrants to the U.S. (1-7, 7=Too Low) | |
|---|---|---|---|---|
| | High-Skilled | Low-Skilled | High-Skilled | Low-Skilled |
| Income under $50,000 | -0.115 | -0.0138 | 0.0195 | 0.0621 |
| | (0.137) | (0.176) | (0.137) | (0.146) |
| Loss fact | 0.105 | 0.199 | 0.156 | 0.211 |
| | (0.124) | (0.169) | (0.132) | (0.137) |
| Income under $50,000*Loss fact | -0.242 | -0.0992 | -0.191 | -0.151 |
| | (0.188) | (0.244) | (0.191) | (0.203) |
| Constant | 5.620*** | 4.039*** | 3.904*** | 3.096*** |
| | (0.0939) | (0.120) | (0.0933) | (0.0930) |
| Observations | 858 | 858 | 858 | 858 |

* p<0.10, ** p<0.05, *** p<0.01 Standard errors in parentheses. Income refers to annual household income.





# Resource Allocation with Externalities

Benjy Firester & Andrew Komo

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May 9, 2020

## Contents



## §1 Introduction

### §1.1 Question and Research Space

Water rights have been an issue across the world, such as when Cape Town ran out of water in 2018 due to poor water management. In most states in the United States, water property rights are conferred based on the ownership of the land and little can be done at the moment to help deal with inefficiencies and inequalities arising from that. However, a large portion of water is also centrally distributed from rivers and public land by the government. For example, in California, who gets access to which water sources is determined by a system of permits given by the state government. This permit system does not include cash transfers and occasionally leads to inefficient usage such as an excess of water being used in agriculture. We ask is there a mechanism that can effectively distribute permits to water that is fair, utility maximizing, and incentivizes sustainability.





### §1.2 Generalization

The market above has many properties that are not unique, and it can be generalized to many other real world applications as follows. The defining feature is that we have multiple agents who all want a piece of some good that they own a share of. In the water market, the agents do not currently own the water, but we could remedy this by taxing them based on the water they consumed in the past year and use that as their estimate of how much they own instead of thinking of it as the government owning it. This leads to a reformulation of the problem as division of a mutually owned asset. Cramton, Gibbons, Klemperer (1987) studied this problem where agents had a single-dimensional defining feature for utility which is how much they valued the total indivisible good. This model works for applications such as dividing a company or children dividing an estate. The main point of this paper was figuring out under what conditions could a mechanism be incentive compatible and individually rational to divide the asset and then the authors created a bidding game to do so. However, in the water market this fails for two main reasons: i) people do not have linear demand for water, and ii) the government might want to be able to act in the market to tax externalities or divide water in an equitable way since it is a necessary good. We propose a generalization of this model that includes (single type) non-linear demand.

Externalities can be handled in various ways and how the model deals with them would likely have to be handled on a case-by-case basis. For example, we will examine how linear externalities based on consumption can be understood through the model as a bounded error. This means that agents cause externalities based on the outcome of the division (linear in a function of their usage of the good). However, in other markets (such as the water market even) agents might have constant externalities (if they are polluting a river with a factory that has little demand for water) or even exponential demand (if gaining more water means you farm on more land and have extra fungicide runoff into the nearby stream). Recognizing this, building a general externality model poses a daunting challenge, but is more doable when the specific market is well defined.

## §2 Model

### §2.1 Definitions

We mostly align our notation to agree with Cramton, Gibbons, and Klemperer.

Our model consists of

- A finite set of $N$ agents indexed by $i \in \{1, \ldots, N\}$.
- Agent $i$ initially owns $r_i \in [0, 1]$ of the good and $\sum r_i = 1$.
- We have a strictly increasing, convex (negative second derivative), base utility function $f$ such that $f(0) = 0$ and $f(1) = 1$. We require that $f$ is smooth on $(0, 1)$, the interior. This is replacing linear utility for the good. However since we still want to have only a single type, we have that all agents utility for the good is a scalar multiple of this function.
- Every agent has a valuation for the total good $v_i$ which is their utility for receiving all of the good. This means that their utility for receiving $x$ of the good is $v_i f(x)$.
- Agents do not know other agents' valuation of the good, but they know it is drawn independently from a distribution $F$ supported on $[\underline{v}, \overline{v}]$.

As in Cramton, Gibbons, Klemperer, we want to examine revelation games as in mechanisms that take input a vector $v = (v_1, \ldots, v_N)$ of reported evaluations. We want to create a mechanism in which it is optimal for each agent to report their truthful $v_i$ (hence the overloaded notation).

**Definition 2.1.** The outcome of the mechanism is determined by two functions

- $s(v) = (s_1(v), \ldots, s_N(v))$ which is the new ownership after the game. We enforce that the good is fully divided meaning $\sum s_i(v) = 1$ and $s_i(v) \geq 0$.
- $t(v) = (t_1(v), \ldots, t_N(v))$ which is a transfer payment in response to some people essentially buying ownership from others. For now, we enforce that $\sum t_i(v) = 0$ to make this market closed, although this could be altered if we wanted externalities to be taxed through the transfer payment mechanism of the game. Unlike linear utilities, net transfers here are not sufficient since two agents losing the same amount of the good lose different utilities. However, we still have a single type of utility, so we can understand (based on the reported $v$ vector) how much each agent changed utility after the game is played. Agent $i$'s net utility change from ownership is $v_i f(s_i(v)) - v_i f(r_i)$.

Such a pair of functions is called a **trading mechanism**.

## §2.2 Properties and Examples of the Utility Function

There are two extreme cases of $f$ that are worthy of examination. The first is $f(x) = x$ which is just Crampton, Gibbons, and Klemperer. All other $f$ in our function space lie above this function. Since $f$ is monotonic and $f(1) = 1$, the other extreme case is the step function where $f(0) = 0$ and $f(x) = 1$ for $x \in (0, 1]$. This is not smooth (as it is not even continuous), but it is a limit of smooth, monotonic, convex functions, so it is the limit of $f$ in our function space and thus it is helpful to think about this as a phantom $f$ to study. This step function we will call $\chi$. In fact, we might want to consider (in the theory at least) the closure of our space $f$ under sequential limits as these functions might help gain intuition, and even if are not actually applicable, they are arbitrarily closely approximated by functions in our space, so in practice they can be used. Other such limiting functions to study could be piecewise linear functions. These functions help understand our ability to approximate $f$ by a linear function (or approximate a linear function by $f$) which we use in out analysis on externalities.

The value of $f'(x)$ at any point limits its behavior drastically afterwards because it can never attain a higher derivative. This means that $\ell = f'(0)$ determines the function to a large extent. If $\ell$ is close to 1, then we know that $f$ is extremely close to linear and approximation will be very accurate. In fact, $\ell$ is a critical property of $f$ that will determine how close to linear it is and we will use the property later on.

If we have a function $f$ with $\ell$ not too large, we may wish to alter $f$ is a tiny neighborhood of 0 such that its derivative at 0 approaches infinity. This will give us the nice property that allocations of the good will give every agent at least $\varepsilon > 0$ amount of water since they have near-infinite marginal utility at 0 and other agents would sell an arbitrarily small amount to them very happily. We want to do this in a way that doesn't affect the ability to linearize $f$ away from the origin. To do this, we must choose an $\varepsilon > 0$ and multiply our function by a smooth bump function that is 1 for $x \geq \varepsilon$ and has derivative approaching infinity at 0. We never want to start with an $f$ with this property, but we may wish to change our $f$ as described above after analysis when we run a mechanism to enforce interior solutions. This will be extremely helpful at showing existence of solutions (with an easy example for 2 players).





**Example 2.2**

Let $f(x) = \frac{\log(1+kx)}{\log(1+k)}$ is an example of a function that limits to $\chi$ as $k \to \infty$.

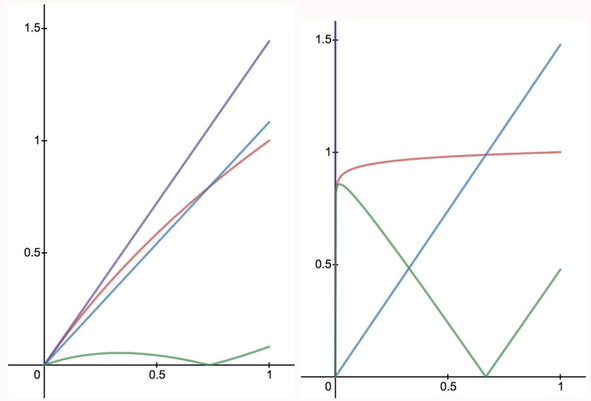


Figure 1: These show the following $f$ for $k = 1$ (left) where $f$ is close to linear and $k = 10^{15}$ (right) which is close to $\chi$. The red function is $f$, the blue function if $y = \alpha x$ the best linear approximation by least squares, the purple function if $y = f'(0)x$ (which on the right is near vertical), and the green is the error of $|f(x) - \alpha x|$. For small $k$ we can clearly see that error is very low, however as we approach $\chi$, this approaches maximum error as the max height of the green error function approaches 1.

**Example 2.3**

For $f(x) = -x^2 + 2x$, we have the property that every agent has no marginal utility for the good after $x = 1$ meaning that this good is such that nobody wants more than 1 of it. In other examples, agents demand was limited by the item which would be considered to be scarce, however here it is not.

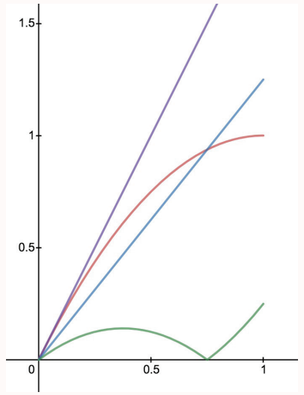


Figure 2: The red function is $f$, the blue function if $y = \alpha x$ the best linear approximation by least squares, the purple function if $y = f'(0)x$, and the green is the error of $|f(x) - \alpha x|$. We see that max error occurs at $x = 1$ since the quadratic is roughly linear near 0. Because of the property that $f'(1) = 0$, we have that agents will not want close to all of the water, which means that the efficient allocation will likely occur with no agent receiving most of the water meaning it will be within the range where linear approximations are quite accurate.

## §2.3 Utility and Expectation

We now want to define our utility functions for these agents. An agent $i$ with initial ownership $r_i$, total valuation $v_i$ and initial money $m_i$ has utility function separable in money

$$u_i(r_i, m_i) = v_i f(r_i) + m_i$$

where $v_i$ is not a parameter of the function as it is constant and thus assumed to be understood when we take $u_i$. We want the agents to be able to afford to play all trading mechanisms, so we can enforce that each agent starts with $m_i \geq \overline{v}$. In practice, if there are many agents this is well over the necessary amount needed to enforce this, but we will use this just to not worry about it in the analysis.

To examine individual rationality, we need to look at the expectation of agent $i$'s outcome given the other agents' decisions irrespective of agent $i$. We define $-i = N \setminus i$ to be the set of agents without $i$ and $\mathbb{E}_{-i}(-)$ to be the expectation operator with respect to $v_{-i}$. This means we can define

$$S_i(v_i) = \mathbb{E}_{-i}(s_i(v)) \text{ and } T_i(v_i) = \mathbb{E}_{-i}(t_i(v))$$

to be the expected share and transfer for agent $i$ after announcing $v_i$ as their evaluation. However,





unlike with linear utility for the good, we cannot say that expected utility is the expected share so we let

$$\mathcal{F}_i(v) = \mathbb{E}_{-i}[f(s_i(v))].$$

We thus define the expected utility as

$$U_i(u) = v_i \mathcal{F}_i(u) + T_i(u)$$

**Definition 2.4.** A trading mechanism is **incentive compatible** if it is rational for each agent to report their actual $v_i$, i.e.,

$$U_i(v_i) \geq v_i \mathcal{F}_i(u) + T_i(u)$$

for all agents $i$ and all $u \in [\underline{v}, \overline{v}]$.

The Revelation Principle from Myerson (1979) allows us to limit our scope to incentive compatible mechanisms without losing any generality.

**Definition 2.5.** A trading mechanism is **individually rational** if the mechanism makes all players better off in expectation,

$$U_i(v_i) \geq v_i f(r_i)$$

# §3 Mechanism Properties

## §3.1 Incentive compatibility and individual rationality requirements

For convenience, let us define $\sigma_i(v_i) = \mathbb{E}_{-i}[f'(s_i(v))]$, so that $d\mathcal{F}_i = \sigma_i dS_i$. The proofs of Lemmas 1-4 follow from Crampton, Gibbons, and Klemperer.

**Lemma 3.1** (Incentive Compatible)

The trading mechanism $(s, t)$ is incentive compatible if and only if for every $i \in N$, $\mathcal{F}_i$ is increasing and

$$T_i(v_i^*) - T_i(v_i) = \int_{v_i^*}^{v_i} u \sigma_i(v_i) dS_i(u) \tag{IC}$$

for all $v_i, v_i^* \in [\underline{v}, \overline{v}]$

*Proof.* Suppose $(s, t)$ is incentive compatible and $S_i$ is increasing. Then, $U_i(v_i) = v_i \mathcal{F}_i(v_i) + T_i(v_i) \geq v_i \mathcal{F}_i(u) + T_i(u)$ for all $u$. So,

$$U_i(v_i) \geq U_i(u) + (v_i - u)\mathcal{F}_i(u)$$

implying that $U_i$ has a supporting hyperplane at $u$ with slope $\mathcal{F}_i \geq 0$. Thus, $U_i$ is convex and the derivative $dU_i/dv_i = \mathcal{F}_i$ almost everywhere. Also $\mathcal{F}_i$ is increasing and

$$U_i(v_i) - U_i(v_i^*) = \int_{v_i^*}^{v_i} \mathcal{F}_i(u) du$$

By integration by parts,

$$\int_{v_i^*}^{v_i} \mathcal{F}_i(u) du = v_i \mathcal{F}_i(v_i) - v_i^* \mathcal{F}_i(v_i^*) - \int_{v_i^*}^{v_i} u \sigma_i(u) dS_i(u)$$

Combining the above with the definition of $U_i$ yields (IC).

Suppose (IC) and $\mathcal{F}_i$ increasing. Adding the identity

$$v_i[\mathcal{F}_i(v_i) - \mathcal{F}_i(v_i^*)] = v_i \int_{v_i^*}^{v_i} \sigma_i(u) dS_i(u)$$

to (IC) results in

$$v_i[\mathcal{F}_i(v_i) - \mathcal{F}_i(v_i^*)] + T_i(v_i) - T_i(v_i^*) = \int_{v_i^*}^{v_i} (v_i - u)\sigma_i(u) dS_i(u) \geq 0$$

where $\mathcal{F}_i$ increasing implies that the intergrand is non-negative for all $v_i, u \in [\underline{v}, \overline{v}]$. Rearranging the terms on the left hand side yields

$$v_i\mathcal{F}_i(v_i) + T_i(v_i) \geq v_i\mathcal{F}_i(v_i^*) + T_i(v_i^*)$$

which is the definition of incentive compatibility. □

**Lemma 3.2** (Minimizer Result)

Given an incentive-compatible mechanism $(s,t)$, agent $i$'s net utility is minimized at $v_i^* = \frac{1}{2}[\inf V_i^* + \sup V_i^*]$ where

$$V_i^* = \{v_i | \mathcal{F}_i(u) < f(r_i) \forall u < v_i; \mathcal{F}_i(w) > f(r_i) \forall w > v_i\}$$

*Proof.* From Lemma 1, we know that $U_i$ is convex, so $U_i(v_i) - v_i f(r_i)$ is convex in $v_i$. So, the minimum of $U_i$ in $v_i$ occurs when the left and right derivatives of $U_i$ approach $f(r_i)$. Recall from Lemma 1 that $dU_i/dv_i = \mathcal{F}_i$ almost everywhere, and $\mathcal{F}_i$ is increasing and $T_i$ is decreasing in $v_i$. The proof proceeds in cases. If $\mathcal{F}_i(u) > f(r_i)$ or $\mathcal{F}_i(u) < f(r_i)$ for all $u \in [\underline{v}, \overline{v}]$, then the minimum must occur at the boundary $v_i^* = \underline{v}$ or $v_i^* = \overline{v}$, respectively. Note that in this case $V_i^* = \{v_i^*\}$. If $\mathcal{F}_i$ is continuous and strictly increasing in a neighborhood around $f(r_i)$, then there exists a unique $v_i^*$ such that $\mathcal{F}_i(v_i^*) = f(r_i)$. If $\mathcal{F}_i$ is not continuous such that it jumps over $f(r_i)$, then the point at which it jumps, $v_i^*$, must minimize the net utility. If $\mathcal{F}_i = f(r_i)$ for some interval, then any point in that interval will equally minimize net utility. □

**Lemma 3.3** (Individual Rationality)

An incentive-compatible mechanism $(s,t)$ is individually rational if and only if for all $i \in N$,

$$T_i(v_i^*) \geq 0 \tag{IR}$$

where $v_i^*$ is defined as in Lemma 2.

*Proof.* Individual rationality will hold for any valuation if and only if it holds for the minimum net utility valuation, $v_i^*$. By construction of $v_i^*$ in Lemma 2, we have $v_i^*\mathcal{F}_i(v_i^*) + T_i(v_i^*) \geq v_i^* f(r_i)$ if and only if $v_i^* f(r_i) + T_i(v_i^*) \geq v_i^* f(r_i)$. □





**Lemma 3.4** (Transfer Function)

For any share function $s$ such that $S_i$ is increasing for all $i \in N$, there exists a transfer function $t$ such that $(s,t)$ is incentive compatible and individually rational if and only if

$$\sum_{i=1}^{N} \left[ \int_{v_i^*}^{\overline{v}} [1 - F(u)] u\sigma_i(u) dS_i(u) - \int_{\underline{v}}^{v_i^*} F(u) u\sigma_i(u) dS_i(u) \right] \geq 0 \tag{T}$$

where $v_i^*$ is defined as in Lemma 2.

*Proof.* The proof below follows from Crampton, Gibbons, and Klemperer. Suppose $(s,t)$ is incentive compatible and individually rational. Then Lemma 1 implies,

$$T_i(v_i) = T_i(v_i^*) - \int_{v_i^*}^{v_i} u\sigma_i(u) dS_i(u)$$

So the expected value is,

$$\begin{aligned}
\mathbb{E}_i[T_i(v_i)] &= T_i(v_i^*) - \int_{v_i=\underline{v}}^{\overline{v}} \int_{u=v_i^*}^{v_i} u\sigma_i(u) dS_i(u) dF(v_i) \\
&= T_i(v_i^*) - \int_{u=v_i^*}^{\overline{v}} \int_{v_i=u}^{\overline{v}} dF(v_i) u\sigma_i(u) dS_i(u) + \int_{u=\underline{v}}^{v_i^*} \int_{v_i=\underline{v}}^{u} dF(v_i) u f'(S_i(u)) dS_i(u) \\
&= T_i(v_i^*) - \int_{v_i^*}^{\overline{v}} [1 - F(u)] u\sigma_i(u) dS_i(u) + \int_{\underline{v}}^{v_i^*} F(u) u\sigma_i(u) dS_i(u)
\end{aligned}$$

Budget balancing requires that for all $v$, $\sum_{i=1}^{N} t_i(v) = 0$, so

$$\sum_{i=1}^{N} \mathbb{E}_i[T_i(v_i)] = \mathbb{E}\left[\sum_{i=1}^{N} t_i(v)\right] = 0$$

Therefore, summing over all agents,

$$\sum_{i=1}^{N} T_i(v_i^*) = \sum_{i=1}^{N} \left[ \int_{v_i^*}^{\overline{v}} [1 - F(u)] u\sigma_i(u) dS_i(u) - \int_{\underline{v}}^{v_i^*} F(u) u\sigma_i(u) dS_i(u) \right]$$

Suppose Equation (T). The proof is then by construction. Let

$$t_i(v) = c_i - \int_{\underline{v}}^{v_i} u\sigma_i(u) dS_i(u) + \frac{1}{N-1} \sum_{j \neq i} \int_{\underline{v}}^{v_j^*} u\sigma_i(u) dS_i(u)$$

where $\sum_{i=1}^{N} c_i = 0$ is implied by the balanced budget constraint that $\sum_{i=1}^{N} t_i = 0$. So, by taking the expectation,

$$T_i(v_i) = c_i - \int_{\underline{v}}^{v_i} u\sigma_i(u) dS_i(u) + \frac{1}{N-1} \sum_{j \neq i} \int_{\underline{v}}^{\overline{v}} [1 - F(u)] u\sigma_i(u) dS_i(u)$$

Thus,

$$T_i(v_i^*) - T_i(v_i) = \int_{\underline{v}}^{v_i} u\sigma_i(u)dS_i(u) - \int_{\underline{v}}^{v_i^*} u\sigma_i(u)dS_i(u) = \int_{v_i^*}^{v_i} u\sigma_i(u)dS_i(u)$$

So, by Lemma 1, $(s,t)$ is incentive compatible. Some algebraic manipulations of (T) mean that $\sum_{i=1}^N T_i(v_i^*) \geq 0$. Then,

$$c_i = \frac{1}{N}\sum_{i=1}^N T_i(v_i^*) + \int_{\underline{v}}^{v_i} u\sigma_i(u)dS_i(u) - \frac{1}{N-1}\sum_{j\neq i}\int_{\underline{v}}^{\overline{v}} [1-F(u)]u\sigma_i(u)dS_i(u)$$

implies that $T_i(v_i^*) = \frac{1}{N}\sum_{i=1}^N T_i(v_i^*) \geq 0$. So, Lemma 3 implies individual rationality for this scenario.

□

## §3.2 Solution Criteria

**Theorem 3.5** (Existence)
A resource with ownership rights $r$ and valuations drawn independently from $F$ can be allocated efficiently if and only if

$$\sum_{i=1}^N \left[\int_{v_i^*}^{\overline{v}} [1-F(u)]u\sigma_i(u)dS_i(u) - \int_{\underline{v}}^{v_i^*} F(u)u\sigma_i(u)dS_i(u)\right] \geq 0 \tag{D}$$

where, for some $j \neq i$, $v_i^*$ solves

$$\mathbb{E}_{-i}[f(s_i(v_i^*, v_{-i}))] = f(r_i)$$

and

$$S_i(u) = \mathbb{E}_{-i}\left[f'^{-1}\left(\frac{v_j}{u}f'(s_j(u, v_{-i}))\right)\right]$$

*Proof.* In order to have an efficient outcome, the social planner solves

$$\max_{s_1,\ldots,s_N} \sum_{i=1}^N v_i f(s_i) \text{ s.t. } \sum_{i=1}^N s_i = 1, s_i \geq 0$$

By assumptions on $f$, we have an interior solution. So, the first order conditions by method of Lagrangian multipliers are

$$v_i f'(s_i) = v_j f'(s_j),\ \forall i,j$$

Since $f$ is increasing and concave, $f'$ has an inverse. Then, for arbitrary $j \neq i$,

$$s_i = f'^{-1}(v_j/v_i f'(s_j))$$

So,

$$S_i(u) = \mathbb{E}_{-i}[s_i(v)] = \mathbb{E}_{-i}\left[f'^{-1}\left(\frac{v_j}{u}f'(s_j(u, v_{-i}))\right)\right]$$





We can find $v_i^*$ by recalling that from Lemma 2, $\mathcal{F}_i(v_i^*) = f(r_i)$. So,

$$\mathcal{F}_i(v_i^*) = \mathbb{E}_{-i}[f(s_i(v_i^*, v_{-i}))] = f(r_i)$$

Lemma 4 is then applied to yield the theorem.

□

**Example 3.6** (2 Player game)
Suppose we have a game with only 2 players each owning half of the good, so $r_1 = r_2 = 0.5$. We know that

$$v_1 f'(s_1) = v_2 f'(s_2)$$

and that $s_1 + s_2 = 1$ so we can solve for the efficient solution by

$$\frac{v_1}{v_2} = \frac{f'(1-s_1)}{f'(s_1)}$$

however, if $\ell = f'(0)$ is small, then the function $f'(1-x)/f(x)$ does not encompass all possible positive values. The range of this function is $\left[\frac{f'(1)}{f'(0)}, \frac{f'(0)}{f'(1)}\right]$. This means that a solution does not always exist if we can choose any $v_i$. However, we can fix this as described in Section 2.2 by changing $f$ is a tiny neighborhood of 0 to make $f'(0)$ arbitrarily high until the range encompasses $\frac{v_1}{v_2}$ (and thus the inverse as well). Interior solutions are forced here by allowing all possible values of $v_i$ and in the more general case with more players, we will definitely need to show existence of solutions.

# §4 Linear Externalities

## §4.1 Approximation method

In this section, we study how the government could add in a tax on consumption of this good. The model here is as people consume more of the good, they induce a linear externality which could be taxed. Each agent is now endowed with a $Z_i$ (either positive or negative) that changes their utility function

$$u_i(v) = v_i f(s_i(v)) + t_i(s_i(v)) + Z_i s_i(v)$$

where $(s,t)$ is a mechanism and $s(v)$ is the amount of the good allocated to agent $i$. If we had that $f$ was linear, we could absorb the $Z_i$ into it which essentially doesn't change anything as we can just relabel each agent as having a new evaluation for the total good $\tilde{v}_i = v_i + Z_i$ and then apply Crampton, Gibbons, and Klemperer. Similarly, if instead of linear externalities, it was a scalar multiple of $f$, then we could do the same trick on a mechanism working within our framework.

Our goal is to find the closest fit of the function $Z_i x$ to some $\alpha f(x)$ and then absorb $\alpha$ into $v_i$ and then apply the mechanism to the general problem and show that the answer is close to being individually rational and incentive compatible given some initial parameters. Because $f$ is monotonic and convex, it is actually pretty easy to approximate linearly and we can bound the difference based on only the properties of $f$. We solve this by approximating using least-squares

error

$$\frac{d}{d\alpha}\int_0^1 (Z_i x - \alpha f(x))^2 dx = 0$$

which implies

$$\int_0^1 Z_i x f(x) dx = \int_0^1 \alpha f^2(x) dx$$

and thus we can solve for and define a new constant based on $f$

$$\kappa = \frac{\int_0^1 x f(x) dx}{\int_0^1 f^2(x) dx}$$

and each $\alpha_i = Z_i\kappa$. Since $f(x) > x$ we can see that $\kappa < 1$ and since $f(x) \leq 1$ we have that $\kappa \geq \frac{1}{2}$. This leads us to approximate

$$u(x) = v_i f(s_i(x)) + Z_i x \rightsquigarrow u(x) \approx (v_i + \alpha_i) f(s_i(x))$$

Based on the geometry of $f$, we know that the line functions $Z_i x$ and $\alpha_i f(x)$ cross in $(0, 1)$ so we want to bound the max difference between them

$$\gamma_i \sup_{x\in[0,1]} (|Z_i x - \alpha_i f(x)|)$$

which will give rise to our next constant in $f$ after dividing by $|Z_i|$

$$\gamma = \sup_{x\in[0,1]} (|x - \kappa f(x)|)$$

Since $f$ is convex, if the max difference occurs after they cross, it must occur at $x = 1$ since the difference is increasing. Thus, it would be $|Z_i - \alpha_i| = |Z_i||1 - \kappa|$ since $f(1) = 1$. If it occurs before, we can bound $f$ by the line $y = f'(0)x$ since it is convex. Thus, the max distance would be bounded by $(f'(0) - Z_i)x$ and since $x$ can be arbitrarily close to 1, this limits to just $\alpha_i f'(0) - Z_i$ which we know is positive. However, if $f'(0) > 1 + \kappa$ , then this is an unnecessarily large bound since we know trivially that the difference can be at most 1 since $f$ is increasing and bounded by $\chi$. Thus, we realize

$$\gamma \leq \min(1, \max(1 - \kappa, \ell - \kappa))$$

where $\ell = f'(0)$ which we can scale by $Z_i$ to get the bound for each agent $i$ which we will denote $\gamma_i$. We can see that this inequality $\gamma$ is indeed sharp by looking at limiting cases. The bound of 1, for example, happens when $f$ is close to the limiting point $\chi$ in which case it is not useful to approximate by a linear function, so for our analysis, we will only really want to apply this theory when $\gamma$ is small. This means that $\ell$ can be represented by $1+\varepsilon$ for small $\varepsilon$ which limits our function space to near linear functions (as determining the derivative at 0 makes the entire function close to the identity function) based on the magnitude of $\varepsilon$. Furthermore, this analysis is dependent not only on these fundamental constants based on $f$, but also by the magnitudes of $Z_i$, so as we will see in what follows, to work within low error, $Z_i$ ought to be bounded and small.





## §4.2 Approximation theorems

**Theorem 4.1** (Γ-Incentive Compatibility)
Suppose we have a trading mechanism that is incentive compatible, meaning

$$v_i\mathcal{F}_i(v_i) + T(v_i) \geq v_i\mathcal{F}_i(u) + T_i(u),\ \forall u \in [\underline{v}, \overline{v}].$$

Then, if we add in linear externalities with $Z_i$ coefficients and approximate them using $\alpha_i f(x)$ where $\alpha_i = \kappa Z_i$, we have Γ-incentive compatibilitiy for some $\Gamma > 0$ meaning

$$v_i\mathcal{F}_i(v_i) + T_i(v_i) + Z_i S_i(v_i) + \Gamma \geq (v_i + \alpha_i)\mathcal{F}_i(u) + T_i(u),\ \forall u \in [\underline{v}, \overline{v}].$$

*Proof.* We first rewrite incentive compatibility as

$$v_i(\mathcal{F}_i(v_i) - \mathcal{F}_i(u)) + T_i(v_i) - T_i(u) \geq 0$$

and then we rewrite the definition of Γ-incentive compatibility as

$$v_i(\mathcal{F}_i(v_i) - \mathcal{F}_i(u)) + T_i(v_i) - T_i(u) \geq \alpha_i\mathcal{F}_i(u) - Z_i S_i(v_i) - \Gamma$$

which by the first inequality in this proof is true if and only if

$$\Gamma \geq \alpha_i\mathcal{F}_i(u) - Z_i S_i(v_i)$$

and by definition, the above difference on the right hand side is bounded by $|Z_i|\gamma$. Thus, we set $\Gamma = \gamma \max_i(|Z_i|)$ and we have shown this approximation is Γ-incentive compatible. □

Incentive compatible means that people can only gain up to Γ by lying about their true evaluation $v_i$. If Γ is small, this means agents will not be able to gain from the system too much by not telling the truth.

**Theorem 4.2** (Γ-Individual Rationality)
If we have a trading mechanism that is individually rational without linear externalities, meaning

$$v_i\mathcal{F}_i(v_i) + T_i(v_i) \geq v_i f(r_i),$$

if we add in linear externalities with coefficients $Z_i$, by approximating the externalities by $\alpha_i f(x)$, then the solution to this altered problem will be Γ-individual rationalality meaning

$$(v_i + \alpha_i)\mathcal{F}_i(v_i) + T_i(v_i) + \Gamma \geq v_i f(r_i) + Z_i r_i.$$

*Proof.* We first apply Lemma 3 and only examine this for $v_i^*$ the minimizer which gives us the new inequality

$$(v_i^* + \alpha_i)\mathcal{F}_i(v_i^*) + T_i(v_i^*) + \Gamma \geq v_i^* f(r_i) + Z_i r_i$$

and this is true if and only if

$$\alpha_i\mathcal{F}_i(v_i^*) - Z_i r_i + T_i(v_i^*) + \Gamma \geq 0$$

and by Lemma 3, we get that this is equivalent to

$$\Gamma + \alpha_i \mathcal{F}_i(v_i^*) \geq Z_i r_i$$

whereby we apply our approximation bound and definition of minimizer $v_i^*$ which tells us

$$\Gamma \geq \gamma \max_i(|Z_i|)$$

finishing the proof by setting $\Gamma$ this this value. □

These results are not surprising. The intuition here is that the further $f$ is from being linear, the more difficult it is to add in linear approximations of it. This gives us that as $\gamma$ grows, our ability to maintain incentive compatibility and individual rationality shrinks. Similarly, the magnitude of $Z_i$ has the same effects. If we have $Z_i$ all 0 (or very small) we are in the assumed incentive compatible or individually rational case. However, as we add in more linear externalities, the magnitude of these screws up their ability to be absorbed by a multiple of $f$ and approximating it gets more and more difficult. Thus, to make these games continue to work with adding in externalities, either $\gamma$ has to be small meaning $f$ is close to linear, or the tax on externalities must be small.

Furthermore, if we take our $f$ to be $\chi$, these bounds are all sharp demonstrating a sort of impossibility result that if $f$ is not at all linear, we cannot use a trading mechanism that approximates linear externalities in an effective way.

## §5 Future Ideas

The main challenge remaining is to prove the existence of trading mechanisms that are incentive compatible, individually rational, and efficient and devise a method to do see as the bidding game in Crampton, Gibbons, and Klemperer. The construction of the bidding game seems virtually untenable with the generalization of utilities. Similarly, the restriction of agents having a single type $v_i$ is limiting, but makes the analysis far easier. To work more on this, we would want to develop similar analysis and results for two types (although this is hard). Perhaps simpler would be to try to deduce some sort of canonical $f$ given a different $f_i$ for each agent and show that performing this single case on this $f$ is within some error of the solution solved for individual $f_i$. Finally, using our framework, we want to analyze water allocation methods that exist in the wild to see in what way they are suboptimal.

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# The Effects of Socialist Policies on Growth:

# A Comparative Study of Greece and Portugal

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14.05: Intermediate Macroeconomics

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# 1.Introduction

Greece's story is one of remarkable success followed by remarkable failure. During the 1950s and 1960s it had one of the highest growth rates in the world, comparable to that of the Asian tigers. However, in the 1980s this growth came abruptly to an end before picking up again in the 2000s, albeit to a lesser degree and before experiencing an enormous fall during the recent crisis of 2007. Portugal on the other hand experienced a smoother growth path, less intense during the 1950s and 1960s but more sustainable than that of Greece. In this paper I attempt to discover the reasons that caused the abrupt halt in the Greek economy, and why attempts to return to a growth path failed. I propose that the reason behind Greece's economic slowdown was its abrupt shift towards socialist policies during the 1980s. This enlargement in the role of the state caused a decline in productivity, which caused growth to stagnate over the next decade.

Greece emerged from the Second World War scarred. The war and the subsequent Axis occupation and resistance had destroyed its infrastructure and decimated its population. Not only that, but as soon as it was liberated, Greece suffered from a three year civil war between the right wing government and communist insurgents, which completed the destruction. But in 1949 things started to look better. The United States, having participated in the Greek civil war, equipped Greece with the necessary institutions to survive in a capitalist world economy and through Marshall Plan funds stabilised the economy and helped put it on a track of growth (Stathakis 1995). Greece enjoyed two decades of democracy until a military coup in 1967 forced a dictatorship, which lasted until 1974. Afterwards democracy resumed in Greece, and European integration soon followed (Tandy et al. 2005).





Portugal, on the other hand, even though it had not participated in the two world wars, was also in a difficult position after 1945, having been hurt both by the great depression and by the economic difficulties of its European neighbors during the war. Furthermore, in 1933 the military seized power and imposed a 40 year fascist regime. With its fall in 1974 and the independence of its colonies, Portugal pursued an increasingly close relationship with Europe (Valério and Elbl 2005).

Although the histories of the two countries differed until the 1950s, Greece and Portugal followed remarkably similar paths thereafter. Being European countries, they both pursued increasingly close ties with the newborn European Economic Community (EEC) and they both became members in the 1980s. Both experienced a military dictatorship that ended in the same year (1974), and afterwards they both established a Parliamentary Democracy. Later on both of them adopted the Euro. Furthermore, throughout the post war years they had similar populations and population growth rates, which allows us to use GDP and GDP per capita measures interchangeably. I use this similarity between the two countries to attribute their different economic performance to their main policy differences, specifically their differing attitudes towards privatiations and the role of the state in the economy.

# 2.Growth Accounting

The following graph shows the evolution of the GDP of Greece and Portugal. A careful examination of the graph shows the differing trends in the two countries. Greece initially had a high growth rate, which it was able to sustain for around 25 years, until 1980. It then experienced a period of meager to no growth, before picking up again in the 2000s and crashing during the recession. Portugal on the other hand enjoyed a lower but more constant growth, which waned during the 2000s.

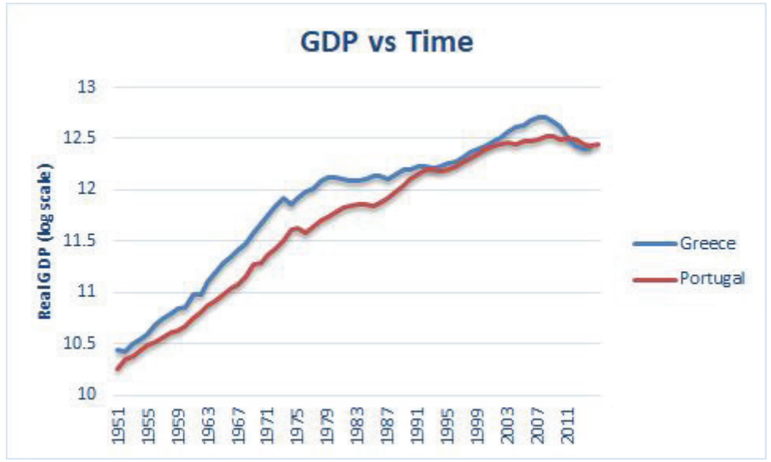


**Figure 1:** GDP of Greece and Portugal

Source: Penn World Tables 9.0

We can then perform a growth accounting exercise on both countries, attributing the growth experienced to either capital, labor, or productivity (computed as the residual) growth. For the analysis we use a Cobb-Douglas production function. For the coefficient α of the production function we use an average over all the available years. For Portugal this number was 0.36, close to the standard value of 0.33, but for Greece the number was significantly higher, at 0.47. We can then divide the data into four periods, according to the different phases we identified in the graph above.

In addition, we also perform a growth accounting exercise using per capita measures and including human capital growth as another potential source of growth. For this analysis we use a Cobb-Douglas production function augmented to include human capital growth.





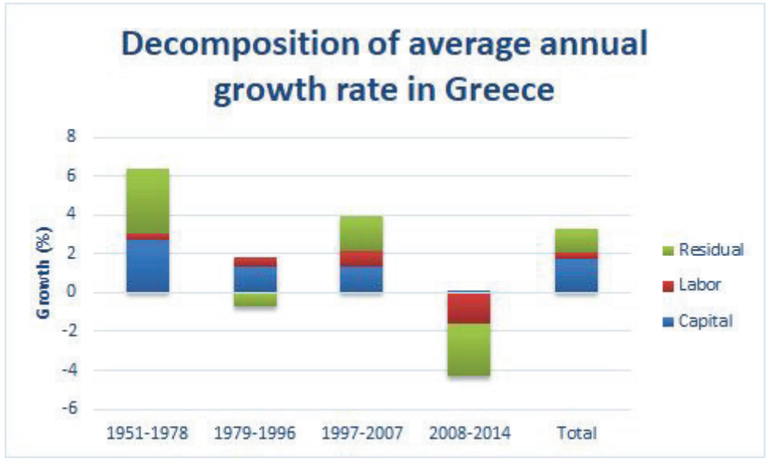


**Figure 2:** Growth Decomposition of Greece

Source: Penn World Tables 9.0

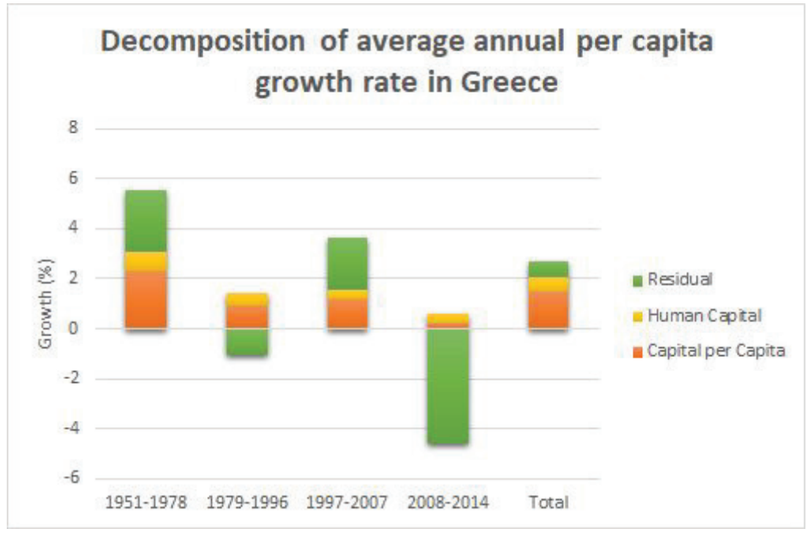


**Figure 3:** Per Capita Growth Decomposition of Greece

Source: Penn World Tables 9.0

As we observe above, Greece experienced a rapid increase in its GDP during 1951-1978, which averaged 6.4% a year. This high number was propelled mainly by rapid capital accumulation and an increase in productivity. However, over the next two decades growth slowed down, averaging just 1.1%, with productivity actually declining in that period. Only capital remained high, albeit not as high as the previous period. In the beginning of the 21st century growth again picked up in Greece, with an average of 4.0% driven mainly by a larger productivity growth. Finally, the crisis saw a massive decrease in Greek GDP, which fell by 4.2% yearly. This decrease was due to a decrease in labor participation, which fell 1.6% yearly, and productivity, which fell 2.7% yearly. Overall, it becomes clear that capital accumulation was the main reason for the growth experienced by Greece, with labor and human capital playing a small but steady role, and with productivity accounting for a large share before the crisis.

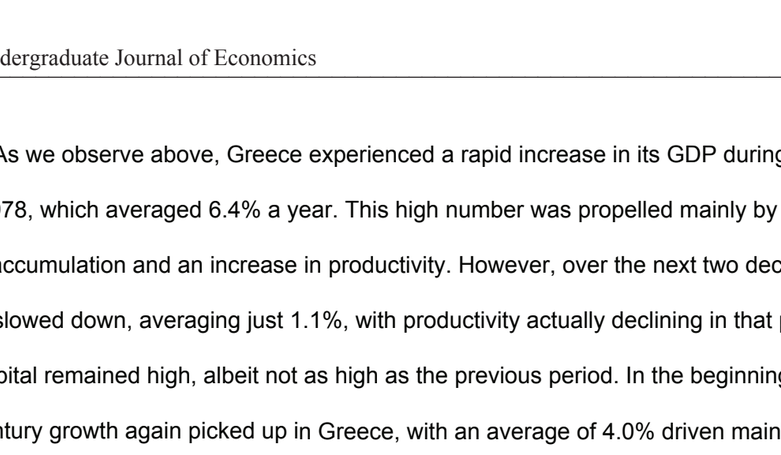


**Figure 4:** Growth Decomposition of Portugal

Source: Penn World Tables 9.0





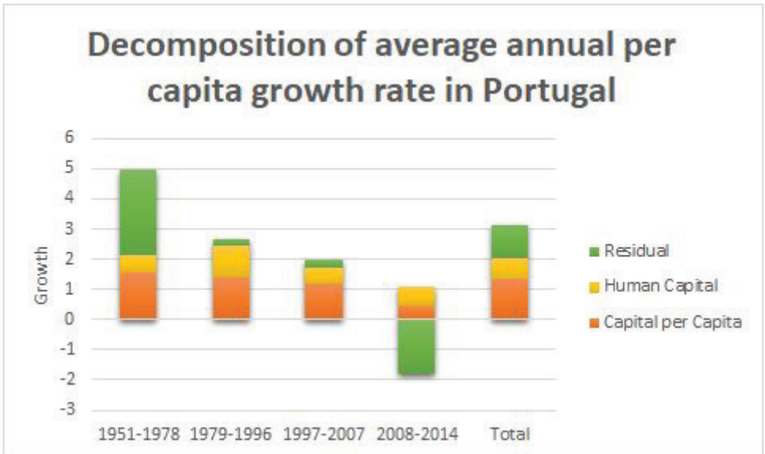


**Figure 5:** Per Capita Growth Decomposition of Portugal

Source: Penn World Tables 9.0

Portugal on the other hand started off with a period of rapid growth in capital and total factor productivity (TFP), which led to GDP rising by 5.3% yearly on average. Over the next period Portugal experienced a lower growth rate of 3.1% due to small productivity gains, which however was higher compared to that of Greece. Growth then slowed down in the 2000s, with only capital growth remaining high. During the crisis, Portugal also experienced a decrease in labor participation and productivity, but these were moderated by growth in human and physical capital which were higher than in Greece, and as a result GDP fell by only about 1% during the crisis. Overall, Portugal seems to have sustained high growth in physical and human capital, with physical capital and productivity taking the lion's share.

## 3.Great Expectations

Greece enjoyed two and a half decades of spectacular growth, averaging 6.3% per year. The reasons for this growth can be attributed to the pro-growth policies of the

governments ruling Greece until 1974. As was mentioned above, after the war the United States maintained a strong influence in Greece, both militarily through the forces sent to combat the Communists and economically through Marshall Plan aid. In the fragile years after the civil war the US leveraged its influential position to favor conservative governments that would implement capitalist institutions and policies (Stathakis 1995). This was furthered by the general anti-communist climate after the conservative government victory in the civil war, which resulted in the banning of Communist parties and the deportation of Communist sympathizers. Thus from 1950 to 1967 Greece was ruled entirely by conservative parties, which maintained close links with the US and encouraged pro-growth policies. From 1967 to 1974 Greece experienced a military dictatorship, which however continued to maintain close ties with the US and support liberal pro-growth policies.

The following graph shows the savings rate in Greece. We observe that total savings exhibited an upward trend during the first two decades post war, even though GDP was also rising rapidly. This means that a great amount of Greece's GDP went towards investment, explaining the high importance of capital in the growth of this period.





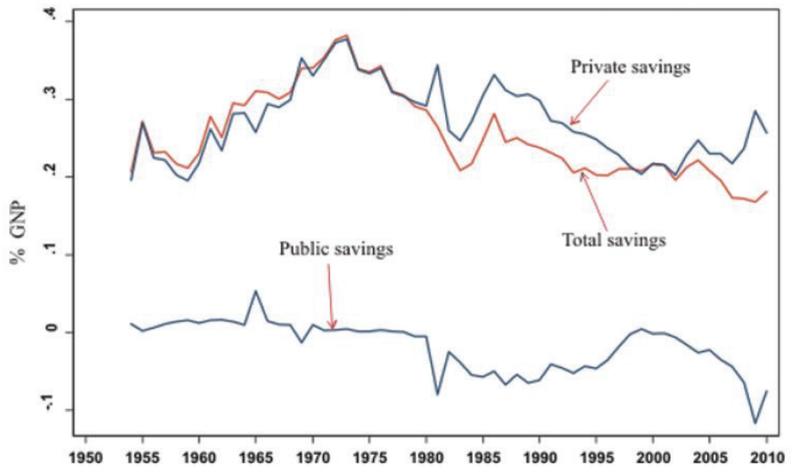


**Figure 6:** Savings in Greece

Source: Bitros, 2013

Another important trend during this period is the rapid rise in productivity of the Greek economy. As the following table shows, from 1959 to 1981 productivity rose 7-fold in the agriculture sector, 6-fold in the industry sector, and 10-fold in the services sector.

**Table 1:** Productivity per Employed in Greece

Productivity per employed in Greece and in EU, Thousands of Euros, Constant prices of 2000

| | 1959 | | 1981 | | 2001 | | 2009 | |
|---|---|---|---|---|---|---|---|---|
| | Greece[1] | EU[2] | Greece | EU[3] | Greece | EU[3] | Greece | EU[4] |
| Agriculture | 2,79 | 8,24 | 14,54 | 10,61 | 11,68 | 22.36 | 13,68 | 29,66 |
| Industry | 3,38 | 9,75 | 17,98 | 31,71 | 30,01 | 53.38 | 32,98 | 56,88 |
| Construction | 18,57 | 18,11[5] | 20,71 | 32,71 | 34,42 | 34.45 | 23,67 | 34,08 |
| Services | 3,79 | 8,58 | 33,60 | 41,91 | 32,86 | 47.94 | 37,43 | 49,31 |

Source: Bitros, 2013

Finally, throughout this period the debt to GDP ratio remained under 30%, and unemployment remained low, falling to 2.1% in the 1970s (Bitros 2013). All these point to a healthy economy, with high growth coming from investment and productivity, low debt, and low unemployment.

# 4.The Great Leap Left

With the fall of the dictatorship in 1974, Greece was again in search of a new identity. The harsh stance of the dictators against the communists along with the latter's role in resisting the regime made them a favorable in the eyes of the people. The new constitution that was drafted was arguably more left leaning than its predecessor, and communist parties were allowed to participate in elections once more (Bitros 2013). However, the great shift in Greek politics did not come until 1981, when the Panhellenic Socialist Movement (PASOK) came to power.

PASOK was created in 1974 by Andreas Papandreou, an economics professor at Berkeley who was influenced by the neo-Marxist and Dependency school traditions (Tsakalotos 1998). In its manifesto, "PASOK declared that its three main aspirations were national independence, popular sovereignty, and social liberation, and that it supported a third way to socialism, lying somewhere between traditional social democracy and Leninism" (Tsakalotos 1998). By appealing to the minorities and those who were marginalized by thirty years of right wing politics, and using strong anti-American and anti-European rhetoric, PASOK was able to gain a parliamentary majority in the elections of 1981. This signaled a shift in Greece, from capitalist and pro-growth policies, to socialist and welfare policies.

This shift towards left wing politics resulted in the state acquiring a much greater role in the economy. It imposed stringent market regulations to protect workers' rights, made it harder for firms to fire them, established minimum wages, and increased workers' bargaining





power, while at the same time offering more benefits to the unemployed (Bitros 2013). It enlarged the public sector, offering permanent high wage jobs to loyal voters, with lavish pension plans afterwards. A lot of companies at that time came under direct control of the state. In the words of Bitros, "by the end of 1999 the group controlled by the Agricultural Bank of Greece (which belonged to the state) consisted of 17 companies, 8 of which were operating in the financial sector, 2 in the insurance industry and the remaining 7 in various other sectors. At the same time, that same bank had minority interests in 31 companies, mainly involved in the processing of agricultural products" (Bitros 2013). Finally, during this period the main workers' union, the General Confederation of Greek Workers (GSEE) acquired an important role in Greek politics, with politicians trying to recruit prominent members of the union and the state sponsoring the union's activities (Duman 2014).

The following graph is indicative of this trend. We can see that from 1960 to 1980 government spending grew constantly from 10% to 15% of GDP. However, from 1980 to 1985, during the first term of PASOK, government spending jumped from 15% to 20%. Furthermore, although the government expenditures started to decline in the years afterwards, they never came back to the levels seen before 1980. It thus becomes clear that starting in the 1980s the government started playing a more aggressive role in the economy.

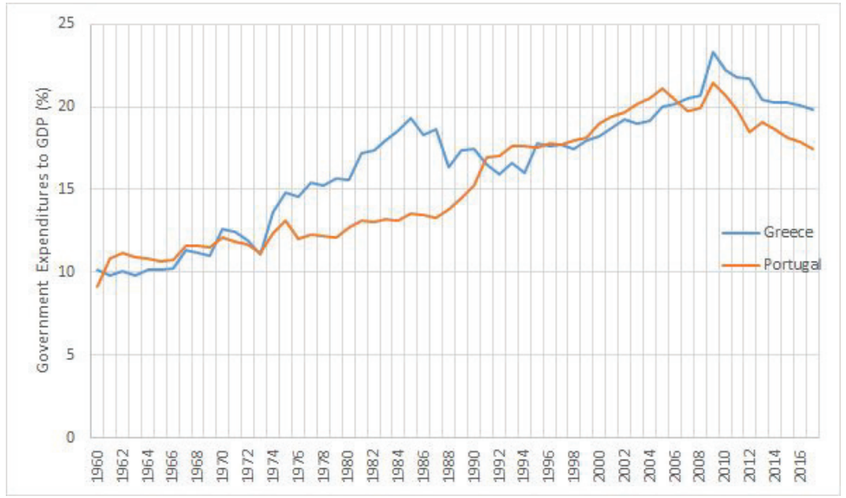


**Figure 7:** Government Expenditures as a percentage of GDP

Source: World Bank

This increased role of the state had negative implications for the economy. The main consequence of the increase in state owned enterprises and of public sector employees was a decrease in productivity. As table 1 shows, productivity in the services sector fell during the 1981-2001 period, when the socialist reforms were implemented, and productivity in agriculture and manufacturing was left far behind the European average. This decreased efficiency of state enterprises can be due to various factors. State enterprises were often used in Greece to decrease the unemployment rate and even more so to acquire voters. In the competitive political environment of Greece, politicians would promise a highly paid job in a state company, with a lavish pension plan afterwards, in exchange for a vote and loyalty to the party. This system obliterated meritocracy, and employees were not appointed based on their abilities but based on their loyalty (Bitros 2013). Furthermore, this created a moral hazard problem. In Greece, public employees are protected by the constitution, and it is therefore extremely hard to lay them off or lower their wages. Furthermore, their pay is





largely constant. There is no genuine assessment of their performance, and any pay increases and promotions are largely a bureaucratic process. As a result there are no incentives for employees to work harder and act professionally (Meghir et al. 2017).

Hakos and Salamouris provide evidence supporting the view that “the indirect control of manufacturing firms that were operating in the competitive sector of the economy, by the state through the banking system was not an efficient policy measure since public owned firms exhibited lower efficiency than the corresponding average efficiency level of the Industry for all the study period” (Halkos and Salamouris 2002). Their results can be summarized in the following graphs. It appears that return on total assets as well as net profit per employee were much lower for state owned enterprises than for the rest of the economy. In fact, both of these measures were negative for all of the years following 1980.

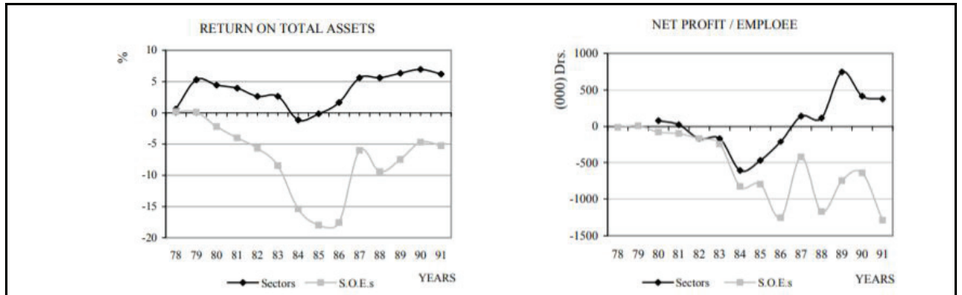


**Figure 8:** Return on total assets and net profit per employee for Greek state owned enterprises and the rest of the economy

Source: Halkos and Salamouris

The above indicate that as the state attempted to increase its participation in the economy, its inefficiency grew. It therefore comes as no surprise that from 1979-1996, total factor productivity in Greece fell by 0.7% per year.

It is instructive to compare the case of Greece with Portugal. During the years prior to 1974 Portugal experienced a dictatorship which aimed at solidifying a market economy. After its fall, like Greece Portugal experienced a shift to the left, which however was less extreme. The main political figure in Portugal in the 1980s was Anibal Cavaco Silva, who carried out extensive liberal reforms. It is worth noting that his Portuguese Socialist Party (PSD) was a member of the Liberal International, while on the other hand PASOK, which ruled Greek politics, was a member of the Socialist International (Lolos 1998).

In preparation for accession to the EU, the government of Cavaco Silva introduced the PCDED (Programme for the structural adjustment of the foreign deficit and unemployment), which introduced many liberal reforms to the economy. This included pursuing an aggressive investment policy to develop infrastructure, and simplifying authorization procedures and offering incentives in order to encourage foreign direct investment (FDI) (Lolos 1998). In addition, the government pursued a successive privatization program, and by 1990 49% of state owned companies were sold to the private sector (Lolos 1998). Portugal was thus able to maintain a constant level of government expenditures up until the 1990s.

The pursuit of privatizations and liberalisation rewarded Portugal with a GDP growth of 3.1% per year for the period 1979-1996. During this period, productivity actually increased, a better performance compared to Greece's 0.7% decline.

# 5.Consequences

The graph below shows the evolution of the Greek debt as a ratio to GDP. The year 1980 stands out prominently. Up to then, Greece's debt was only 20% of GDP. By the end of the first term of PASOK in 1985 it had more than doubled to over 40%. And by 1993 it had increased five fold to 100%. The debt increased primarily as a result of the government's





attempts to create a more participatory state. The increase in the number of public sector employees and of the government's stake in many enterprises required large amounts of money. These funds came largely as a result of increased borrowing, as it was politically infeasible to raise the necessary amounts through taxes in a short amount of time.

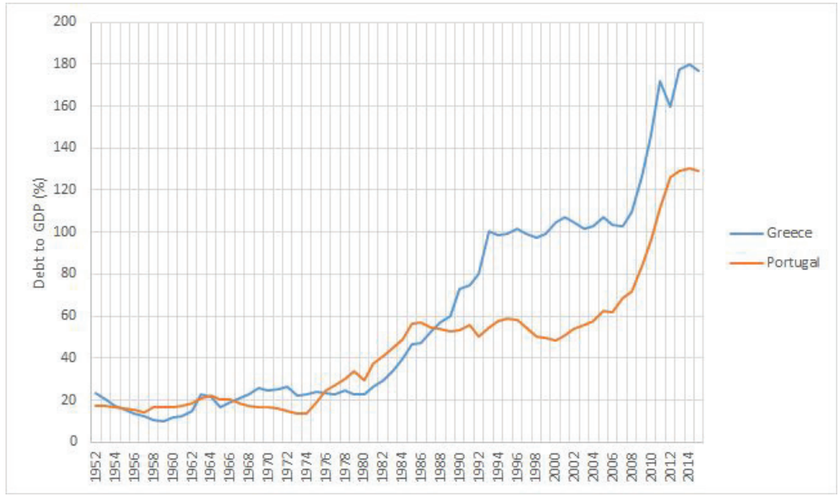


**Figure 9:** Debt in Greece and Portugal

Source: IMF

In addition, as was argued above the newly bought state enterprises were less efficient than their private counterparts. They were not able to optimally allocate their resource and labor. On the other hand, they also faced intense political pressure to keep prices low in order to please consumers. This was particularly true of the state controlled banking sector, where the government pressurized banks to offer loans to itself or its companies, exposing these institutions to excessively high risk and being forced to bail them out when they failed. Finally, as is interestingly shown by the following graph, although public employees were less efficient than their private counterparts, they were paid more, and this wage gap increased over the years. This paradox was probably due to attempts by the

government to please voters and loyal party members through increased wages. All of the above inevitably led state enterprises to fail and require government funds to keep them from going bankrupt, further straining the government's finances and increasing its debt.

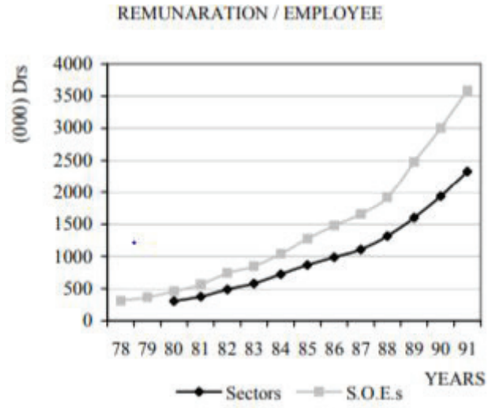


**Figure 10:** Remuneration per employee for Greek state owned enterprises and the rest of the economy

Source: Halkos and Salamouris

However, this sudden shift in Greek politics towards the left had the benefit of reducing inequality. The figure below shows that various measures of inequality all decreased remarkably during the first post-dictatorship years, with the Gini coefficient falling by a little less than 0.1 units, illustrating the success of the government's welfare and redistributional policies.





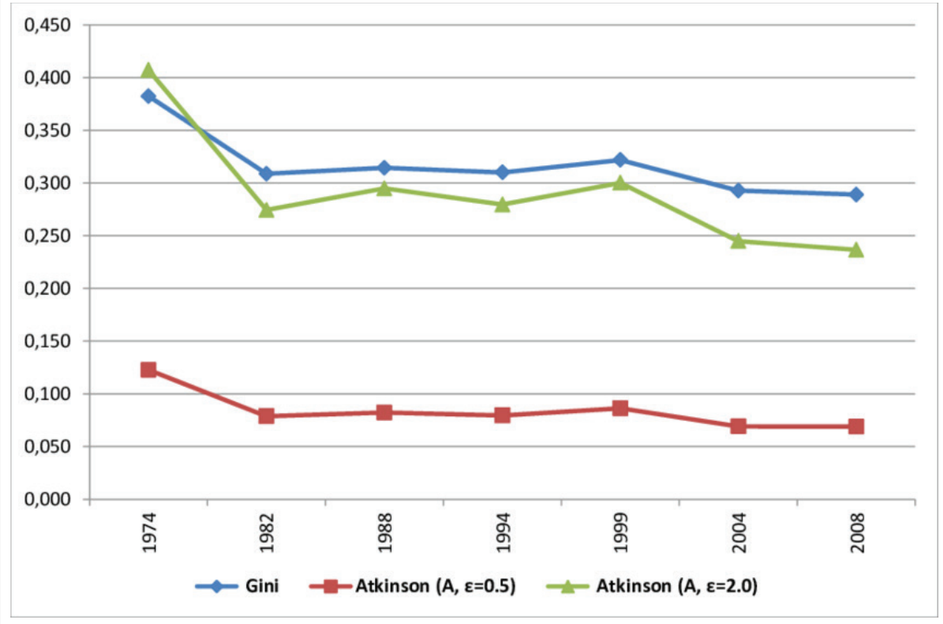


**Figure 11:** Inequality in Greece

Source: (Katsimi et al.)

Portugal on the other hand was more fiscally responsible. Although its debt also increased in the post dictatorship years, its relatively more liberal stance helped stabilize its finances quicker. By 1984 its debt had settled at 50% of GDP, half of that of Greece. In addition, Portugal's more favorable stance towards privatization and liberalization resulted in more foreign capital inflows. The graph below shows how Portugal's FDI rose considerably after the 1980s and averaged four times that of Greece for the next decades.

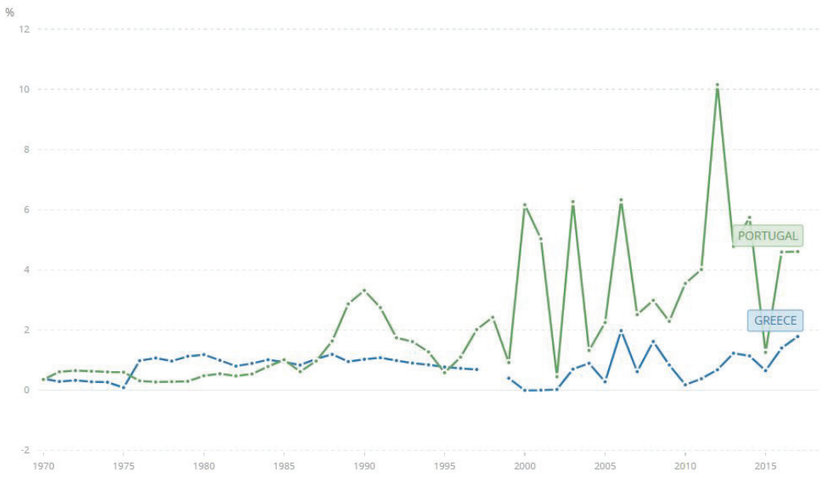


**Figure 12:** Foreign Direct Investments as a percentage of GDP, Portugal and Greece

Source: World Bank

Thus Portugal was better prepared to enter a common European market. In the year 2002, when the Euro was introduced, Portugal ranked 23rd in terms of competitiveness, while Greece was 38th (Frenkel et al. 2003). In terms of economic freedom, Portugal ranked 53rd, while Greece ranked 81st. In terms of government effectiveness, Portugal ranked 27th, while Greece ranked 42nd. Finally, in terms of regulatory quality Portugal ranked 27th, while Greece ranked 39th (“Global Economy, World Economy” 2019). Thus Portugal was better prepared to participate in a common currency area.

Although Portugal performed better than Greece in terms of efficiency, it did worse in terms of equity. As the following graph shows, in 1994 Portugal’s Gini coefficient was 37, higher compared with Greece’s 31. And in 2003, when both countries were part of the Eurozone, Portugal’s Gini index was 38.7, compared to Greece’s 32.8.





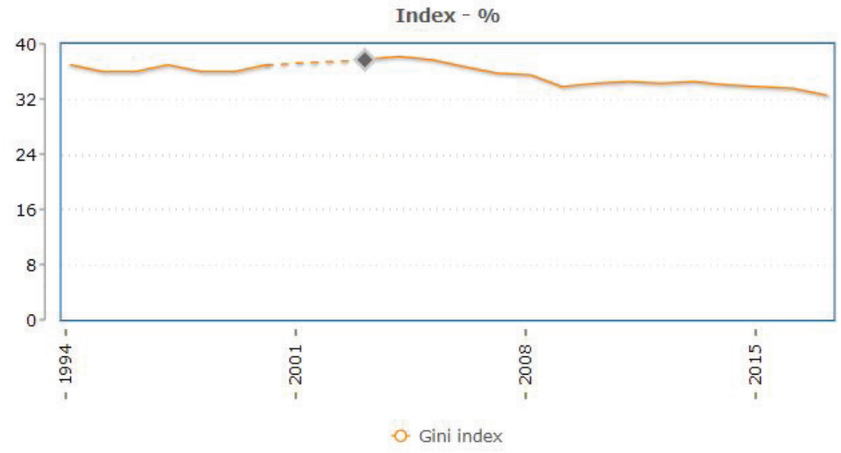


**Figure 13:** Inequality in Portugal, Gini Coefficient

Source: Pordata

# 6.Difficulty of Reforms

It soon became clear that Greece’s current path was unsustainable. With the reelection of PASOK in 1985, the new finance minister Konstantinos Simitis attempted to rein in the government’s expenses and reduce the deficit. However, it became clear that such reforms would have an immense political cost, and they were abandoned two years later (Lolos 1998).

In the elections of 1989 the conservative right wing party New Democracy came to power, with the goal of stabilizing Greece’s finances. Some privatizations occured, the credit market was liberalized, and the deficit was controlled, as is seen in the following graph. However, opposition by powerful interest groups led to the government’s collapse (Pelagidis and Mitsopoulos 2014). In the new elections in 1993 PASOK regained power, and rolled

back many of the liberal policies pursued previously. The death of Papandreou halfway through his term and the rise of the pro-Europe Konstantinos Simitis as leader of the party consolidated Greece's objective for further integration in the EU (Lolos 1998). During the years prior to accession to the Eurozone Greece followed a more fiscally responsible path, and deficits were kept low. However, as soon as Greece entered the Eurozone the situation again deteriorated, with both PASOK and New Democracy following similar leftist policies and encouraging consumption instead of growth. It is notable that during the last decade before the crisis growth picked up again in Greece, mainly driven by the fiscally responsible stance of the governments in the 1990s.


**Figure 14:** Deficit of Greece, excluding interest payments

Source: European Commission

The above serve to illustrate the point that the socialist system, once implemented, was very hard to alter. The statist policies pursued in the 1980s were very popular among the people. Loyal voters were granted a permanent government job, increases in their salaries, and generous pensions, and consumers could benefit from the low cost of state-enterprises. This attitude was obviously unsustainable in the long run, as it relied on





external financing and high taxes. However, no one was able to successfully alter the system, because in the short run the economy was smooth and voters were reluctant to lose their privileges.

# 7.Conclusions- Evaluation of the two countries

The above analysis leads us to the conclusion that the different growth patterns in Greece and Portugal were due to their differing political orientations. Prior to 1974, this orientation was similar for both countries, with both having similar debt levels, similar consumption levels, similar FDI levels, similar inequality levels, and, unsurprisingly, similar growth levels, with even the growth components being similar. However, after their dictatorial governments fell in 1974, they were forced to decide on the direction that their country would take. Portugal chose the road to the right, and picked growth and competitiveness over equality. Having lost its former colonies and determined to enhance its role within the EU, it undertook liberalization policies and extensive privatization programs. Greece on the other hand went left, prioritizing equity over efficiency, and borrowed large amounts of money to increase the role of its welfare state. It only started to take seriously its role within the EU in the 1990s, at which point the movement towards socialist policies had gained so much momentum that no serious attempts were made to correct its course, and those who proposed meaningful reforms were marginalized in the competitive political arena.

From the point of view of the 2000s, the paths chosen by the two countries would have both seemed legitimate, each prioritizing different needs. However, the experience of the recent economic crisis offers insight into the resilience of the two approaches. For the case of Portugal, GDP fell 23.9% in total after the crisis, while its debt rose to 130% of GDP. Greece's experience was much more severe, with its GDP falling 45.6% in total compared to its pre-crisis levels, while its debt skyrocketed to 180% of GDP. This was accompanied by a

substantial rise in inequality, with the Gini coefficient moving from 33.6 in 2008 to 36 in 2015. Portugal on the other hand was able to maintain its steady trend towards lower inequality, and in 2015 its Gini index was 35.5, lower than Greece's. We can thus see that Greece's push to the left ultimately proved unsuccessful, and although Greece had a higher GDP, lower debt, and lower inequality than Portugal after the dictatorship, it ended up worse off in all three measures after the crisis.

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# Low Interest Rates, Decline in Market Competition, and Slowdown in Productivity Growth

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*Do low long-term interest rates reduce competition and slow down productivity? Using data from CRSP-Compustat and FRED, this paper estimates the impact of a decrease in the long-term interest rate on the returns of leader firms (top 5 percent of firms by market capitalization in a given industry in a given quarter) relative to the returns of follower firms. Following a triple difference-in-difference specification, we document evidence that long-term low interest rates could be the the cause of the recent decline in competition and slowdown in productivity growth. We also study the mechanisms by which low interest rates reduce competition and slow down productivity. We find that research and development expenses is not a plausible mechanism by which small firms get squeezed out of the market. Our results suggest that long-term low interest rates have persistently generated excess returns for leader firms and argue against claims that the anti-competitive effects of low interest rates are negligible.*

## I. Introduction

Long-term interest rates have been falling steadily since the 1980's. Central banks have traditionally assumed that lower interest rates stimulate the production-side of the economy by reducing the cost of borrowing on firms, allowing them to take out loans more easily and increase investments, thereby increasing productivity growth. Monetary policy and quantitative easing have been especially relevant since the 2008 financial crisis as central banks in developed economies around the world have lowered interest rates to historically low levels. The United States is a prime example with the Fed lowering interest rates to 0.25 percent in December 2008.



Surprisingly, although interest rates have been historically low, the US economy has been sluggish with productivity growth reaching some of its lowest levels in recent years. Corporate profits have also been rising steadily since the 1980's. We know very little about the underlying causes of the recent rise in corporate profits, decline in competition, and slowdown in productivity growth. In this paper, we document evidence that long-term low interest rates could be the the cause of the recent decline in competition. We also study the mechanisms by which low interest rates reduce competition and slow down productivity.

There is an emerging literature that discusses the relationship between low interest rates and productivity slowdown. Berlingieri and Criscuolo (2017) and Andrews et al. (2016) document the increase in the productivity gap between the $90^{th}$ and $10^{th}$ percentile firms within industries since 2000 using firm-level data from the OECD. Berlingieri and Criscuolo also document evidence that the industries that have exhibited the slowest productivity growth are the ones in which the productivity gap is the widest. Hoshi, Caballero, and Kashyap (2008) study the effect of insolvent borrowing on productivity gaps in Japan; they find that industries dominated by insolvent borrowers exhibit lower productivity. Gopinath, Kalemli-Ozcan, Karabarbounis, and Villega (2017) find that the decline in real interest rate leads to decline in sectoral total factor productivity. Liu, Mian, and Sufi (2019) document evidence that long-term low interest rates freeze the economy by making industries less competitive, thereby slowing productivity growth. This paper studies the effect of a decline in interest rates on the slowdown in (i.e. growth rate of) productivity and the mechanisms that underlie these effects.

The paper proceeds as follows. Section II provides a background on the model, and Section III provides a description of our data construction. Section IV presents the empirical

analysis and links the empirical results back to the model in an attempt to interpret which economic mechanisms were likely most important in this context. Section V provides concluding remarks.

## II. Model and Theoretical Framework

To build intuition, consider the case of a large "leader" firm and a small "follower" firm operating in the same industry. The firm's purpose of investing is to increase market share and production relative to competitors within its industry. The small firm will only borrow and invest if it will improve its productivity position relative to the leader, its competitor. If the competitive gap between the leader and the follower is small, then both firms will invest to gain competitive edge over each other. However, if the competitive gap is sufficiently large, then the small firm will not invest due to a discouragement effect. The discouragement effect stems from the fact that it is impossible for the follower firm to gain competitive edge over the leader firm because the competitive gap is sufficiently large.

We define competitive industries as industries in which the competitive gap is small and monopolistic industries as industries in which the competitive gap is large. At lower interest rates, future cash flows are more valuable, so firms find it cheaper to invest. There are three competitive effects that come to play at lower interest rates. First, competition is increased in competitive industries as firms invest heavily to gain competitive edge over each other. Second, competition could be restored in monopolistic industries, where small firms who were previously discouraged from investing can now invest and gain competitive edge. Third, industry leaders are further incentivized to generate and maintain a sufficiently large competitive gap to stay ahead of competitors. All three effects increase investments, competition, and productivity in the short-



run as all firms invest heavily to gain competitive edge. The first two effects increase competition and productivity in the long run, while the third effect decreases competition and productivity in the long run as industry leaders are incentivized to gain monopolistic power.[1]

The model[2] predicts that the *anti-competitive effect* dominates the *pro-competitive effect* in the long run when interest rates are low. Essentially, at any given time, some industries are competitive and other industries are monopolistic. At higher interest rates, industry leaders avoid investing because futures cash flows are less valuable. This implies that at higher interest rates, monopolistic industries can switch to competitive industries. At lower interest rates, industry leaders are incentivized to invest because future cash flows are more valuable. This implies that at lower interest rates, monopolistic industries will remain monopolistic and competitive industries could turn into monopolistic industries if the industry leaders gain sufficiently large competitive edge. In this paper, we find that the *anti-competitive effect* of a decrease in interest rates dominates the *pro-competitive effects*.

The model[3] predicts that there are two main channels through which interest rates affect valuations of firms. The *traditional effect* makes future cash flows more valuable for both leaders and followers, which results in a proportional increase in the market valuation of all firms. The *strategic effect* incentivizes industry leaders to gain competitive edge and monopolistic power, which results in stronger investment response of industry leaders than followers to a decline in

[1] Liu, Ernest, Mian, Atif, and Sufi, Amir, "Low Interest Rates, Market Power, and Productivity Growth," National Bureau of Economic Research, 2019, Working Paper 25505.
[2] Liu, Ernest, Mian, Atif, and Sufi, Amir, "Low Interest Rates, Market Power, and Productivity Growth," National Bureau of Economic Research, 2019, Working Paper 25505.
[3] Liu, Ernest, Mian, Atif, and Sufi, Amir, "Low Interest Rates, Market Power, and Productivity Growth," National Bureau of Economic Research, 2019, Working Paper 25505.

interest rates and a larger proportional increase in the market valuation of industry leaders relative to industry followers. In this paper, we find that the *strategic effect* of a decrease in interest rates dominates the *traditional effect*.

## III. Data and Summary Statistics

The primary data sources used to test this hypothesis are the CRSP-Compustat merged data obtained from Wharton Research Data Services (WRDS) and the 10-year US Treasury yield data obtained from St. Louis Federal Reserve Economic Data (FRED). The data cover the years 1962 to 2018 and contain approximately 1.175 million observations. For each security, the data include price, shares outstanding, SIC ID, company name, total current assets, total current liabilities, total income taxes, pre-tax income, research and development expenses, and current S&P quality ranking.

All data manipulations are recorded in Table 1. We sort the firms in the dataset into 17 industries by the Fama-French definitions. We generate asset-liability ratios, debt-equity ratios, and percentage of pre-tax income that goes to taxes. By industry and quarter, we generate a rank for firms by market capitalization. We then generate a "leader" dummy from the rankings. We define "leader" firms as the top 5 percent in an industry in a given quarter by market capitalization. We allow firms to move in and out of the leader sample from non-leader (follower) and back. There are a variety of reasons that firms may enter and exit the sample including mergers and acquisitions and technological development. In our analysis, we discuss several possible biases in our data and control for possible omitted variables.

From our original sample of around 1.175 million observations, we retain around 70 percent of the observations after performing data manipulations. We drop non-positive



observations of price, shares outstanding, asset-liability ratio, and debt-equity ratio. Our final sample includes 765,308 observations, with 52,802 leader observations and 712,506 follower observations. Table 2 records summary statistics for all observations and for leaders and followers separately. The characteristics of the two groups are broadly similar, although there are some differences. Leaders and followers tend to have similar asset-liability ratios, and percent of pre-tax income that goes to taxes. Relative to followers, leaders tend to have higher stock prices, greater shares outstanding, market capitalization, debt-equity ratios, S&P quality rankings, and research and development expenses.

## IV. Empirical Strategy

In this paper, we implement a triple difference-in-difference specification to study the asymmetric effects of interest rate changes on firm value. There are two relationships to be studied based on the model: first, starting at low interest rate, a drop in interest rates generates excess returns for leaders versus followers; second, this effect is more pronounced when the initial interest rate is close to zero. We are interested in the differential responses to interest rate changes of leaders versus followers. We find that long-term lower interest rates increase market concentration and slow down productivity; we also find that the effect is more pronounced when the initial rate is near zero.

We find a plausible parallel trends assumption for our triple difference-in-difference specification. Figure 1 plots the average change in natural log of stock price of leaders and followers. The vertical black lines represent a decrease in the 10-year US Treasury yield of at least 1 percentage point. We see that preceding each black line, the average change in natural log of stock price of leaders and followers follow parallel trends. That is, the trend in natural log of stock

price of leaders and followers is similar pre-drop in long-term interest rates. Following each black line, we see an excess change in the natural log of stock price of leaders versus that of followers. We also see the excess change is more pronounced when the initial rate is near zero. The excess change for leaders relative to followers is more pronounced after the black lines between 1998 and 2018, when the long-term rate was near zero, than before 1998 when the long-term rate was much greater than zero. The parallel trends assumption is plausible for our triple difference-in-difference specification.

We run a triple difference-in-difference empirical test as follows:

$$\Delta \ln P_{i,j,t} = \alpha_{j,t} + \beta_0 D_{i,j,t-1} + \beta_1 D_{i,j,t-1} * \Delta i_t + \beta_2 D_{i,j,t-1} * i_{t-1} + +\beta_3 D_{i,j,t-1} * \Delta i_t * i_{t-1} + \varepsilon_{i,j,t}$$

where $\Delta \ln P_{i,j,t}$ is the change in natural log of stock price of firm *i* in industry *j* from quarter *t-1* to *t* (i.e., one quarter growth), and $D_{i,j,t-1}$ is an indicator variable equal to 1 if firm *i* is in the top 5 percent of market capitalization in its industry *j* at start of the quarter. Firms with $D_{i,j,t-1}$=1 are leaders while the rest are followers. The variable $i_t$ is the 10-year US Treasury yield, with $i_{t-1}$ being the 10-year yield from the prior quarter and $\Delta i_t$ being the change in the 10-year yield from prior quarter to date *t*. All standard errors are two-way clustered by industry and date. The parameters $\alpha_{j,t}$ are industry-time period fixed effects. The analysis includes industry level controls based on the Fama-French definitions.

Our analysis of the empirical test focuses on the coefficients ß$_1$ and ß$_3$. If the coefficient of ß$_1$ is negative, then a decrease in interest rates results in higher returns for industry leaders relative to followers. In terms of the model, a negative ß$_1$ implies the decrease in interest rates does not result in proportional increases in valuations of industry leaders relative to industry followers, so the *strategic effect* dominates the *traditional effect*. Thus, industry leaders generate



higher excess returns when interest rates are lowered. If the coefficient of ß$_3$ is positive, then the effect of lower interest rates on higher market valuations of industry leaders is strengthened when interest rates are near zero.

Some problems we encounter in our empirical analysis concern omitted variable bias. One concern is that the measure of industry leaders is correlated with some balance sheet factors. If industry leaders have higher leverage than industry followers, then a drop in interest rates will reduce the burden on the leaders and they will invest more heavily. We include balance sheet controls (asset-liability ratio, debt-equity-ratio, and percent of pre-tax income that goes to taxes) to control for potential balance sheet correlations. Another concern is that the measure of industry leaders is correlated with credit ratings. If industry leaders have higher credit ratings than industry followers, then when interest rates are lower and banks tend to be less profitable, they will favor low risk firms even more. We include credit ratings controls (S&P Quality Ranking) for robustness check in the empirical analysis and find no effect on our results. A third concern is that the evolution of industry leader valuations is more correlated with the economic cycle (GDP growth) than the evolution of industry follower valuations.

Table 3 presents the results of our empirical analysis. The results in column (2) confirm the first part of our hypothesis: the *strategic anti-competitive effect* of a drop in interest rates dominates the *traditional pro-competitive effect*. Lower interest rates result in excess returns for the leader securities – negative and significant ß$_1$ (leader change rate interaction term). On average, a 1 percent decrease in the long-term interest rate increases the returns of leader firm by 2 percent relative to the follower firm. Column (2) includes industry-date fixed effects and firm-level controls, so our results are robust.

The results in column (4) confirm our the first and second parts of our hypothesis: the *strategic anti-competitive effect* of a drop in interest rates dominates the *traditional pro-competitive effect,* and this is more pronounced when interest rates are near zero. Lower interest rates result in excess returns for the leader securities and the effect is more pronounced when the initial rate is near zero - negative and significant $ß_1$ (leader change rate interaction term) and positive and significant $ß_3$ (leader change rate lagged rate interaction term). On average, a 1 percent decrease in the long-term interest rate increases the returns of the leader firm by 7 percent. If the initial interest rate is near zero, then on average a 1 percent decrease in the long-term interest rate increases the returns of the leader firm by 8 percent. Column (4) include industry-date fixed effects and firm-level controls, so our results are robust.

If long-term low interest rates are increasing market concentration and slowing productivity growth, by what mechanism are small firms getting squeezed out of the market? The model suggests that small firms get squeezed out of the market through an investment-related discouragement effect. Essentially, if the competitive gap between industry leaders and followers is sufficiently large, industry followers will be discouraged from investing. This implies that followers get squeezed out of the market by reducing the size of their productivity-related investments.

We test the discouragement squeezing out effect by looking at the effect of a drop in interest rates on the research and development expenses of leaders versus followers. We find that research and development expenses is not a plausible mechanism of the investment-related discouragement effect; we lack sufficient statistical power to assert that small follower firms get squeezed out of the market through the R&D mechanism.



We again find a plausible parallel trends assumption for our triple difference-in-difference specification. Figure 2 plots the average change in natural log of research and development expenses of leaders and followers. The vertical black lines represent a decrease in the 10-year US Treasury yield of at least 1 percentage point. We see that preceding each black line, the average change in natural log of research and development expenses of leaders and followers follow parallel trends. That is, the trend in natural log of research and development expenses of leaders and followers is similar pre-drop in long-term interest rates. Following each black line, we see an excess change in the natural log of research and development expenses versus that of followers. We also see the excess change is more pronounced when the initial rate is near zero. The excess change for leaders relative to followers is more pronounced after the black lines between 1998 and 2018, when the long-term rate was near zero, than before 1998 when the long-term rate was much greater than zero. The parallel trends assumption is plausible for our triple difference-in-difference specification.

We run a triple difference-in-difference empirical test as follows:

$$\Delta \ln \mathrm{R\&D}_{i,j,t} = \alpha_{j,t} + \beta_0 D_{i,j,t-1} + \beta_1 D_{i,j,t-1} * \Delta i_t + \beta_2 D_{i,j,t-1} * i_{t-1} + +\beta_3 D_{i,j,t-1} * \Delta i_t * i_{t-1} + \varepsilon_{i,j,t}$$

The analysis of the empirical test will focus on the coefficients $ß_1$ and $ß_3$ and the interpretation of the coefficients is the same as in the previous specification; our empirical analysis looks for a negative $ß_1$ coefficient and a positive $ß_3$ coefficient. Column (6) in Table 3 presents the results of our empirical analysis. We find that lower interest rates do not result in excess research and development expenses for the leader firms versus the follower firms – statistical zero $ß_1$ coefficient (leader change rate interaction term). We also do not find the effect to be more pronounced when the initial rate is near zero – statistical zero coefficient on $ß_3$ (leader

change rate lagged rate interaction term). Our findings imply that small firms do not get squeezed out of the market via research and development expenses. We note two important considerations. First, the magnitude of the $ß_1$ and $ß_3$ coefficients are lower in the R&D regression than in the stock price regression, implying that Research & Development might not be the exact mechanism by which small firms get squeezed out of the market. Second, there is a significant drop in the number of observations (N) from column (4) to column (6). We retain only 16 percent of the data from column (4) when we conduct the empirical analysis in column (6). This drop indicates very low statistical power in the column (6) regression.

We perform a robustness check of our empirical analysis on a restricted sample of data points that include the R&D measure. Column (5) in Table 3 presents the results of our robustness check. We run the change in natural log of stock price empirical analysis on a restricted sample of data points. The restricted sample includes all data points with non-missing values of research and development expenses. We retain around 25 percent of our data from column (4) in the robustness check. The results in column (5) confirm that our hypothesis holds for the restricted sample of data points. The *strategic anti-competitive effect* of a drop in interest rates dominates the *traditional pro-competitive effect,* and this is more pronounced when interest rates are near zero. Lower interest rates result in excess returns for the leader securities and the effect is more pronounced when the initial rate is near zero - negative and significant $ß_1$ (leader change rate interaction term) and positive and significant $ß_3$ (leader change rate lagged rate interaction term). On average, for the restricted R&D sample, a 1 percent decrease in the long-term interest rate increases the returns of the leader firm by 10 percent. If the initial interest rate is near zero, then on average, for the restricted R&D sample, a 1 percent decrease in the long-term interest rate



increases the returns of the leader firm by 11 percent. Column (5) include industry-date fixed effects and firm-level controls, so our results are robust.

There are important implications of our empirical findings on the theoretical model described in Section II. We find robust evidence that, on average, a 1 percent decrease in the long-term interest rate increases the returns of the leader stock by 7 percent. Furthermore, of the initial interest rate is near zero, then on average a 1 percent decrease in the long-term interest rate increases the returns of the leader stock by 8 percent. We do not find any robust evidence that the decrease in long-term interest rates increases the research and development expenses of leaders over followers. The model suggests that a drop in interest rates yields excess returns for leaders versus followers, and this effect is more pronounced when the initial rate is near zero. Our empirical results confirm this hypothesis. The model also suggests that small firms get squeezed out of the market through an investment-related discouragement effect. Our empirical analysis finds no robust evidence that the squeezing out mechanism is related to research and development expenses of leaders versus followers.

## V. Conclusion

In this paper, we document evidence that long-term low interest rates are the cause of the increase in market concentration and the slowdown in productivity growth. We find that on average, a 1 percent decrease in the long-term interest rate increases the returns of the leader stock by 7 percent. Furthermore, of the initial interest rate is near zero, then on average a 1 percent decrease in the long-term interest rate increases the returns of the leader stock by 8 percent. We do not find any robust evidence that the decrease in long-term interest rates increases the research and development expenses of leaders over followers.

Our empirical analysis is not sufficient to draw strong conclusions about the efficiency of observed variations in the returns of leaders and followers. Although interest rate driven heterogeneity in returns may reflect *strategic effect* domination over *traditional effect*, it could also reflect stronger correlations with the economic cycle of leaders versus followers. We view our findings as a first step towards documenting the anti-competitive effects of interest rate drops and towards understanding the mechanisms that underlie these anti-competitive effects.

Our findings both reinforce and refine the conclusions of existing literature on the relationship between interest rates, competition, and productivity growth. On the one hand, they confirm that drops in interest rates generate excess returns for the top 5 percent of firms in an industry by market capitalization and argue against claims that the anti-competitive effects are negligible. On the other hand, the mechanisms that underlie these anti-competitive effects remain uncertain. We find that drops in interest rates have no statistically significant effect on research and development expenses, implying that the level and growth rate of productivity-related investments is not how small follower firms get squeezed out of the market.

Interest rate policy is fundamental to central banks. Monetary easing has been the go-to policy for central bankers in response to weak economic outlooks. Central banks have traditionally assumed that lower interest rates stimulate the production-side of the economy by reducing the cost of borrowing on firms, allowing them to take out loans more easily and increase investments, thereby increasing productivity growth. However, this dynamic does not account for market competition. Interest rate drops can incentivize leader firms to invest and gain monopolistic power, which leads to the anti-competitive effects increased market concentration and decreased productivity growth.



The evidence is robust that the *strategic anti-competitive effect* of a drop in interest rates dominates the *traditional pro-competitive effect*. However, we are still unclear on the specific mechanism through which these anti-competitive effects work. The directions for future work could try to look at the percentage of research and development expenses that translate into additional revenue for the firms. Given that leader firms tend to have more resources, it is plausible that a higher percentage of research and development expenses gets realized in leader returns as opposed to follower returns. Thus, it might not be the level or growth rate of research and development expenses that differs between leaders and followers, but rather it might be the percentage of research and development expenses that translates into realized returns that differs.

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1: Selection of CRSP-Compustat Merged Data Variables and 10 Year Yield

| Definition | CRSP-Compustat FRED Variables | Notes |
|---|---|---|
| sample definition: | dgs10 | 10-year US Treasury yield |
| variable definition: **date** | datadate | Format dates to quarter to merge CRSP-Compustat and FRED data |
| variable definition: **price** | prccq | Drop if price is non-positive |
| variable definition: **shrout** | cshoq | Drop if shares outstanding is non-positive |
| variable definition: **sicd** | sic | Change SIC company ID from string to integer |
| | price | |
| variable definition: **mktcap** | shrout | Generate market capitalization |
| | actq | Generate asset-liability ratio |
| variable definition: **al_ratio** | lctq | Drop if asset-liability ratio is non-positive |
| | dlttq | Generate debt-equity ratio |
| variable definition: **de_ratio** | ceqq | Drop if asset-liability ratio is non-positive |
| | txtq | Generate percent of pre-tax income that goes to taxes |
| variable definition: **tax_percent** | piq | Drop if percent of pre-tax income is non-positive |
| variable definition: **xrdq** | xrdq | Drop if research and development expense is negative |
| variable definition: **spcsrc** | spcsrc | Change S&P quality ranking from string to integer |
| variable definition: **ffind** | siccd | Sort companies by Fama-French defintions |
| | **ffind** | |
| | **date** | By industry and quarter, generate rank for companies by market capitalization |
| variable definition: **rank** | **mktcap** | Generate leader dummy for top 5% of companies by market capitalization |
| variable definition: **leader** | **rank** | |

**Notes:**

[1] Selected to sort the firms into 17 industries by the Fama-French definitions. The industries are Food; Mining & Minerals; Oil & Petroleum Products; Textiles; Apparel & Footwear; Consumer Durables; Chemicals; Drugs, Soap, Perfumes, Tobacco; Construction & Construction Materials; Steel Works; Fabricated Products; Machinery & Business Equipment; Automobiles; Transportation; Utilities; Retail Stores; Banks, Insurance Companies, & Financials; Other.

[2] Selected to define **leader** firms as the top 5 percent in a given industry in a given quarter by market capitalization. Firms can move in and out of the sample from non-leader and back.

## 2: Summary Statistics

| | All | Leaders | Followers |
|---|---|---|---|
| **Price ($)** | 30.65 | 80.91 | 27.14 |
| | (719.44) | (2072.15) | (503.84) |
| Min | 0.00100 | 0.00100 | 0.00200 |
| Max | 141,600 | 141,600 | 108,990 |
| **Shares Outstanding** | 84 | 680 | 62 |
| | (415) | (1290) | (324) |
| Min | 1 | 1 | 1 |
| Max | 29,206 | 28,620 | 29,206 |
| **Market Capitalization** | 3,062.01 | 40,895.24 | 1,922.10 |
| | (15715.08) | (66696.40) | (8715.29) |
| Min | 1.00 | 13.53 | 1.00 |
| Max | 1,073,391 | 1,073,391 | 571,614 |
| **Asset-Liability Ratio** | 2.35 | 2.19 | 2.35 |
| | (7.83) | (30.83) | (4.03) |
| Min | 0.00 | 0.04 | 0.00 |
| Max | 4,262.00 | 4,262.00 | 1,257.46 |
| **Debt-Equity Ratio** | 88.95 | 2,015.19 | 1.80 |
| | (65764.97) | (316103.84) | (208.20) |
| Min | 0.00 | 0.00 | 0.00 |
| Max | 49,610,180 | 49,610,180 | 109,762 |
| **Tax/Pre-Tax Income (%)** | 46.06 | 40.80 | 46.36 |
| | (515.59) | (167.80) | (528.73) |
| Min | 0.00 | 0.00 | 0.00 |
| Max | 201,600 | 18,873 | 201,600 |
| **R&D Expenses** | 56.03 | 403.15 | 32.08 |
| | (276.90) | (756.51) | (183.28) |
| Min | 0.00 | 0.00 | 0.00 |
| Max | 10,924 | 10,924 | 8,000 |
| **Observations (N)** | 765,308 | 52,802 | 712,506 |

**Notes:**

[1] Standard deviations in parentheses.

[2] Selected to sort the firms into 17 industries by the Fama-French definitions. The industries are Food; Mining & Minerals; Oil & Petroleum Products; Textiles; Apparel, & Footwear; Consumer Durables; Chemicals; Drugs, Soap, Perfumes, Tobacco; Construction & Construction Materials; Steel Works; Fabricated Products; Machinery & Business Equipment; Automobiles; Transportation; Utilities; Retail Stores; Banks, Insurance Companies, & Financials; Other.

[3] Selected to define **leader** firms as the top 5 percent in a given industry in a given quarter by market capitalization. Firms can move in and out of the sample from non-leader and back.



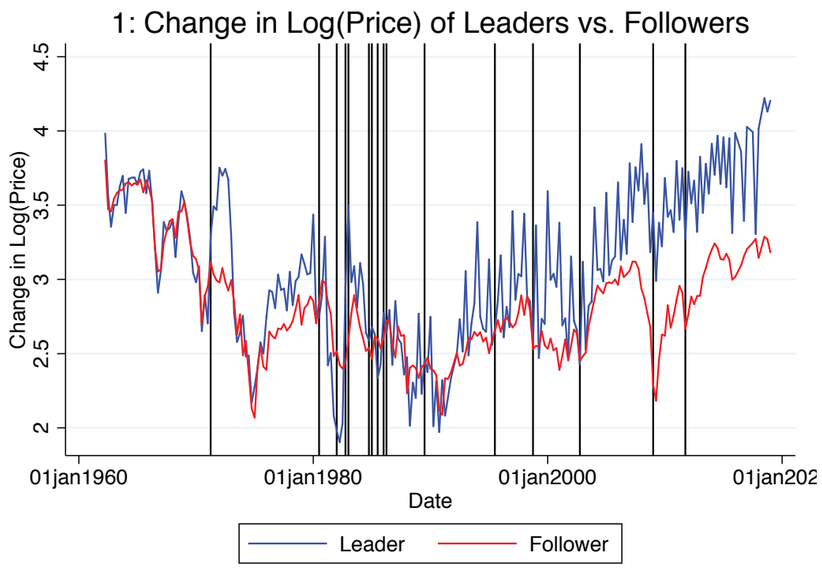
## 3: Differential Interest Rate Responses of Leaders Versus Followers

| | Change in Natural Log of Stock Price | | | | | Change in Natural Log of R&D |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| **Leader** | 0.0034 | 0.0113 *** | 0.0245 *** | 0.0107 * | -0.0033 | 0.0048 |
| | (0.0026) | (0.0030) | (0.0085) | (0.0062) | (0.0109) | (0.0164) |
| **Leader × Δi** | 0.0142 *** | -0.0247 *** | 0.1316 *** | -0.0700 *** | -0.1073 *** | -0.0034 |
| | (0.0066) | (0.0055) | (0.0152) | (0.0138) | (0.0254) | (0.0284) |
| **Leader × Lagged i** | | | -0.0036 *** | 0.0003 | 0.0046 *** | -0.0003 |
| | | | (0.0012) | (0.0008) | (0.0025) | (0.0040) |
| **Leader × Δi × Lagged i** | | | -0.0139 *** | 0.0054 *** | 0.0114 *** | -0.0043 |
| | | | (0.0013) | (0.0012) | (0.0052) | (0.0068) |
| **Industry-Date FE** | N | Y | N | Y | Y | Y |
| **Controls** | N | Y | N | Y | Y | Y |
| **Restricted R&D Sample** | N | N | N | N | Y | N/A |
| **Observations (N)** | 489,998 | 309,563 | 489,998 | 309,563 | 76,612 | 49,398 |
| **R-squared** | 0.0001 | 0.1673 | 0.0011 | 0.1674 | 0.1703 | 0.0087 |

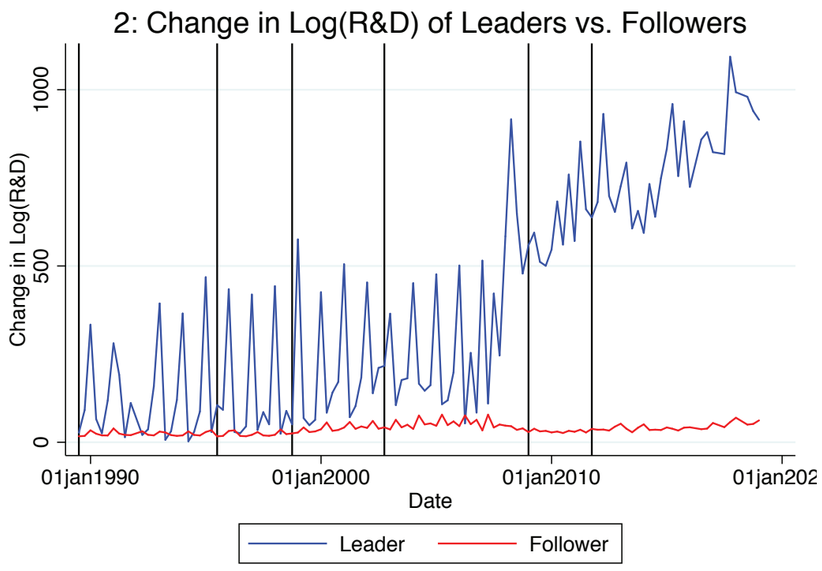
**Notes:**

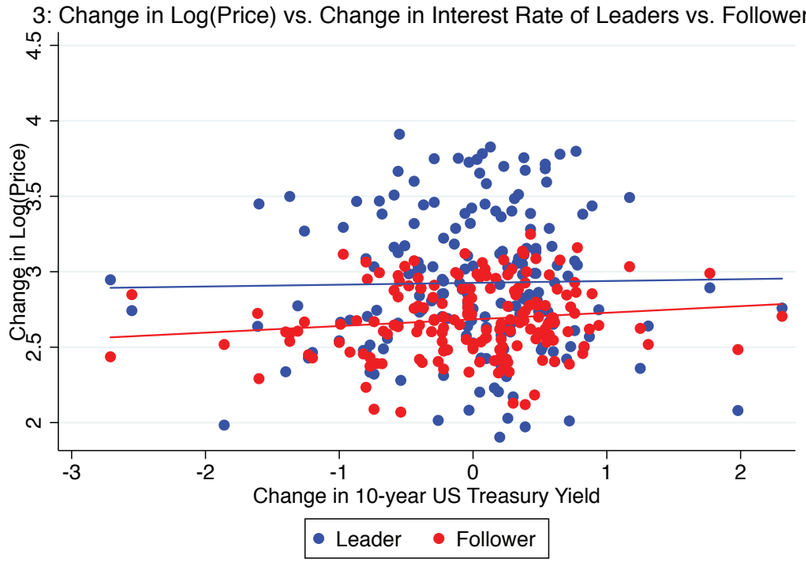
[1] Standard errors in parentheses. Standard errors are two-way clustered by industry and date.

[2] *p < 0.05, **p < 0.01, ***p < 0.001.


1: Change in Log(Price) of Leaders vs. Followers
Change in Log(Price)
2
2.5
3
3.5
4
4.5
01jan1960
01jan1980
01jan2000
01jan202
Date
Leader
Follower




2: Change in Log(R&D) of Leaders vs. Followers
Change in Log(R&D)
0
500
1000
01jan1990
01jan2000
01jan2010
01jan202
Date
Leader
Follower






# Liquidation by Speculators as a Cause of Post-Earnings Announcement Drift

Scott Perry

14.33: Economics Research and Communication

December 11, 2019

## Section 1: Introduction

Earnings announcements are extremely important indicators of the current and future profitability of a company, and thus can have a substantial impact on a company's share price. The average share price volatility for a company in the S&P 500 on the day of its earnings announcement is 5.57% compared to 0.95% on a normal trading day. According to the semi-strong form of the efficient-market hypothesis, all publicly available information is incorporated almost instantaneously into asset prices (Degutis and Novickytė, 2014). Therefore, an earnings announcement that contains information that is very surprising (different from expectations) should have the new information reflected in the share price immediately after the new information is released. This implies that there should be no predictable share price drift in the days and weeks after the earnings announcement.

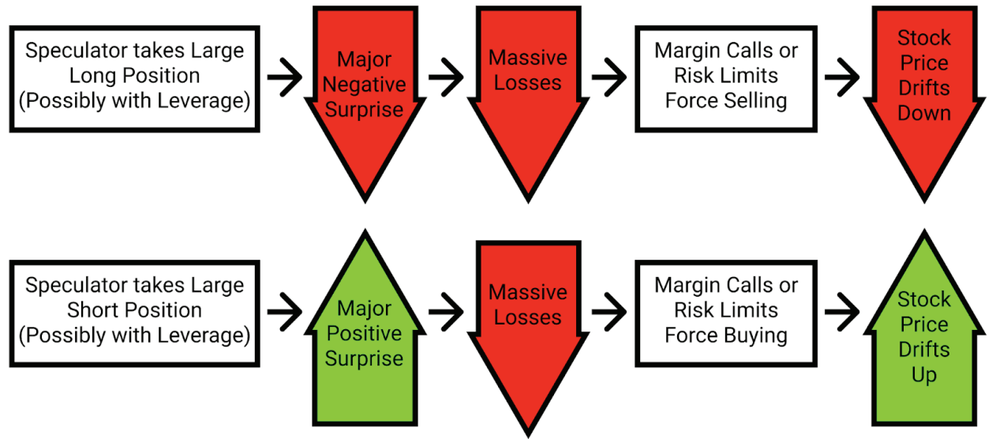
Nonetheless, several academics, beginning with Ball and Brown in 1968, have found significant evidence that the share price of U.S. companies that release earnings per share numbers significantly above or below equity analysts' expectations continue to drift in the direction of the earnings per share surprise for a period of days to weeks after the announcement (Ball and Brown, 1968). This phenomenon is known as post-earnings announcement drift (PEAD). However, market behavior can change over time so it is possible that PEAD is no longer present in the U.S. equity markets.

This paper examines whether there is still evidence of significant PEAD in the U.S equity markets, as represented by the S&P 500, in recent years. The paper also investigates a novel explanation for PEAD: that speculators, especially those using leverage, who suffer significant losses after a major earnings announcement surprise move the stock price in the direction of the surprise as they are forced to close out (liquidate) their positions due to loss control risk limits or margin calls from brokers. After a positive surprise, speculators who borrowed shares of a stock and sold them short would need to buy back an equivalent amount of stock in order to liquidate (cover) their short position, leading to further share price increases from increased demand. After a negative surprise, speculators with a significant long position would need to sell their stock in order to close out of their position, leading to further share price decreases from increased supply.





*Figure 1*
**Mechanism for How Liquidation by Speculators Causes PEAD**




To determine whether PEAD is still present in the U.S. equity markets, I perform a regression analysis for two different measures of surprise to see whether there is statistically significant stock price drift in the direction of the earnings announcement surprise in the days and weeks after a major positive or negative earnings announcement surprise. To identify whether liquidation by speculators is the cause of PEAD, I examine whether the shares of a stock borrowed as a fraction of the shares available for trading in a stock (short-interest share of equity float (SISEF)) before the earnings announcement has a statistically significant positive correlation with the stock returns after a major positive announcement surprise. I also look for evidence of speculator position liquidation directly by checking whether SISEF is correlated with a greater trading volume after a major positive earnings announcement surprise after controlling for the size of the surprise. I beta hedge all stock returns against the S&P 500 to remove the influence of general market trends.

I find strong evidence for the existence of PEAD in the first full trading day after either major positive (top decile) or negative (bottom decile) surprises using data from the S&P 500 from Q3 2016 to Q4 2019. I also find evidence for PEAD after major negative surprises one week, one month, and two months after the announcement. However, in the weeks and months after positive surprises, the stock price tends to drift downward which is the exact opposite of what PEAD predicts. This indicates that PEAD has weakened or even reversed for positive

surprises as previous literature has found significant PEAD after positive surprises at these time scales.

The existence of statistically significant PEAD in the first full trading day after the announcement implies that a profitable trading strategy may exist to buy stocks that have just had a major positive surprise and sell stocks that have just had a major negative surprise. Using reasonable assumptions about financing and transaction costs, this strategy generates returns of 19.5% with a Sharpe ratio of 1.58.

I find no evidence that liquidation pressure on speculators is driving any PEAD as SISEF actually has a negative correlation with stock price drift in the weeks following major positive surprises. This means that PEAD is weaker after a major positive earnings announcement surprise if there was significant short selling right before the announcement. This could indicate that even when short-sellers are wrong about the direction of the earnings announcement surprise, they still have important information about the future prospects for the company.

**Section 2: Related Literature**

The current academic literature offers three main explanations for PEAD: methodological problems in previous studies, leading to documentation of a phenomenon that does not exist in reality; shifts in the risks of firms with extreme surprises, justifying higher returns; and investor under-reaction to the information contained in earnings announcements, which is subsequently corrected due to new information, delayed processing of the previously-released information, or both (Livnat, 2003).

The literature on whether methodological problems are leading to the false identification of PEAD is primarily focused on whether the transaction costs involved in trading PEAD remove all the available profit. Studies reported in 2005 and 2011 report that profitable trading strategies do exist exploiting PEAD using estimated transaction costs (Ke and Ramalingegowda, 2005; Battalio and Mendenhall, 2011). However, Ali et al. find that when analyzing the returns of actual mutual funds trading PEAD the profitability of the strategy is lower than would be expected using previous estimates of transaction costs (Ali, Chen, Yao, and Yu, 2016). These results are very relevant to this paper's analysis as I use estimated rather than actual transaction costs.

Others studies have focused on identifying when PEAD is most and least likely to be observed. George et al. finds that PEAD is weakest after major positive (negative) earnings announcement surprises when the stock is trading at a high (low) price relative to the last 52 weeks (George, Hwang, and Li, 2015). These findings seem to be evidence against liquidation by speculators being the cause of PEAD. If the liquidation were the cause of PEAD, we would





expect PEAD to be strongest after a major positive (negative) surprise when the stock is trading at a high (low) price relative to the last 52 weeks since speculators would have already suffered losses on their positions before the earnings announcement surprise; thus the surprise would be more likely to force them to liquidate their positions. However, it is possible that speculators mostly enter positions right before earnings announcements, or that the speculators who suffered significant losses leave the market. These conditions would make historical price movements irrelevant.

Perhaps the most related paper is by Hong et al. who investigate whether short-seller positions before earnings announcements are predictive of stock price drift after the announcements (Hong, Kubik, and Fishman, 2012). They find that high short-selling activity before an earnings announcement is correlated with a bigger stock price movement the day of the announcement and downward drift after the announcement. They attribute these effects to short-sellers buying shares to cover their short position the day of the announcement driving the share price above fundamental value. However, they "do not model post earnings announcement drift" (pg. 5) as they do not focus specifically on large earnings announcement surprises. For major surprises the stock price may continue drifting up for significantly longer as many speculators may have suffered losses great enough that they are no longer participating in the markets. Therefore, there would be fewer investors left with the expertise to determine what the fair value is and trade the stock back to that value.

**Section 3: Data**

This paper's analysis focuses on the U.S. equity markets because there is ample high quality data on U.S. public companies. I use the S&P 500 as a proxy for the U.S. equity markets as it is by far the most widely traded equity index and represents more than 70% of the total value of the U.S. equity markets. However, it does exclude smaller companies which could potentially have different reactions to major earnings announcement surprises. My analysis considers the stocks present in the S&P 500 on June 30$^{th}$, 2016 obtained from Bloomberg which gives me 13 quarters of earnings releases per company for companies that have remained in the index until today. It is necessary to use the S&P 500 composition at a prior point in time to avoid lookahead bias. The stocks currently in the S&P 500 are stocks that currently have a high market capitalization and thus have had relatively high returns. Therefore, if I use the current S&P 500 membership in my analysis I would likely see higher returns after earnings announcements than an investor trading the stocks in the index at the time.

I choose to start my analysis on June 30th, 2016 because it represents a good tradeoff between having enough earnings releases to have the statistical power necessary to identify PEAD due to liquidation by speculators and while still having conclusions that are relevant to the current U.S. equity markets. The behavior of the stock prices after major earnings announcement surprises could change over time for several reasons. The company composition of the S&P 500 changes over time so many companies that were at one point in the index are no longer in it. It is possible that different companies have different stock price reactions to major earnings announcement surprises. This source of bias can be partly alleviated by adjusting the basket of stocks considered over time as stocks are added and removed from the S&P 500. However, this rebalancing is too difficult to perform for this paper. More importantly, market participants' behavior changes over time so even for the same stock the behavior of the stock price after a major earnings announcement surprise may be very different from what it would have been several years ago.

After choosing which stocks to consider, to identify if PEAD exists it is necessary to assemble data on earnings release dates and times, consensus earnings per share estimates, unrevised reported earning per share values, daily stock returns, and the beta between the stocks and the S&P 500. It is also necessary to know the financing and transaction costs accrued when trading the relevant equities to determine whether any predictable stock price drift actually represents a profitable trading opportunity. To analyze if PEAD is caused by liquidation by speculators I need a metric for speculator holdings before earnings announcements and the daily trading volume of stocks.

Information on daily stock returns, earnings release dates and times, consensus earnings per share (EPS) estimates, and unrevised reported EPS values is readily available on Bloomberg. Since Bloomberg maintains data on companies that exited the S&P 500 or the public markets all together due to poor returns, bankruptcy, acquisitions, fraud, et cetera I am able to get data on more than 99% of the companies of interest. Therefore, my analysis is free from significant survivorship bias. The return of a stock for a given day is computed as the percent change of the price of the stock from the market close of the previous day to the market close of the given day adjusted for dividends and other distributions. Bloomberg seems to have an issue in how it computes the historical return of Baker Hughes and Level 3 Communications. I exclude these companies from my analysis.

Bloomberg provides the calendar day and time of the earnings announcement. However, the calendar day that an earnings announcement occurs is not necessarily the same as the first

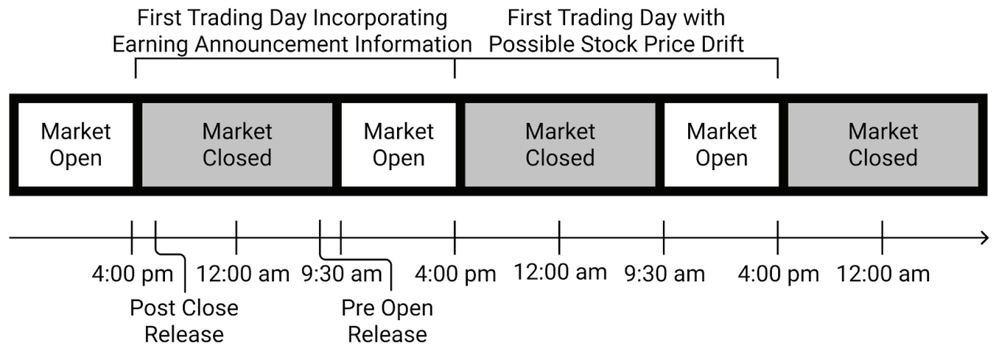




trading day that the information from the announcement can be incorporated into the share price because 42% of companies in my dataset release earnings after the markets close (4:00 pm) with most of the rest reporting earnings just before the market opens (9:30 am). Therefore, I assign the earnings announcement to the next day if it occurs after the markets close.

*Figure 2*

**United States Equity Markets Earning Announcement Schedules**




Bloomberg also provides information on the beta between stocks and the S&P 500 which is necessary in order to remove noise in stock returns arising from exposure to general market movements. To avoid lookahead bias this beta is computed in a rolling fashion using the most recent two years of data available at a given date. To compute the daily beta hedged return for a stock, I subtract beta times the return of SPY, an S&P 500 tracking ETF, from the return of the stock.

I consider two different measures for earnings announcement surprise based on those used by Brandt et al. the percent difference between the consensus EPS estimate and the unrevised reported EPS (Consensus Estimate Surprise (CES)), and the percent return of the stock price on the trading day of the earnings announcement (Earnings Announcement Return (EAR)) (Brandt, Kishore, Santa-Clara, and Venkatachalam, 2008). In my sample of earnings announcements CES has a standard deviation of 202.82% which is much greater than the standard deviation of EAR of 5.11%. The extremely high standard deviation of the CES surprise metric is likely a result of companies that were expected to be very close to breaking even experiencing significant profits or losses. CES also has a significant bias in the positive direction with a median surprise of 3.60% compared to -0.02% for EAR. The distributions CES and EAR look roughly normal but have fatter tails than the normal distribution with excess kurtosis of 2.34 and 1.53 respectively.

*Figure 3*
**CES from Q3 2016 to Q4 2019 for S&P 500**

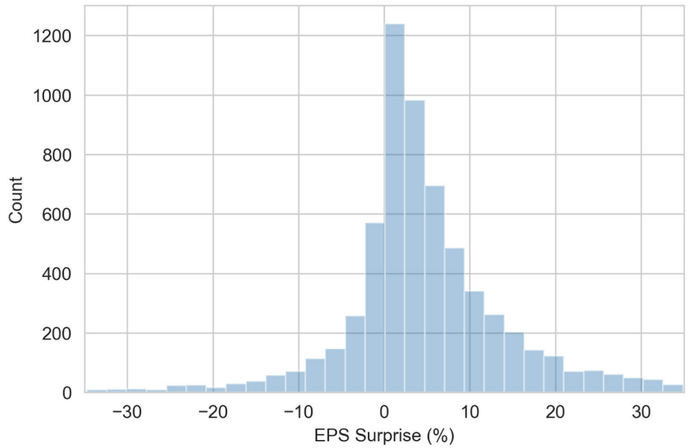
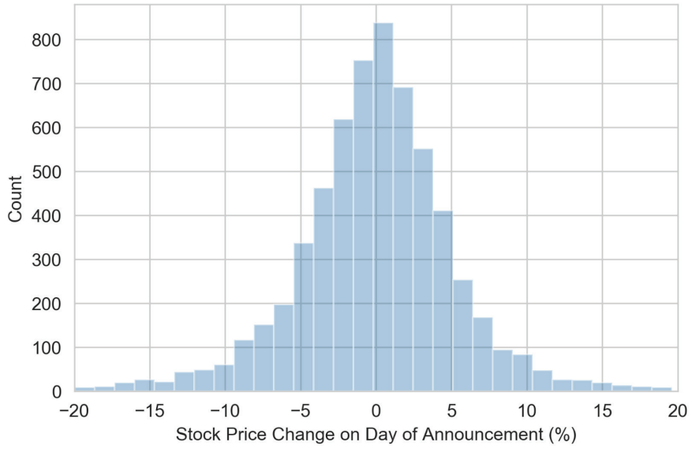



*Figure 4*
**EAR from Q3 2016 to Q4 2019 for S&P 500**




CES has several flaws as a measure of surprise. The consensus EPS estimate represents the mean of equity analysts' EPS estimates for the upcoming earnings announcement made in the days and weeks before the release. Therefore, news released just before the earnings announcement that changes investor expectations would not be reflected in the consensus estimate if the equity analysts do not submit revisions to their previous estimates. In addition, some equity analysts may have more credibility among investors than





others and thus their estimates should be more heavily weighted. Most problematically, equity analysts systematically make EPS estimates that are below the actual reported EPS value, as previously noted. Examining the cause of this bias is beyond the scope of this paper but Brown et al. find through interviews with equity analysts that analysts perceive it as personally beneficial to report numbers below their true estimate of the firm's EPS (Brown, Call, Clement, and Sharp, 2014). If investors know that analysts bias their estimates they may adjust their expectations accordingly.

EAR is immune from several of the issues that plague CES. It should respond much more quickly to information released right before the earnings announcement and does not show a systematic positive or negative bias. One additional advantage of EAR is that it takes into account all of the information contained in the earnings announcement. Therefore, unexpected information about revenue, margins, or investment will affect EAR if it matters for investors' perceptions about the future profitability of the company even if the reported EPS number is in line with expectations.

Data on financing costs for investors are difficult to obtain, especially given that financing costs differ for different investors. For margin rates I use those available from Interactive Brokers for very large institutional accounts of the Federal funds rate plus 30 basis points (Margin Rates, n.d.). Short-selling involves two additional financing fees: the borrow fees which are paid to the brokerage firm as compensation for arranging the short sale and the rebate fees which compensate the individual loaning the stock for dividends and other distributions made by the company. Both borrow and rebate fees vary greatly both between stocks and over time. For a consevative estimate of the borrow fees incurred when trading the stocks that have experienced major surprises I use the average 90$^{th}$ percentile option implied borrow fees of 1.88% computed by Muravyev et al. (Muravyev, Pearson, and Pollet, 2018). Rebate fees are already included when using daily returns from Bloomberg because Bloomberg includes the dividends and other distributions when calculating returns. When trading SPY I assume borrow fees are negligible. I use Federal funds minus 25 basis points as the rate short-sellers receive on cash generated from their short-sales as it is the rate paid by Interactive Brokers for large institutional accounts (Securities Financing, n.d.).

There are three important transaction costs to consider, the price of crossing the quoted bid-ask spread, the market impact caused by your trading, and the exchange fees paid to execute your trades. Since the return of a stock on a given day is computed using closing prices and the closing prices of stocks in the U.S. equity markets is determined by a closing auction

where all buyers and sellers get a single price there are no costs incurred from crossing the bid-ask spread. Costs from market impact could be substantial. However, they are very difficult to model and are dependent on the amount of trading done so I ignore them in this analysis. I also ignore exchange fees as they are less than one cent per trade (NASDAQ BX Exchange Fees, n.d.).

The metric I use for speculator holdings before earnings announcements is short-interest as a share of equity float (SISEF) obtained from Bloomberg because it represents the share of shares available for trading that are currently held by short sellers. The higher the SISEF the greater the fraction of the shares available the short-sellers would need to buy to cover their positions. I create a standardized metric to measure excess volume by dividing the average volume in the days or weeks after the announcement by the average volume in the 2 months before the announcement.

*Table 1*
**Important Variable Definitions**

| Variable Name | Variable Definition |
|---|---|
| *CES* | Percent difference between the consensus EPS estimate and the unrevised reported EPS |
| *EAR* | Return of the stock on the trading day of the earnings announcement |
| *Consensus EPS* | Mean of equity analysts EPS estimates for an earnings announcement |
| *EPS* | Earnings Per Share |
| *Excess Volume*$_{a,\,n}$ | Ratio of the average volume in the *n* trading days after earnings announcement *a* to the average volume in the 42 trading days prior to the announcement. |
| *Hedged Return*$_{a,\,n}$ | Return in the *n* days after earnings announcement not including the day of the announcement beta hedged with S&P 500. |
| *SISEF* | Share of stock borrowed as a fraction of the shares available for trading |
| *Surprise Direction* | 1 if surprise direction positive and 0 if surprise direction negative |





*Table 2*
**Summary Statistics for Important Variables**

| Variable Name | Obs. | Mean | Median | Std. Dev. | Min | Max |
|---|---|---|---|---|---|---|
| *CES* | 6178 | 11.58% | 3.60% | 202.82% | -2344.50% | 9400.00% |
| *EAR* | 6178 | 0.02% | 0.11% | 5.57% | -35.50% | 29.80% |
| *Consensus EPS* | 6178 | $1.25 | $0.94 | $1.47 | $-3.90 | $32.24 |
| *EPS* | 6178 | $1.31 | $1.00 | $1.54 | $-4.00 | $37.78 |
| *SISEF* | 6178 | 4.06% | 2.40% | 4.77% | 0.14% | 54.20% |

## Section 4: Methodology and Results

This paper has two goals, to determine whether PEAD currently exists in the U.S. equity markets and to determine if any PEAD observed is caused by liquidation by speculators that have suffered significant losses after a major earnings announcement surprise.

To identify PEAD I first have to define the threshold for what constitutes a major earnings announcement surprise. I choose the top and bottom deciles as the threshold because it is the threshold used by (Brandt, Kishore, Santa-Clara, and Venkatachalam, 2008). However, this threshold is somewhat arbitrary. PEAD could be present after smaller surprises or only be present after surprises even more extreme. Therefore, I also perform the analysis to identify PEAD with all the surprises in the top and bottom quintiles counted as major surprises and with only the surprises in the top and bottom ventiles counted as major surprises.

After I filter my data to include only the earnings announcements that constitute a major surprise I run a regression from the surprise direction to the beta hedged stock return for four different marks 1, 5, 21, and 42 trading days after the announcement. In this regression the constant $\beta_0$ represents the average PEAD after negative surprises, $\beta_1 + \beta_0$ represents the average PEAD after positive surprises, and $\beta_1$ represents the difference between PEAD for positive and negative surprises.

$$Spec\ 1:\ \%\ Hedged\ Return_{a,n} = \beta_{0,n} + \beta_{1,n}\, Surprise\ Direction_{a,n} + \varepsilon_{a,n}$$

The results in Table 3 show that there is statistically significant PEAD at the 1% level one trading day after the earnings announcement for both positive and negative surprises using the EAR measure of surprise with a magnitude of slightly more than 30 basis points. Though 30 basis points seems small this corresponds to an annualized return of more than 100%. I also

find statistically significant PEAD in the negative direction using both the EAR and CES measure of surprise out to two months. Stock price drift after positive surprises using both the EAR and CES measure of surprise is negative at the one week mark and beyond. However, this finding is not consistently statistically significant.

*Table 3*
**Identification of PEAD with Decile Threshold for Major Surprise**

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| *Trading Days Since Announcement* | 1 | 5 | 21 | 42 | 1 | 5 | 21 | 42 |
| *Surprise Direction$_{EAR}$* | 0.579*** (0.169) | 0.168 (0.279) | 0.532 (0.481) | 0.293 (0.623) | | | | |
| *Surprise Direction$_{EAR}$ + Constant* | 0.280*** (0.107) | -0.197 (0.177) | -0.243 (0.320) | -0.463 (0.402) | | | | |
| *Surprise Direction$_{CES}$* | | | | | 0.216 (0.139) | 0.225 (0.258) | 0.018 (0.495) | 0.265 (0.645) |
| *Surprise Direction$_{CES}$ + Constant* | | | | | -0.042 (0.102) | -0.333* (0.197) | -1.21*** (0.386) | -0.659 (0.500) |
| | | | | | | | | |
| *Constant* | -0.298** (0.130) | -0.366* (0.216) | -0.775** (0.359) | -0.756* (0.472) | -0.258*** (0.095) | -0.558*** (0.166) | -1.228*** (0.31) | -0.924** (0.408) |
| *R^2* | 0.009 | 0.0 | 0.001 | 0.0 | 0.002 | 0.001 | 0 | 0 |
| *Observations* | 1236 | 1236 | 1236 | 1236 | 1240 | 1240 | 1240 | 1240 |

* Significant to 10% level ** Significant to 5% level *** Significant to 1% level
Note: Standard errors are robust to heteroskedasticity.

The greater magnitude and significance of PEAD one trading day after the announcement using the EAR measure of surprise as opposed to the CES measure of surprise seems to be because the CES measure fails to capture much of the information in the earnings announcement that is important to investors valuing the company. This makes it a relatively poor measure of surprise. Stocks in the top and bottom deciles of CES surprise only move around 3% on average on the day of the earnings announcement as shown in Figure 5. Stocks in the top of bottom deciles of the EAR measure of surprise move around 10% on the day of the earnings announcement as shown in Figure 6.





*Figure 5*
**Beta Hedged Market Reaction to Earnings Announcements by CES Surprise Decile**

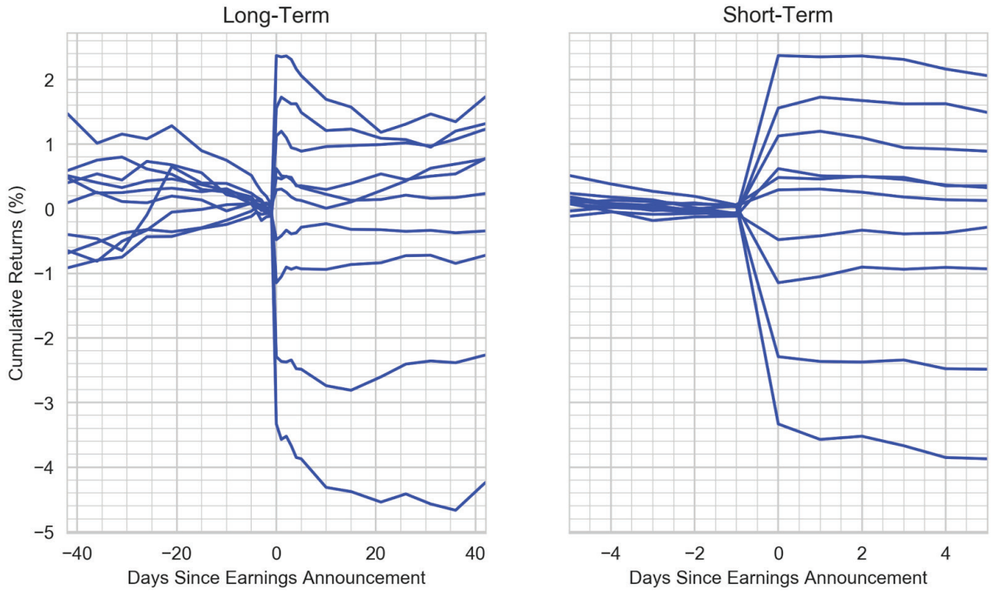
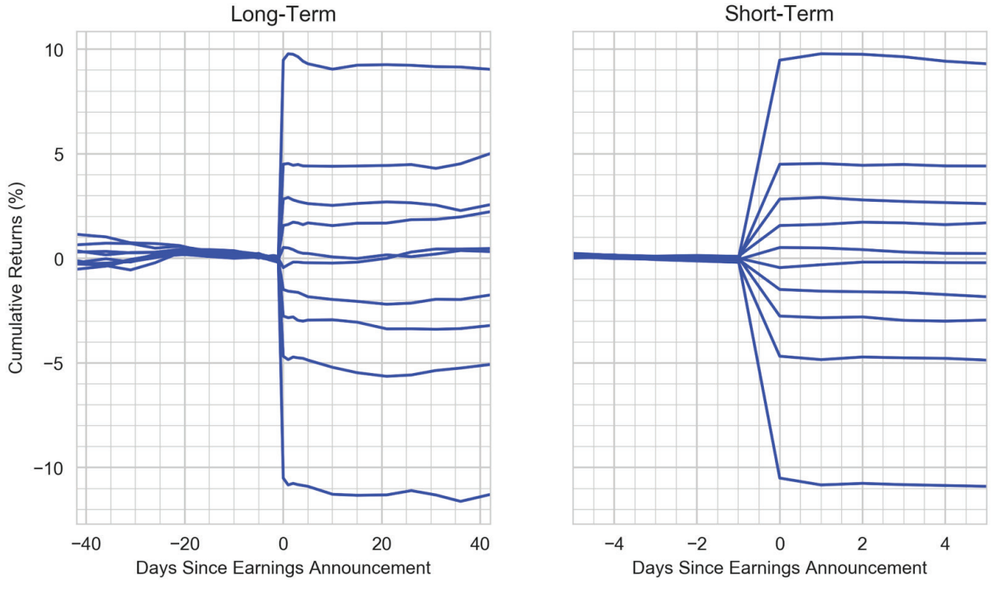



*Figure 6*
**Beta Hedged Market Reaction to Earnings Announcements by EAR Surprise Decile**



The regression results in Table 4 and Table 5 show that conclusions about PEAD one trading day after the announcement using the EAR measure of surprise are robust to the threshold chosen for what constitutes a major surprise. Interestingly, I continue to find evidence for negative stock price drift at the one week mark and beyond after major positive surprises. Though examining the impact of using different thresholds for and measures of earnings announcement surprise is valuable, for brevity in the remainder of the paper I will only present and discuss the results with the threshold set at the top and bottom deciles with the EAR measure of surprise.

*Table 4*
**Identification of PEAD with Quintile Threshold for Major Surprise**

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| *Trading Days Since Announcement* | 1 | 5 | 21 | 42 | 1 | 5 | 21 | 42 |
| *Surprise Direction$_{EAR}$* | 0.380*** (0.102) | 0.127 (0.171) | 0.703** (0.300) | 0.568 (0.392) | | | | |
| *Surprise Direction$_{EAR}$ + Constant* | 0.145** (0.066) | -0.154 (0.111) | -0.167 (0.205) | -0.002 (0.259) | | | | |
| *Surprise Direction$_{CES}$* | | | | | 0.216** (0.099) | 0.162 (0.172) | -0.081 (0.314) | -0.013 (0.411) |
| *Surprise Direction$_{CES}$ + Constant* | | | | | 0.047 (0.069) | -0.217* (0.125) | -0.855*** (0.233) | -0.467 (0.304) |
| | | | | | | | | |
| *Constant* | -0.235*** (0.077) | -0.281** (0.130) | -0.870*** (0.219) | -0.570* (0.295) | -0.169** (0.071) | -0.379*** (0.119) | -0.775*** (0.211) | -0.454 (0.276) |
| *R^2* | 0.006 | 0 | 0.004 | 0.001 | 0.002 | 0 | 0 | 0 |
| *Observations* | 2472 | 2472 | 2472 | 2472 | 2474 | 2474 | 2474 | 2474 |

* Significant to 10% level ** Significant to 5% level *** Significant to 1% level
Note: Standard errors are robust to heteroskedasticity.





*Table 5*
**Identification of PEAD with Ventile Threshold for Major Surprise**

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| *Trading Days Since Announcement* | 1 | 5 | 21 | 42 | 1 | 5 | 21 | 42 |
| *Surprise Direction$_{EAR}$* | 0.960*** (0.283) | 0.647 (0.452) | 0.423 (0.758) | 0.401 (0.956) | | | | |
| *Surprise Direction$_{EAR}$ + Constant* | 0.381** (0.179) | -0.109 (0.277) | -0.58 (0.489) | -0.822 (0.59) | | | | |
| *Surprise Direction$_{CES}$* | | | | | 0.372* (0.202) | 0.635* (0.371) | 0.173 (0.721) | -0.053 (0.941) |
| *Surprise Direction$_{CES}$ + Constant* | | | | | 0.021 (0.143) | -0.342 (0.279) | -1.514*** (0.521) | -1.234* (0.678) |
| | | | | | | | | |
| *Constant* | 0.579*** (0.219) | -0.756** (0.358) | -1.003* (0.579) | -1.223 (0.753) | -0.352** (0.144) | -0.976*** (0.244) | -1.687*** (0.498) | -1.181* (0.652) |
| *R^2* | 0.018 | 0.003 | 0.001 | 0.0 | 0.005 | 0.005 | 0.0 | 0.0 |
| *Observations* | 618 | 618 | 618 | 618 | 618 | 618 | 618 | 618 |

* Significant to 10% level ** Significant to 5% level *** Significant to 1% level
Note: Standard errors are robust to heteroskedasticity.

The biggest obstacle to accurately estimating the parameters in these regressions is noise in the responder. Stock returns fluctuate significantly due to factors that have nothing to do with the earnings announcement surprise such as interest rates and political turmoil. Using more data would help mitigate this noise, but could reduce the applicability of my conclusions to the current U.S. markets as discussed in detail in Section 3. The beta hedging I already perform with the S&P 500 removes some noise but it fails to account for sector specific stocks. I can address this source of noise by additionally hedging with sector indices instead of just with the S&P 500, but this is beyond the scope of the paper.

To determine if the PEAD I identify in the first trading day after major earnings announcement surprises represents an opportunity to earn abnormal returns I simulate a basic trading strategy. In this PEAD trading strategy I take a beta hedged long (short) position in a stock if it has experienced a major positive (negative) earnings announcement surprise and then compute the return I would have earned accounting for the financing and transactions outlined in Section 3. For each earnings announcement traded I deploy one fifth of my capital, using

leverage when necessary, so that the volatility of the PEAD strategy's returns matches the volatility of the S&P 500's total returns in the studied period. I aggregate both the PEAD strategy's and S&P 500's returns on a quarterly basis and find the PEAD strategy has an impressive Sharpe ratio of 1.58.

To determine whether the PEAD strategy's returns are abnormal after adjusting for risk I use the Capital Asset Pricing Model (CAPM). CAPM states that the expected return of an asset over the risk-free (Federal funds) rate should be proportional to the asset's exposure (Beta) to unhedgeable market risk (Fama and French, 2003). The constant (Alpha) in this regression represents the abnormal return beyond what would be expected given the PEAD strategy's exposure to the market. I do not evaluate the PEAD strategy's returns with a multifactor model such as the Fama and French Five Factor Model because 13 quarters of earnings announcements would not be enough to fit the parameters in the model with any degree of precision. I do not need to subtract the risk-free rate from the PEAD strategy's return because I already adjusted for the strategy's capital utilization when handling financing costs.

$$Spec\ 2: \%\ PEAD\ Strategy\ Return_t = \alpha + \beta\ \%\ Market\ Return_t - \%\ Risk\ Free\ Return_t + \varepsilon_t$$

The regression results in Table 6 show that the Alpha generated by the PEAD strategy of 5.354% per quarter is statistically significant to the 1% level. This is extremely impressive, however, given I use simulated financing and transaction costs it is possible that these high abnormal returns cannot actually be realized in practice.

*Table 6*
**Abnormal Quarterly Return of PEAD Trading Strategy using CAPM**

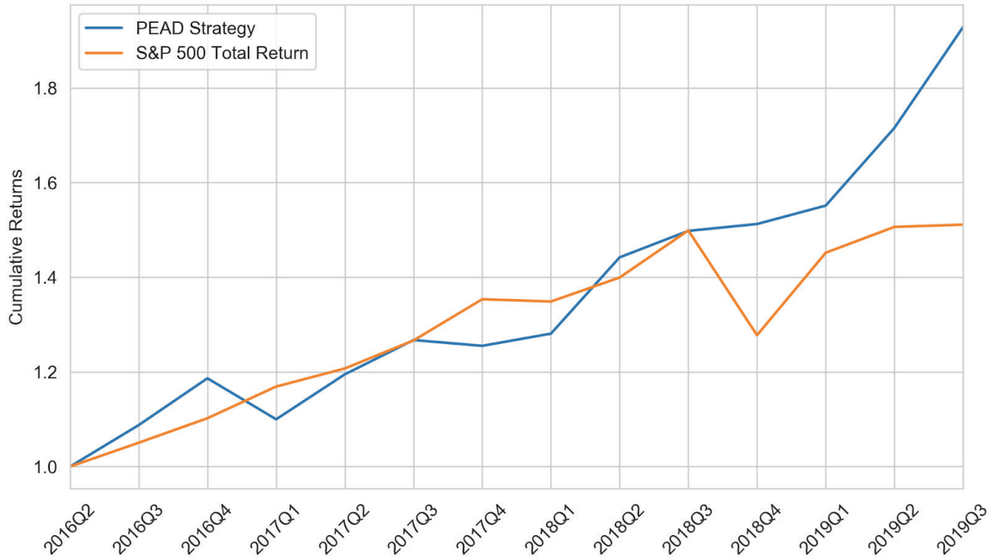
| | (1) |
|---|---|
| *S&P 500 Total Return - Risk-Free Rate (Beta)* | -0.061<br>(2.148) |
| | |
| *Constant (Alpha) (%)* | 5.354***<br>(1.769) |
| *R^2* | 0.0 |
| *Observations* | 13 |

* Significant to 10% level ** Significant to 5% level *** Significant to 1% level
Note: Standard errors are robust to heteroskedasticity.





*Figure 4*
**Cumulative Total Returns of PEAD Strategy and S&P 500**




It is surprising that a trading strategy as extensively documented as PEAD would be so profitable, as one would expect speculators to arbitrage it away. However, if PEAD is caused by speculators who are forced to liquidate their positions it may be that there are not enough speculators active in the markets after major earnings announcement surprises to arbitrage PEAD away. I investigate two indicators to determine if this is the case. The first is whether greater short-interest as share of equity float (SISEF) before a major positive earnings announcement surprise is positively correlated with PEAD after the announcement controlling for the magnitude of the surprise. This relationship should exist if PEAD is caused by liquidation by speculators because higher SISEF before an earnings announcement indicates that a larger number of speculators are betting that the stock price will fall, so a major positive surprise will lead to larger speculator losses.

$$Spec\ 3: \%\ Hedged\ Returns_{a,n} = \beta_{0,n} + \beta_{1,n} SISEF_{a,n} + \beta_{2,n} EAR_{a,n} + \varepsilon_{a,n}$$

The second indicator is whether SISEF before a major positive earning announcement is positively correlated with trading volume after the surprise after controlling for the magnitude of the surprise. This relationship should exist because to liquidate their positions short-selling speculators have to buy shares in the stock they were betting against increasing trading volume in that stock.

$$Spec\ 4: Excess\ Volume_{a,n} = \beta_{0,n} + \beta_{1,n} SISEF_{a,n} + \beta_{2,n} EAR_{a,n} + \varepsilon_{a,n}$$

The regression results in Table 7 show that there is no evidence that SISEF is positively related to the magnitude of PEAD after major positive earnings announcement surprises. In fact, for the later marks there is moderate evidence that SISEF is correlated is stock price drift in the negative direction. This could be because the short-selling speculators, though wrong about the direction of the surprise, do have some information about the future profitability of the company.

*Table 7*
**Relationship between SISEF and PEAD using EAR Measure of Surprise**

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| *Trading Days Since Announcement* | 1 | 5 | 21 | 42 |
| *SISEF* | -0.834<br>(3.130) | -8.729**<br>(4.053) | -20.601**<br>(9.316) | -20.293*<br>(11.987) |
| *EAR* | 2.278<br>(4.569) | 7.706<br>(6.609) | 12.033<br>(11.087) | 8.148<br>(14.828) |
| | | | | |
| *Constant (%)* | 0.114<br>(0.361) | -0.405<br>(0.640) | -0.151<br>(1.046) | -0.021<br>(1.400) |
| *R^2* | 0.001 | 0.013 | 0.022 | 0.014 |
| *Observations* | 618 | 618 | 618 | 618 |

* Significant to 10% level ** Significant to 5% level *** Significant to 1% level
Note: Standard errors are robust to heteroskedasticity.

The results in Table 8 show that there is little evidence that the SISEF is related to higher excess volume after a positive earnings announcement surprise. I currently lack a good explanation for the extremely statistically significant negative coefficient on SISEF at the two month mark. However, it could be an artifact of my definition of excess volume as the ratio of average number of shares traded in the periods before and after the earnings announcement instead of as the ratio dollars traded before and after the announcement. Since stock prices increased significantly during the period studied the former ratio would decline over time even the latter ratio remains constant.





*Table 8*
**Relationship between SISEF and Excess Volume using EAR Measure of Surprise**

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| *Trading Days Since Announcement* | 1 | 5 | 21 | 42 |
| *SISEF* | 0.134<br>(0.815) | -0.238<br>(0.402) | -0.340<br>(0.227) | -0.504***<br>(0.186) |
| *EAR* | 10.389***<br>(2.04) | 4.291***<br>(0.949) | 1.840***<br>(0.504) | 1.229***<br>(0.459) |
| | | | | |
| *Constant* | 1.092<br>(0.160) | 1.075<br>(0.076) | 0.961<br>(0.041) | 0.958<br>(0.038) |
| *R^2* | 0.121 | 0.069 | 0.034 | 0.022 |
| *Observations* | 618 | 618 | 618 | 618 |

* Significant to 10% level ** Significant to 5% level *** Significant to 1% level
Note[1]: Significance for constant evaluated against a null hypothesis of 1.
Note[2]: Standard errors are robust to heteroskedasticity.

## Section 5: Conclusion

PEAD remains one of the most important apparent violations to the efficient-market hypothesis. This paper demonstrates that PEAD is still present in U.S. equity markets and can be profitably traded. However, this paper fails to find evidence that liquidation by speculators is a cause of PEAD. The SISEF of a stock before a major positive earnings announcement surprise is actually negatively related with the returns of the stock after the earnings announcement. Short interest also lacks a positive relationship with excess volume after major positive earnings announcement surprises.

There are several reasons why I could have failed to find evidence that liquidation by speculators is a cause of PEAD. One is that it simply is not a cause of PEAD. However, it is also possible that SISEF is a poor proxy for speculators positions before an earnings surprise or that certain subsets of speculators are especially vulnerable to losses and should be treated as a separate group. My failure to adjust for the dollar magnitude of earnings announcement surprises could also prevent me from identifying liquidation by speculators as a source of PEAD. Analyzing speculators' positions directly either using publicly available data on mutual funds and

other investment vehicles or by collecting a confidential dataset may enable me to identify liquidation by speculators as a cause of PEAD under certain specific circumstances.

It may initially seem that understanding a phenomenon like PEAD would be of interest only to finance professionals seeking profit. However, it is important to remember the societal purpose of markets, to allocate capital in the economy to where it is most productive. Inefficiencies such as PEAD indicate that the market is in some way failing to adequately process publicly available information. Its persistence despite its extensive documentation raises questions as to whether there are other unknown pricing inefficiencies in the market that could have consequences for the health of the real economy.

Furthermore, evidence that PEAD is caused by liquidation by speculators would have substantial ramifications for understanding risk in the economy. Speculators should be somewhat insulated from losses from even major earnings announcement surprises due to diversification. If a shock to one company was enough to force them to exit their positions potentially driving the share price away from its fair value one wonders if a major system wide shock could lead to a market wide crash.





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# *Wirtschaftswunder*: Incentives Aligned for Growth

## A Comparative Study of West Germany and the UK 1950-1980

Whitney Zhang

May 16, 2019

Word Count: 5383

# 1 Introduction

After World War II, West Germany was left in a shambles, with 20% of all housing destroyed, industrial output in 1947 at only one-third of its 1938 level, and a large portion of its working age population dead (Henderson 2010). The UK similarly had some decline in capital and output, but to a much lesser extent than Germany; it still managed to maintain a 1.8% growth rate throughout the war period (Alford 1988). Shortly after, Germany's growth rate dramatically increased in a recovery called the *Wirtschaftswunder* or "economic miracle," reaching over 9% annual growth, compared to the UK's stagnant 2-3%. Germany soon became one of Europe's major economic powerhouses, a far cry from its original post-war state.

In this paper, I argue that the strong growth of Germany and stagnant growth of the UK can be attributed to their degree of alignment of employee, management, and bank incentives, and the ability of agents to check each others' rent-seeking. These were much better aligned in Germany than in the UK, leading to better worker productivity, financing, and longer-term decision-making, driving Total Factor Productivity (TFP) and capital growth.

In Germany, employees' incentives were aligned with those of the firm through codetermination, in which employees were required to sit on the supervisory board of the firm, as well as through firm-level works councils, which focused employees more on growth and less on collecting rents. The codetermination and works councils system resulted in more productive employees, better information flows, and better supervision of management, driving TFP growth. This higher productivity also made firms more attractive to investment, driving capital growth. On the other hand, the UK had relatively powerful crafts unions bargaining for wages. As a result, employees were more focused on collecting rents from the firm and each other than on labor productivity.

Similarly, financiers' incentives were aligned with those of the firm through banks being able to sit on the supervisory board of the firm. This alignment resulted in more trust and supervisory power, so banks were more willing to invest and make more long-term investments, and were able to help check management. These effects helped increase investment, and, specifically, investment in innovation, stimulating both capital and TFP growth. The UK, in contrast, had a shareholder-focused financing model, which led to myopic investors and general lack of capital.





In the next section, I present a graphical analysis and growth accounting for the period 1950-1980 to show that growth was capital and TFP driven, and present data on labor productivity in this time period. In section 3, I analyze how codetermination helped align employee and management incentives. In section 4, I analyze how works councils helped align employee incentives. In section 5, I analyze how bank representation helped align bank and management incentives. Lastly, I conclude about the importance of policies that develop aligned incentives in bringing about growth.

# 2 Growth Facts

First, I conduct a graphical analysis of the major growth patterns in output, capital, employment, and human capital. Then, I conduct a growth accounting, both aggregated and per labor, to decompose the growth factors for both countries. All data is from the Penn World Tables 9.0.

## 2.1 Graphical Analyses

Total output (as measured by GDP) grew from $0.44 trillion to $2.0 trillion in Germany and $0.55 trillion to $1.08 trillion in the UK 1950-1980 (in 2011 chained US Dollars). Throughout this period, the UK remained at a roughly 2.6% growth rate, while Germany grew quickly, at around 8.7% in the first decade, during which it surpassed the UK in output, before slowing down to converge to the UK's growth rate.

The overall trends for output per labor are the same. However, Germany surpasses the UK nearly a decade later than in the aggregated output. This is most likely because

throughout this period Germany had a labor force about 1.5 times the size of the UK due to its naturally larger population, rather than the labor force participation rate—in fact, the UK's labor force participation rate was consistently higher than Germany's.

Figure 1

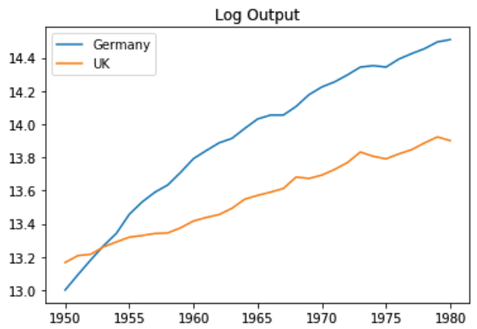
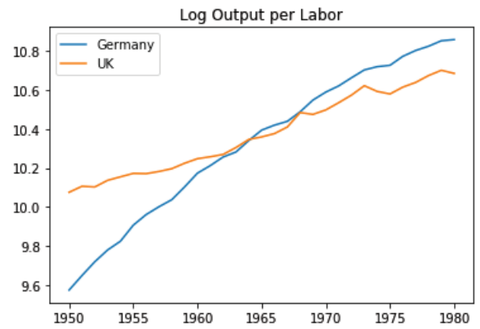



Figure 2




Similarly to total output, the UK's capital stock grew at roughly the same rate throughout the period, whereas Germany's capital stock grew quickly at first, surpassing the UK's, before slowing down. Per labor capital stock follows the same trends. However, while Germany does seem to catch up to the UK's capital stock per labor, Germany does not surpass the UK at any time.

Figure 3

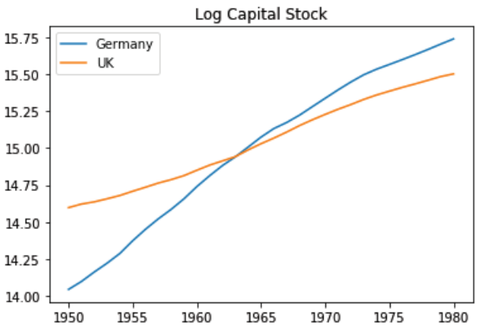
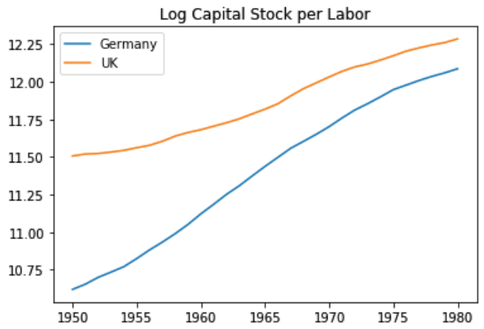



Figure 4




Both countries' labor forces grew quickly at first, before leveling off. Human capital grew





strongly for both countries.

Figure 5

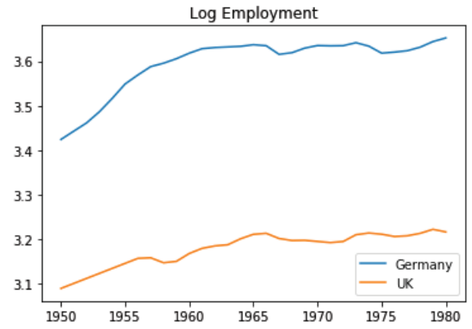
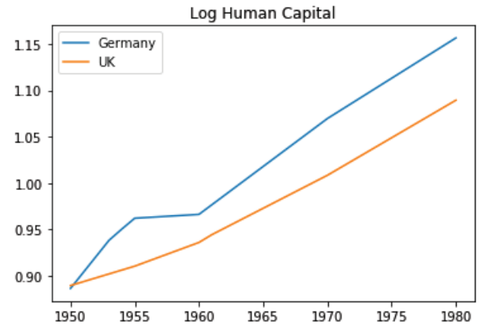



Figure 6




As with output and capital, Total Factor Productivity (TFP) growth was steady for the UK, and fast, then slow, for Germany. After considering human capital, TFP does seem to be growing slightly less quickly for both countries, indicating that human capital growth did have some effect on the growth of both Germany and the UK, but does not appear to be substantial. An explanation of how TFP was calculated and a more in-depth breakdown is provided in the next section.

Figure 7

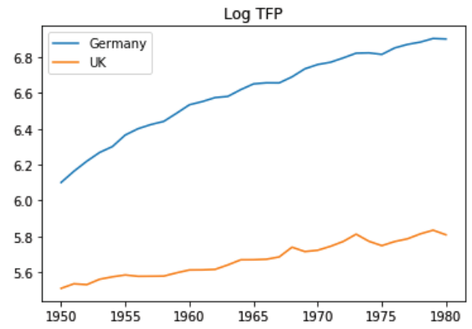
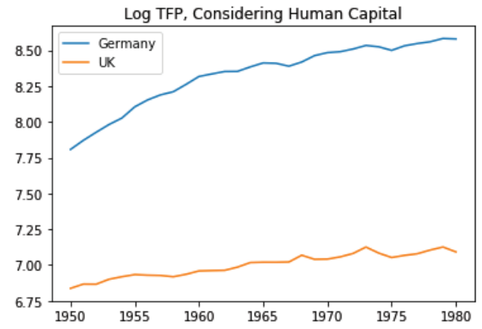



Figure 8



## 2.2 Growth Accounting

First, I conduct a growth accounting in terms of aggregate output, capital, and employment, beginning with the Cobb-Douglass production function:

$$Y_t = A_t K_t^{\alpha} L_t^{1-\alpha}$$

where $Y$ is output, $A$ is TFP, $K$ is capital, $L$ is labor, and $t$ is year. In discrete time, this is

$$\frac{Y_t - Y_{t-1}}{Y_t} = \frac{A_t - A_{t-1}}{A_t} + \alpha \frac{K_t - K_{t-1}}{K_t} + (1-\alpha)\frac{L_t - L_{t-1}}{L_t}$$

Since TFP cannot be directly measured, I treated it is as a residual:

$$\frac{Y_t - Y_{t-1}}{Y_t} = \alpha \frac{K_t - K_{t-1}}{K_t} + (1-\alpha)\frac{L_t - L_{t-1}}{L_t} + x_t$$

I use 1− labor share for $\alpha$. Since labor share is 0.659 for Germany and 0.610 for the UK, both give $\alpha$ close to $\frac{1}{3}$. As such, using $\alpha = \frac{1}{3}$ gives similar values. This decomposition results in the following table, where "Output Growth" is $\frac{Y_t - Y_{t-1}}{Y_t}$, "Weighted Capital Growth" is $\alpha\frac{K_t - K_{t-1}}{K_t}$, "Weighted Labor Growth" is $(1-\alpha)\frac{L_t - L_{t-1}}{L_t}$, and $x_t$ is TFP growth. "Output %" refers to the percentage of output growth the respective factor contributes.

Table 1 Aggregate Growth Decomposition

| Aggregate Growth in | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Year | Country | Output | Capital | | Employment | | TFP | |
| | | | Growth | Output % | Growth | Output % | Growth | Output % |
| 1951-1980 | Germany | 0.0520 | 0.0191 | 37% | 0.005 | 10% | 0.028 | 53% |
| | Britain | 0.0250 | 0.0122 | 49% | 0.003 | 10% | 0.010 | 41% |
| 1951-1960 | Germany | 0.0868 | 0.0240 | 28% | 0.014 | 18% | 0.049 | 56% |
| | Britain | 0.0262 | 0.0102 | 39% | 0.0051 | 19% | 0.0109 | 42% |
| 1961-1970 | Germany | 0.0490 | 0.0211 | 43% | 0.0019 | 4% | 0.0260 | 53% |
| | Britain | 0.0290 | 0.0154 | 53% | 0.0028 | 10% | 0.0108 | 37% |
| 1971-1980 | Germany | 0.0275 | 0.0137 | 50% | 0.0004 | 2% | 0.0134 | 49% |
| | Britain | 0.0183 | 0.0113 | 62% | 0.0008 | 4$ | 0.0062 | 34% |





It is clear that Germany and the UK both have similar decompositions of growth factors, with capital and TFP being the main drivers of growth. Germany has consistently much higher capital and TFP growth than the UK. The capital difference, however, is less stark than the TFP difference, and Germany's capital growth declines to near-UK levels in the latter part of this period.

Labor contributes relatively little, especially towards the later part of the period, where growth at times is even negative. Germany initially has slightly higher labor growth, but converges to UK levels at the end of the period. As such, labor is unlikely to be a driver of growth for either country and does not explain Germany's strong growth relative to the UK.

Next, I conduct a growth accounting in terms of output per labor, capital, and human capital. I assume the following model, where human capital is labor augmenting:

$$Y_t = A_t K_t^{\alpha} (h_t L_t)^{1-\alpha} \Rightarrow y_t = a_t k_t^{\alpha} (h_t)^{1-\alpha}$$

for $y_t = Y_t/L_t$, $a_t = A_t/L_t$, $k_t = K_t/L_t$, and $h_t$ as human capital. In discrete time, this is

$$\frac{y_t - y_{t-1}}{y_t} = \frac{a_t - a_{t-1}}{a_t} + \alpha \frac{k_t - k_{t-1}}{k_t} + (1-\alpha)\frac{h_t - h_{t-1}}{h_t}$$

As above, I treat TFP as a residual:

$$\frac{y_t - y_{t-1}}{y_t} = \alpha \frac{k_t - k_{t-1}}{k_t} + (1-\alpha)\frac{h_t - h_{t-1}}{h_t} + x_t$$

This decomposition results in the following table, where "Output Growth" is $\frac{y_t - y_{t-1}}{y_t}$, "Weighted Capital Growth" is $\alpha\frac{k_t - k_{t-1}}{k_t}$, "Weighted Labor Growth" is $(1-\alpha)\frac{h_t - h_{t-1}}{h_t}$, and $x_t$ is TFP growth. "Output %" refers to the percentage of output growth the respective factor contributes.

Table 2 Per Labor Growth Decomposition

| Per Labor Growth in | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Year | Country | Output | Capital | | Employment | | TFP | |
| | | | Growth | Output % | Growth | Output % | Growth | Output % |
| 1951-1980 | Germany | 0.0483 | 0.0164 | 36% | 0.006 | 14% | 0.021 | 49% |
| | Britain | 0.0207 | 0.0105 | 51% | 0.004 | 19% | 0.006 | 30% |
| 1951-1960 | Germany | 0.0643 | 0.0167 | 26.03% | 0.0060 | 9.36% | 0.0415 | 64.62% |
| | Britain | 0.0176 | 0.0068 | 38.58% | 0.0028 | 15.68% | 0.0080 | 45.74% |
| 1961-1970 | Germany | 0.0459 | 0.0201 | 43.70% | 0.0064 | 14.03% | 0.0194 | 42.27% |
| | Britain | 0.0243 | 0.0135 | 55.64% | 0.0043 | 17.56% | 0.0065 | 26.80% |
| 1971-1980 | Germany | 0.0268 | 0.0135 | 50.32% | 0.0060 | 22.23% | 0.0074 | 27.44% |
| | Britain | 0.0168 | 0.0108 | 63.68% | 0.0048 | 28.78% | 0.0012 | 7.34% |

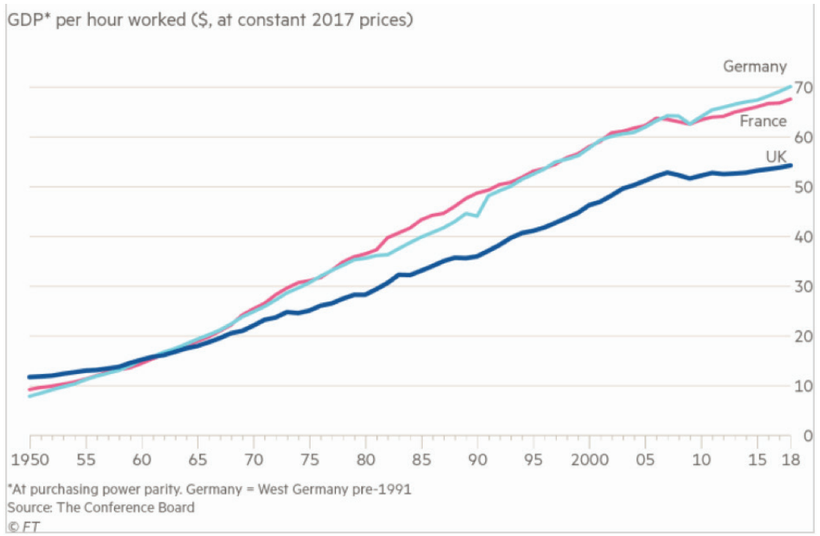
Similar to above, capital and TFP are the main drivers of growth for both countries, although TFP's percentage of output is slightly decreased with the inclusion of human capital. Human capital's contribution is larger than that of employment, especially in the later years, where human capital is strongly positive. However, human capital growth for Germany and the UK is roughly the same for all time periods, and so is unlikely to be explanatory of the difference in output growth between Germany and the UK.

Within TFP growth, a significant factor is the growth in labor productivity of Germany compared to the UK. The following graph shows GDP per hour worked for Germany and the UK. Germany's labor productivity growth rate appears to be continuously higher than that of the UK, surpassing the UK level around 1960. Furthermore, looking at the log output per labor from the growth accounting, it is clear that Germany's output per labor was growing much faster than the UK's throughout this time period. By 1972, labor productivity was 27 percentage points higher in Germany than in the UK (Pratten 1976).





Figure 9




Source: Financial Times

The following sections will examine reasons for the considerably higher labor productivity in Germany compared to the UK, as well as other factors contributing to TFP and capital growth.

## 3 Codetermination

Starting in 1951, many firms in Germany were required to have employees sit on their supervisory boards, leading to better information flow between employees and management, better incentivization schemes for management, and more company ownership by employees, producing higher productivity. On the other hand, employee representation in the UK was based on unions, which often were more focused on rent-seeking than productivity. This difference in employee representation accounts for some of the difference in TFP growth, and, through higher productivity, explains some of the difference in capital growth.

Firms in Germany were governed by a two-tiered system, with a supervisory board and

a management board. The supervisory board monitored the management, appointed and dismissed members of the management board, fixed management's salaries, and approves major decisions of the management board. Generally, boards had either 16, 18, or 20 members (Emmons and Schmid 1998).

Over the period 1950-1980, a variety of laws were made that cemented employee representation on the supervisory board. First, *Montanmitbestimmung*, introduced in 1951, "mandated equal representation of employees and shareholders on the supervisory boards of firms operating in the coal and steel industry." Additionally, it mandated that at least one member of the management board, under the approval of a majority of the employee representatives of the supervisory board, must represent workers' interests (Emmons and Schmid 1998).

Next, *Betreibsverfassungsgesetz* (Workplace Governance Act) was introduced in 1952. It mandated that all LLC companies have at least "one-third of the supervisory seats reserved for representatives of employees," although organizations with which '"freedom of speech is central to their mission" and family-owned corporations with fewer than 500 employees were exempted. (Emmons and Schmid 1998).

Lastly, under the Codetermination Act of 1976, all corporations with more than 2000 employees were mandated to have at least half of the supervisory board be employee-elected. Additionally, if the supervisory board had 16 or 18 members, two of the worker representatives must have been labor union representatives, 3 if the supervisory board had 20 members (Emmons and Schmid 1998).

Codetermination improves productivity because it improves the flow of information between employees, shareholders, and management, and ensures that employees can bargain for some of the returns of this better flow of information. Employees have unique information that management may not, since they are able to better understand what is happening at the shop-floor level. They also better understand the technologies that are being used, since they encounter it on a day-to-day basis, so they can relay this information to management





and investors, who can then invest in the technologies. Lastly, since they have supervisory-level representation, they are more likely to be able to bargain for the benefits of technology to be distributed to them through higher wages. For example, Atkin et.al. find that a new technology for more efficiently producing soccer balls in Pakistan is only adopted after employees are financially incentivized to provide management with information about the new technology (2017).

Thus, one would expect that German firms would adopt newer technologies more rapidly, since employee and management incentives are better aligned. The empirical data is consistent with this hypothesis: Pratten finds that in 1972, German firms had significantly more newer technologies than UK firms, as shown in table 3. He estimates that the firms that used newer plant and machinery were 13 percentage points more productive. In total, differences in plant and machinery account for 5 percentage points of the 27% productivity differential between Germany and the UK (1976).

Table 3 Germany-UK Capital and Productivity Differentials

| | | Average differences in productivity | | Average estimated effect of differences in plant and machinery |
|---|---|---|---|---|
| | Number of observations | Gross | After allowing for scale difference | |
| Plant and machinery very similar in the two countries or favorable to the UK | 16 | 13 | 10 | 0 |
| More plant and machinery used overseas or plant and machinery overseas on average newer | 11 | 48 | 31 | 13 |
| Differences in plant and machinery not known | 8 | 26 | 19 | 5 |
| All observations | 35 | 27 | 20 | 5 |

Source: Pratten 1976

Additionally, one would expect that this productivity effect of information flow would be more pronounced for firms whose production requires high levels of coordination, such as those in manufacturing and construction, since in these processes, it is more important that each member of the firm understands the state of the other members. Thus, the returns to capital under codetermination should increase significantly for these firms. Indeed, Fauver and Fuerst find that Codetermination Act of 1976 increased the Tobin's Q (a measure for returns to capital) for firms whose production required high levels of coordination (2006).

Furthermore, codetermination improves employee feeling of ownership of companies,

which can also boost morale and incentive to improve labor productivity. Pratten notes how in discussion with German firms, "Several managers with experience of German factories referred to the identification of German workers with their firms ... One manager recounted how, at a meeting of managers and all employees, one section of workers questioned the lack of time keeping by another section" (1976). Denison also finds that, empirically, climates that encourage company involvement in company decision making have more financial success (1990).

Lastly, codetermination improves the monitoring of management, since it provides a pathway for employees to keep management in check and limit management's rent-seeking. For example, Dyballa and Kraft find that co-determined firms provide 26 percentage points of a higher share of variable (incentive-based) compensation than non-co-determined firms (2016). Fauver and Fuerst also find that companies with with employee representatives are more likely to pay dividends, which is a sign of dampened insider expropriation and more effective monitoring (2006).

Overall, Fitzroy and Kraft find that codetermination positively contributes to firms' financial success. They examine panel data for 179 manufacturing firms from 1972-76 and 1981-85 to determine the effects of the 1976 Codetermination Act and find a small, but significant, positive effect (2004). This positive effect supports that codetermination improves information flows, employee morale, and monitoring of management, increasing labor productivity and driving TFP growth.

The next section will discuss the UK model of employee representation through unions and show how it developed poor relationships between both management and employees, as well as within employees themselves.





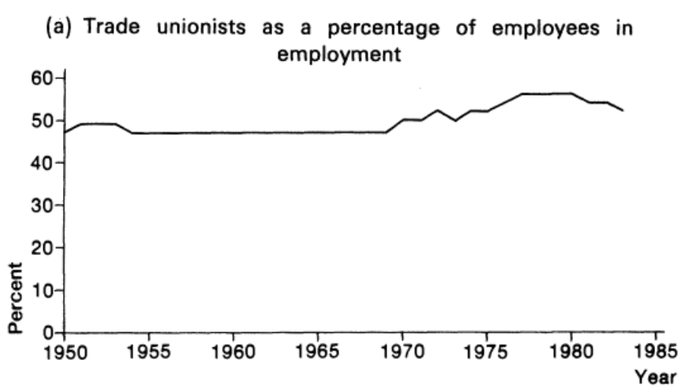
# 4 Unions

The UK's system of wage bargaining consisted of small, crafts unions, which resulted in factionalization and rent-seeking. They did not have structures for cooperating with management, leading to lowered morale and productivity-hurting conflicts. Additionally, they sought to collect benefits at the expense of each other, leading to conflict within employees.

On the other hand, large, firm-sized works councils in Germany were able to align all of their employees interests and bargain as a group. This structure resulted in increased labor productivity, which helped drive TFP growth. Higher labor productivity also made firms more attractive to investment, driving capital growth.

About half of employees in the UK were part of trade unions throughout this period, as shown in figure 10.

Figure 10




Source: Layard and Nickell 1986

Many of these workers were in firms that had multiple bargaining units, especially for non-manual workers. Although there is not union data available for most of this period, table 4 helps illustrate the degree to which multi-unionism occurred in Britain. Bean and Symons note that there was a "considerable degree of autonomy accorded to local shop stewards in representing their members' interests" (1989). Unlike in Germany, they could

each separately represent only a fraction of the employees.

Table 4 Multi-unionism in 1980 and 1984 (all establishments, %)

| | Manual Workers | | Non-Manual Workers | |
|---|---|---|---|---|
| | 1980 | 1984 | 1980 | 1984 |
| Number of unions | | | | |
| 1 | 65 | 65 | 43 | 39 |
| 2 or more | 35 | 35 | 57 | 61 |
| Number of bargaining units | | | | |
| 1 | 77 | 82 | 57 | 61 |
| 2 or more | 20 | 18 | 42 | 37 |
| Unknown | 2 | 1 | 1 | 2 |

Source: Layard and Nickell 1986

On the other hand, Germany's labor bargaining system was formed around works councils, which represented all of the employees at a firm, aligning their incentives. In addition to codetermination, the Workplace Governance Act of 1952 required that all companies with more than five employees have a works council. The representatives on the works council were elected by all employees eighteen years or older and with six months or more of experience at the company (Rasnic 1992, Fioretos 2011). Therefore, although only some workers in Germany were part of a union, all were represented by their firm's works council.

Furthermore, the act gave works councils the legal status to bargain with firms over wages. The legal status of bargaining between employees and firms helped legitimize power on both sides and incentivized both management and employees to negotiate agreements that "enhanced the long-term competitiveness of individual firms" (Fioretos 2011).

This difference in union structure and legitimacy in bargaining with employees helped develop better relationships between employees and management. These relationships were also augmented by codetermination; for example, if a firm was noticing rising costs, having employees on the supervisory board would help to explain to other employees why they needed to work longer hours or have wages cut, rather than causing antagonistic behavior.

Pratten found that in 1972, UK firms on average lost one day per worker due to strikes, whereas Germany lost only half a day (1976). Figure 11 illustrates the percentage of employees in employment involved in industrial conflicts in Britain. There is clearly a significant





level of industrial conflict, especially in the mid 1960s and late 1970s.

Figure 11


Source: Layard and Nickell 1986

Fioretos notes that even in the 1970s, when the economy began to slow, cooperation between management and employees was better in Germany than in the UK (2011). This gives further evidence that it was the German system, rather than the economic circumstances, that supported good relationships between employees and management.

These industrial conflicts in the UK hurt productivity, since they caused stoppages in work. The conflicts also indicate the lack of morale and feeling of ownership in the UK, in contrast to their pervasiveness in the German work climate, as previously discussed. Pratten calibrates that the incidence of strikes and major restrictive practice accounted for 3.5 percentage points of the 27% productivity difference between the UK and Germany; other behavioral problems with workers accounted for 8.5 percentage points of the productivity difference (1976).

The multi-union structure in the UK also misaligned interests between workers themselves. Some groups of workers were able to negotiate higher wages at the expense of other groups of workers, "provoking discontent among workers in less favourable conditions" (Bean and Symons 1989). This caused internal factionalization, likely resulting in poor cooperation, a stark contrast from the high levels of coordination in Germany, as previously discussed.

The especially poor output growth in manufacturing and construction, two highly coor-

dinated industries, in the UK, as compared to the EEC Five (Belgium, France, Germany, Italy, and the Netherlands), provides evidence that factionalization may have caused slow growth. The output in manufacturing and construction in the UK was consistently two to three percentage points lower than that of the EEC Five. In manufacturing, gross value added per worker in Germany was 155% that of a worker in the UK (Alford 1988).

Table 5 UK Comparative Growth of Industrial Output 1955-73

| | (i) Overall output growth (average percentage growth per annum) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | UK | | | | EEC Five* | | | |
| | 1995-60 | 1960-4 | 1964-9 | 1969-73 | 1955-60 | 1960-4 | 1964-9 | 1969-73 |
| Agriculture, forestry, and fishing | 3.1 | 3.1 | 1.3 | 4.0 | 2.3 | 1.9 | 1.7 | 1.4 |
| Mining and quarrying | -2.9 | 0.4 | -5.7 | -2.8 | 0.8 | 0.9 | -0.7 | 1.8 |
| Manufacturing | 2.9 | 3.3 | 3.2 | 2.8 | 6.9 | 6.6 | 6.5 | 5.4 |
| Electricity, gas, and water | 4.6 | 5.6 | 5.2 | 5.2 | 8.8 | 7.3 | 8.1 | 10.0 |
| Construction | 3.1 | 3.5 | 2.3 | 1.3 | 5.6 | 7.1 | 4.3 | 2.4 |
| Industrial production | 2.6 | 3.5 | 2.8 | 2.6 | 6.4 | 6.5 | 6.0 | 5.1 |
| | (ii) Output per person (average percentage growth per annum) | | | | | | | |
| Agriculture, forestry and fishing | 5.0 | 6.0 | 5.7 | 7.1 | 6.1 | 7.4 | 6.1 | 6.3 |
| Mining and quarrying | 0.1 | 4.4 | 4.2 | 1.8 | 2.6 | 4.6 | 5.9 | 5.2 |
| Manufacturing | 2.2 | 3.2 | 3.4 | 4.4 | 4.1 | 5.5 | 6.3 | 4.7 |
| Electricity, gas and water | 4.9 | 3.5 | 5.5 | 8.7 | 6.8 | 6.6 | 9.1 | 9.6 |
| Construction | 2.2 | 1.6 | 2.7 | 0.4 | 2.3 | 3.2 | 4.3 | 2.9 |
| Industrial production | 2.2 | 3.1 | 3.5 | 3.9 | 3.7 | 5.0 | 6.1 | 4.7 |

* Belgium, France, Germany, Italy, Netherlands
Source: Alford 1998

Furthermore, the multi-union structure had much poorer incentives for achieving growth, since the factions would be more interested in rent-seeking at the expense of other workers than achieving firm-wide growth. As Olson's theory of interest groups argues, "The more inclusive the special interest group, the greater will be the share of any inefficient policies to be borne by its own membership." For example, if there are two unions in one firm, A and B, and union A's members are able to bargain for higher wages at the expense of union B, union A will receive all of the benefits, but all of the costs will be borne by union B. On the other hand, if there is instead one all-encompassing union, the union will bear both the benefits and costs of bargaining for higher wages. As such, an all-encompassing union would be concerned about its bargaining effects on productivity and the future welfare of its

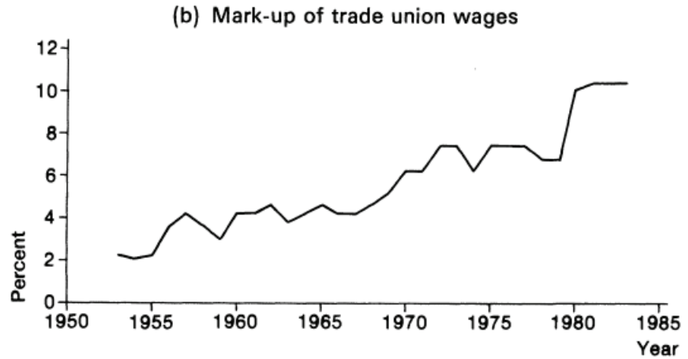




members more than many small unions, promoting "efficient practices." On the other hand, crafts unions will "impose constraints upon the rate of growth of productivity since they will evade many of the costs associated with their protection of particular occupational interests and job territories" (Batstone 1986).

Marked-up wages are evidence of the rent-seeking behavior of employees in the UK. Figure 12 illustrates the mark-up of trade union wages in the UK during this time period. They begin at 2% and rise steadily to around 6 percent by 1980. Additionally, workers in Germany earned 86 percent of what their UK counterparts did per unit output (Pratten 1976). While some of this difference may be due to differences in labor supply, it is likely that UK wages were inflated by rents.

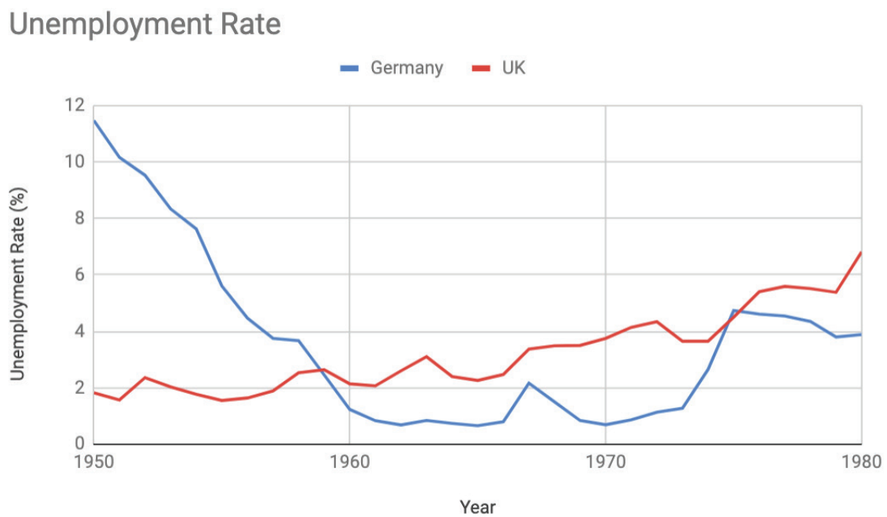
Figure 12




Source: Layard and Nickell 1986

These differences in structure were exacerbated by the differences in unemployment rates between Germany and the UK. The unemployment rate was much higher in Germany for most of the 1950s, before declining to below UK levels around 1958, as shown in figure 13.

Figure 13




Source: FRED, Deustche Bundesbank

In general, employees in Germany had a lot less power in the labor market than in the UK because of the comparatively high unemployment rate in Germany compared to the UK, at least at the beginning of this period. As a result, unions in Germany were overall less able to rent-seek. Alford argues that the low unemployment rates allowed unions to bargain for more overmanning, leading to lower productivity (1988).

Overall, these factors led to much more rent-seeking, overmanning, and conflict in the UK compared to Germany, reducing productivity. Bean and Crafts found that "the presence of multiple unions significantly depressed TFP growth, with multiple-union workplaces exhibiting annual TFP growth as much as one percentage point lower than that achieved by single union workplaces" (Eichengreen and Ritschl 2009).

Capital growth also suffered as a result of low productivity. Alford measured that gross profit rates in the UK declined steadily over the 1960s and dramatically fell between 1970 to 1945 from 23% to 13% (1988). Based on Q theory, when returns to capital decrease,





investors are less willing to invest. Indeed, the Radcliffe Report (1959), found that low profits weakened expectations of future profits and "weakened the incentive to invest—a factor ... far more important in determining investment policy than the rate of interest" (Alford 1998).

In sum, the works council system in Germany, combined with codetermination, incentivized labor bargaining that benefited all, rather than a subset, of the workers, and pushed workers to strive for long-term firm growth. Thus, workers were more productive and less rent-seeking, leading to higher labor productivity. The higher labor productivity then increased investment, driving capital growth.

Further reasons for poor capital growth in the UK relative to Germany will be discussed in the next section.

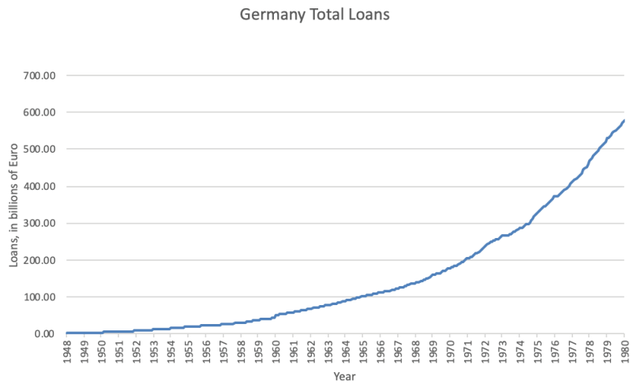
## 4.1 Financiers

Similar to employees and codetermination, in Germany, banks sat on the supervisory board of firms, and, as a result of proxy voting for shareholders, held much voting power. This developed greater trust between firms and banks and improved information flow, creating steadier investment flows to firms and longer-term investments, facilitating investment in technology. This resulted in more capital growth and TFP growth. On the other hand, banks in the UK were not interested in domestic firm investment. UK firms were mostly funded by stocks, and by financiers who were more interested in short-term profits, partly as a result of the Companies Act of 1948.

In general, compared to other forms of financing, banks tend to be longer-term investors. (Gorton and Schmid 2000). While unfortunately there is no data on UK bank lending during this time, it is clear that German lending significantly increased over this time period, the vast majority of which was in long-term lending. This long-term lending is conducive to investment technology, increasing TFP. As such, there was much more investment in technology in Germany than in the UK.

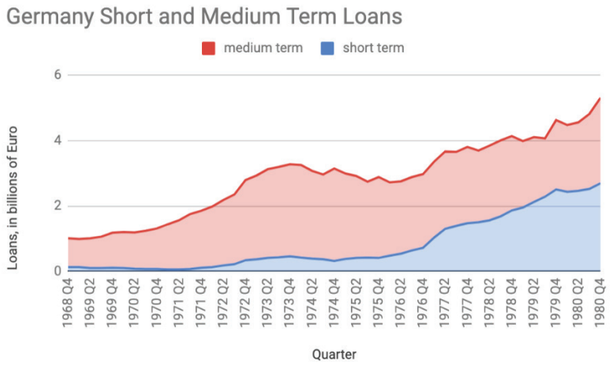
Figures 14 and 15 present total loans in Germany in 1948-1980 and short and medium term loans in Germany in 1968-1980, respectively. (Data for prior to 1968 was not available.) Loans dramatically grew in Germany during this time period, providing evidence for banks driving capital growth. Additionally, the vast majority of these loans were for the long-term. Note how short and medium term loans stay under 6 billion euro, whereas by 1968, total loans were already above 100 billion euro.

Figure 14




Source: Deustche Bundesbank

Figure 15




Source: Deustche Bundesbank

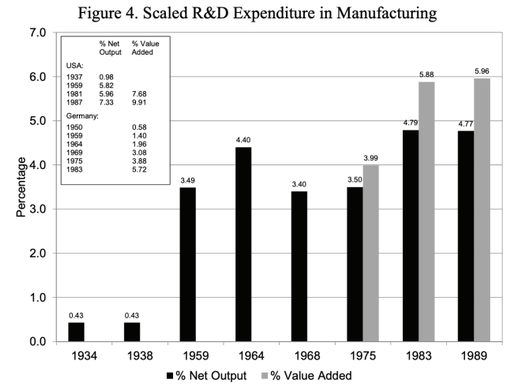




This long-term investment helped spur investment in technology, since R&D generally is only profitable in the long term, because it takes a lot of initial capital and cannot generate returns until years into the future. As a result of the lack of long term investors in the UK, the relative cost of capital for long-term R&D was about 60 percent higher in the UK than Germany (Crafts and Harley 1992).

Comparisons of German and UK R&D spending are shown in figure 16. German R&D expenditure grew from 0.58% to 5.72% of total value added, compared to the UK's consistent level of expenditure of around 3.5-4% of net output (Nicholas 2014). While total value added and net output cannot be exactly compared with each other, they still provide good indicators of change in R&D expenditure in this period.

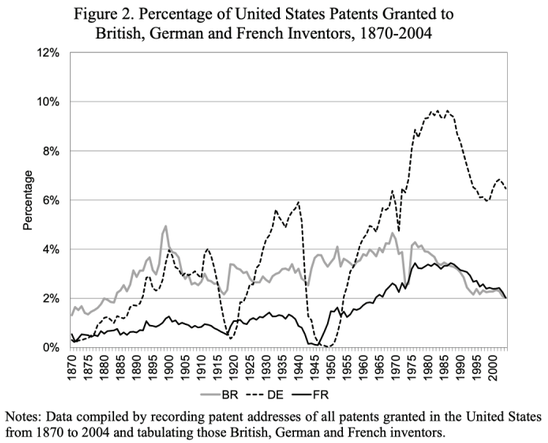
Figure 16




Source: Nicholas 2014

This investment generated new technologies, as shown by the patent data presented in figure 17. The number of US patents granted to German investors dramatically grew after 1950, surpassing the UK around 1955.

Figure 17




Source: Nicholas 2014

Furthermore, technology diffused better in Germany than in the UK, for reasons described in prior sections. Thus, this investment in technology created significant growth. R&D in Germany accounts for 0.3 percentage points of growth in 1960-1973 and 0.5 percentage points of growth in 1960-1975 (Crafts and Harley 1992).

In addition to banks' natural tendency to focus on long term investments, Germany had the benefit of having its banks sit on companies' supervisory boards. In 1970, in Germany, banks had representation on the boards of 61 of the largest 100 companies. They held 145, or 9.8% of seats of the largest 100 companies, with 65% of these seats being held by the big three universal banks: Deutsche, Dresdener, and Commerzbanks (Cable 1985).

Furthermore, banks were able to proxy vote for shareholders who deposited shares with them. Banks held 5% of voting rights from direct holding; with proxies, Banks held 36% of voting rights (Cable 1985). This voting power was frequently exercised. Emmons and Schmid note, "At the 1975 annual meetings of 56 of the 100 largest stock corporations, banks exercised at least 5 [percent] of the votes." About 50% of these votes were proxy votes. In 11 meetings, bank cast 25-50 percent of the votes, in 15 meetings, 5-25% of the





votes, and in 30 meetings, more than 50% of the votes (1998).

Bank representation helped align bank and firm interests, and was useful for improving information flows, which both steadied credit flows to firms and increased firm productivity. First, compared to the public market, or a separate bank, banks on supervisory boards better understand the situation that a firm is in, and thus would be less likely to reduce lending when times are bad. Emmons and Schmid find that banks are "better at handling shocks than public markets" and that "'main-bank' relationships reduce firms' costs of financial distress." They also find "reduced liquidity constraints when strong banking relationships were present" (1998).

Furthermore, banks want higher returns to their investment, and will thus try to monitor the firm and influence it to be more productive. They have more incentive to do this than individual financiers, because if the stock market is illiquid, they can only sell at a large loss. They also have more expertise than a single firm because of their capacity for broader industry research, from supervising many different firms, and their better understanding of financial markets. As with employees, they can also reduce over-compensation of management and overpaying of labor.

Empirically, estimates show that there is significant, positive relationship between degree of bank involvement in leading industrial companies and their financial performance. Cable finds that both bank lending and bank control increase profitability, in line with the above argument that bank lending spurs both productivity and capital growth (1985). Gorton and Schmid measure firm performance by market to book value, and also find that "firm performance increases as a function of the banks' control rights from equity ownership." They find that banks improve firm performance beyond what non-bank blockholders can achieve, for the reasons listed above (2000).

On the other hand, the UK corporate financing system incentivized short-term profits over long-term growth, causing suboptimal investment allocations. The financial system in the UK was not set up for facilitating investment in domestic firms, and the government did

not see a reason to change it. A 1959 government report stated that "the basic structure of the financial system was sound and there was sufficient capital available to modernize production without significant reforms." Additionally, the financial industry did not want to change its practices, as the British banks at the time "were extensively engaged in commercial lending and were not oriented toward long-term loans to the manufacturing sector." Furthermore, stemming from their imperial past, banks were focused on international, rather than domestic, investment (Fioretos 2011).

This was exacerbated by the 1948 Companies Act. Prior to 1948, management could only be removed by shareholders under a "special resolution," which required at least 75% of the votes. Thus, removing management through a hostile takeover was near-impossible, since management themselves often held around 25% of the votes. The 1948 Companies Act changed this to a simple majority (Johnston et.al. 2018).

This ushered in the hostile takeover, in which shareholders would buy up 50% of a company's shares, often unbeknownst to the company itself, and then replace its management. Between 1948 and 1961, 25 percent of companies on the London Stock Exchange were taken over this way. Because management could now be replaced at any time, this incentivized management to prioritize delivering values to shareholders, rather than balancing stakeholder interests and striving for growth. Additionally, many of these takeovers were not industrially, but rather financially, motivated, as "bidders sought to gain control of companies and remove the board in order to access reserves, liquidate undervalued assets or gain tax advantages" (Johnston et.al. 2018). This further increased the incentives for short-term, rather than long-term growth, since at any point in time the company could change hands.

This caused a reduction in overall investment, specifically in R&D and technology (Johnston et.al. 2018). As shown in the following table, gross fixed capital formation per worker in manufacturing in the UK is much lower than in any of the other countries (other than Italy in 1965) during this time period, especially in 1970 and 1975, indicating the lack of willingness to invest.





Table 6 Gross Fixed Capital Formation per Head of Employed Labor Force in Manufacturing—UK Compared 1965-1975

| | Current US $ and exchange rates UK = 100 | | |
|---|---|---|---|
| | 1965 | 1970 | 1975 |
| UK | 100 | 100 | 100 |
| Belgium | 168 | 203 | 257 |
| France[a] | 197 | 238 | 267 |
| Germany[b] | — | — | 186[d] |
| Italy[a] | 80 | 124 | 160[d] |
| Netherlands[a] | 170 | 270 | 309 |
| Japan | 100 | 218 | 176 |
| Sweden | 167 | 200 | 292 |
| USA | 365 | 355 | 293 |

[a] Plus other industrial sectors.
[b] Production industries excluding quarrying and mining.
[c] Manufacturing employment estimated.
[d] 1974
Source: Alford 1998

The extremely low GFCF of the UK's compared to that of the other countries', especially in 1970 and 1975, highlights the poor financing of manufacturing—as well as other sectors—during this time period. The UK suffered from myopic investors as a result of the emergence of hostile takeovers, directly slowing capital growth and indirectly slowing TFP growth through a lack of investment in technology. Germany fared much better, with tight bank-firm relationships that helped secure more robust credit lines and provide supervisory assistance.

## 5 Conclusion

In 1950-1980 in Germany and the UK, there were many important firm and market level mechanisms that stimulated—or slowed—growth. These organizational structures all helped align—or misalign—incentives between employees, management, and financiers, either pushing them towards striving for growth together or collecting rents at each others' expense.

In Germany, incentives between employees and management were aligned by the codetermination system, whereas in the UK, incentives between employees and management were misaligned by crafts union bargaining. In Germany, employees banded together in works councils, whose all-encompassing nature pushed employees to strive for higher productivity. On the other hand, in the UK, employees in factionalized crafts unions instead were more focused on collecting rents from each other. Lastly, in Germany, banks were at the core of the financial system. The supervisory system helped align the interests of banks and firms toward long-term growth. In the UK, financiers were more concerned with their short-term financial gains, leading to poor investments.

This alignment of incentives improved information flows and checks and balances on other agents, as well as boosted morale and the feeling of ownership over the firm's production. This increased productivity, accountability, and investment in technology and innovation, driving TFP and capital growth.

It is important to remember that most of these structures did not come from culture or sheer luck, but from deliberate policies. In Germany, codetermination and works councils were mandated under the Workplace Governance Act of 1952 and Codetermination Act of 1976. In the UK, the financial system was crafted—intentionally or unintentionally—by the 1948 Companies Act.

This Anglo-German comparison highlights the impact of legislation of firm- and financier-level action on aggregate national growth. Macro-level governmental decisions like monetary and fiscal policy are certainly effective, but policymakers cannot forget the import of perhaps seemingly minor institutional changes in spurring or retarding economic growth.





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