Institutional Ambiguity and Economic Growth: An Experimental Approach

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Abstract

Current literature on why some countries have been able to produce enormous material wealth, while others have struggled to do so, varies greatly in its approach to the subject. Some papers focus on the neoclassical growth model, others analyze cross-country panel data sets, and many have looked at institutional quality within a country. Approaching economic growth from the latter of these perspectives, I propose a different institution-based theory for why some countries succeed economically while others have not performed as well. Looking at how ambiguity aversion affects micro-economic actors propensity to invest through an experimental study, I find evidence for a theory that ambiguous economic environments are a principle factor in poor growth performance. This paper provides initial evidence for the *ambiguity effect* as a higher-order explanation of economic growth, and encourages further research to be conducted in alignment with the proposed theory.

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Introduction

"I do not see how one can look at figures like these without seeing them representing possibilities. Is there some action a government of India could take that would lead the Indian economy to grow like Indonesia's or Egypt's? If so, what exactly? If not, what is it about the "nature of India" that makes it so? The consequences for human welfare involved in questions like these are simply staggering: once one starts to think about them, it is hard to think about anything else." – Robert E. Lucas

Questions about what drives economic growth have occupied a significant amount of economics' energy since essentially the inception of the field. A myriad of papers has sought for explanations and answers, be it from the perspective of neoclassical growth models, regression analyses on multi-country panel data sets, or the analysis of institutional quality (Rodrick 2005). Most recently, a particularly prominent approach has been focused on the importance of good, inclusive economic and (generally democratic) political institutions (Acemoglu and Robinson 2013). That is, the importance of having institutions which protect private property, allow for the economic inclusion of diverse and large portions of a society, and have a rule of law which provides stable litigation processes.

While this theory can successfully and broadly explain the majority of observed economic trends in recorded history, it can be strained noticeably by examples where countries with authoritarian governments have experienced significant economic growth, while in serious violation of some of these guiding institutional principles. As an example where this is the case, we can point to Singapore and China, two countries which have grown enormously under authoritarian and otherwise extractive governments.

Could it be that there is an underlying mechanism which is present mainly in inclusive, traditionally thought of as 'good', institutions, and not generally present in exclusive institutions, that is really driving economic growth, and would explain the moments where countries with non-'Washington Consensus', extractive institutions grow significantly? This is the fundamental question that this paper will set out to answer. That is, is there a higher-order explanation for why some countries tend to be successful in achieving economic growth that does not conflict with previously proposed institutional growth theories?

The proposed answer to this question derives from a conception of macro-economic being an aggregation of micro-economic decisions made millions and millions of times by millions of

micro-economic actors. By understanding how individuals operating within an economic environment respond to varying institutional frameworks, we can better think about how those different frameworks would affect macro-economic trends.

The concept of ambiguity aversion provides a theoretical basis by which micro-economic actors behave differently under different institutional environments. When all micro-economic actors are affected, noticeable macro-economic trends may be observed. While ambiguity aversion has been discussed since at least the 1920's with Keyes (Davidson 1996), the theory was formalized by Ellsberg in 1961. Ambiguity Aversion theory states that human beings irrationally choose explicit risk scenarios when presented with a choice between un-tractable, *ambiguous* risk scenarios, and explicit, concrete risk scenarios (when probabilities of different outcomes are clear and tractable) which have the same payoff in expectation[1]. We might expect, via ambiguity theory, that investors faced with more ambiguous payoffs to investment would choose to invest less often than if their investment payoffs were less ambiguous. I propose that while institutions fundamentally drive economic growth, what matters most for economic growth is that a country's institutions provide stable, easily predictable economic environments with tractable risks and rewards. It follows that institutions which create ambiguous economic environments would experience more difficult growing. As will be discussed further, this theory does require that a country has democratically-driven economic and political institutions, and makes no specific policy recommendations beyond this "first principal" of less ambiguous economic policy environments, all else being equal.

The plan for this paper is as follows. Section II discusses in greater depth the literature which motivates my proposed theory. Section III formally defines the proposed theory, and explains the experimental design used to provide evidence for it. Section IV will present results from the experiment, while Section V will go through a series of robustness checks which qualify the main results. Lastly, Section VI will conclude with suggestions for future research and

[1] As a thought experiment, imagine you were given the choice of picking between two chance-based scenarios involving a coin flip. In both scenarios, which we will call A and B, respectively, if the flipped coin ends up being heads, you win $100. In scenario A, the coin being flipped is a fair coin, with 50% probability of a flip being heads. In scenario B, the probability of a flip being heads is unknown. Most people presented with a similar choice opt to select scenario A, and avoid the ambiguity present in scenario B, even though a perfectly rational actor would see that in both scenarios the expected payout is identical.

extensions to the experiment used, and some potential policy implications that come with the proposed theory.

Section II

In 2017, Haiti's GDP per capita, measured by Purchasing Power Parity (PPP) was $1,815 whereas US GDP per capita, PPP was $59,532[2]. Similarly profound wealth gaps exist between the United States, Western Europe, former British Colonies in the South Pacific and many countries in Sub-Saharan Africa. Some of the fastest and slowest growing countries in the world have much lower levels of GDP per capita (such as India and Zimbabwe, respectively). Political power is secured and lost, in both democratic and authoritarian regimes, on the realization, or lack thereof, of economic growth. With such large cross-country differences and societal implications, the field of economic growth theory has proved to be a fruitful ground for economic discussion and debate since the inception of economics.

The quintessential model for economic growth taught in most introductory and intermediate Macro-economic classes is the Solow Growth Model (Solow 1956). The Solow Growth Model has been a standard from which further neo-classical models have been developed, and comes with a well-known implication that countries with lower starting levels of income per capita grow faster, whereas countries with higher initial levels of capital grow slower, when preferences and resource allocations are similar across countries. In a cross-country regression analysis of countries' economic growth between 1960 and 1985, convincing evidence is found in support of Solow and later neo-classical models and the implications derived from them. Particularly, that GDP per capita growth is negatively associated with initial levels of GDP per capita, and positively associated with initial levels of human capital. Other empirical results relevant to this discussion include that measures of political stability are positively associated with growth (Barro 1991). With this later finding, however, empirical evidence is not available to assert with confidence if instability causes depressed growth or not. Interestingly, others have argued that the opposite causal relationship exists, with extreme poverty leading to political instability (Londragan and Poole 1990).

[2] Figures from the World Bank Open Data portal

These neoclassical growth models, while powerful and extremely useful for theorizing about the interplay between labor, capital and technology, and backed by empirical evidence, do not fundamentally explain why we observe such disparities between high-income and low-income countries today. If neo-classical growth models were taken as the truth and we assumed we were approaching some long-run equilibrium, would we not expect to have seen wealth differences between countries drastically decrease over time? While for some countries within certain regions this phenomenon has occurred (southern European countries converging to northern and western Europe wealth levels), for others, wealth disparities have steadily increased (sub-Sahara African countries) in comparison to the industrialized west. Many have postulated about the fundamental causes of wealth differences across different countries in a more qualitative, higher level manner. We now review two of the leading theories which address the large wealth differences across countries we observe today.

Jared Diamond proposes that geographic differences are what ultimately lead to the current wealth gaps between countries observed today. He argues that the large East-West nature of the Eurasian land mass contained better crops for agriculture and many more species of domestic-able mammals, all of which were relatively adoptable across the entire continent. This in turn led to a faster agricultural transition for Eurasia than in the Americas and Africa, who had less species of high-calorie grains available, and where developed agricultural products were not very adaptable across the largely varying continent climates (ie: The climates of Nanjing, China, and Nice, France are more compatible for agricultural exchange than Montreal, Canada, and Rio de Janiero, Brazil).

With a faster and more robust transition to agriculture, Eurasian populations urbanized more heavily, and participated in more cross-continental trade than the Americas. This, according to Diamond, lead to higher levels of disease exposure in Eurasia, which, when it came time for the continents to meet in the late 15^{th} century, led to more-developed European diseases ravaging native populations. Diamond also argues that European countries in particular built up superior levels of technology because of the high density of competing city states and nations due to significant geographic barriers on the European continent which prevented consolidation (borders like the Alps and Pyrenees mountain ranges). These nations could not afford to repress new technologies, as a neighboring adversary would adopt them to obtain a competitive

advantage. In other words, in Europe there was a greater competitive market for technological innovation, whereas in Asia, and particularly in China, technological innovation had no outlet if suppressed by hegemonic emperors (Diamond 1998).

Diamond's analysis paints a broad story, but it fails to capture significant details of the current wealth picture, and fails to successfully explain other historical evidence. For example, some of the wealthiest nations in the world (proxied by urbanization and population density) in 1500 were the Aztec and Inca civilizations in the America's, and some of the poorest areas were where modern day Australia and the United States are located (Acemoglu et al 2005). Additionally, we do not receive a coherent explanation as to why South Korea, one of the poorest countries in the world immediately after the Korean Civil War, currently has the 11th largest economy in the world while North Korea, its nearly identical neighbor in terms of linguistic, cultural and initial economic foundation, has progressed minimally (Chun 2018).

From Daron Acemoglu and James A. Robinson we receive a theory which explains both the broad strokes and the missed phenomena pointed out above. The pair concludes that the fundamental long-run drivers of economic growth are the economic and political institutions that govern a nation (Acemoglu and Robinson 2013). When economic institutions are inclusive, in that they provide opportunities for broad swaths of the population, protect private property rights, and allow for technological innovations, and political institutions are inclusive in that they allow for the inclusion of the population in the political process in a structured way, long run economic growth takes place. The "Reversal of Fortune" between the Americas and Europe was due to Europe developing more inclusive institutions, whereas extractive, colonial institutions were created in Central and South America (Acemoglu et al 2001, Acemoglu et al 2005, Rodrik et al 2004). In these colonial institutions, resource extraction was the only goal; since colonial empires did not want to be challenged politically, they had no incentive to allow new technological advances to occur as those driving advances would receive new economic power which in turn would create a rivalrous political power that threatens the extractive regime. With some countries having an institutional environment where technological advances were able to occur, when the industrial revolution arrived, select countries were able to take advantage of new economic opportunities, jolting decades, and in some cases centuries, ahead of countries with extractive institutions.

Multiple papers support both empirically and theoretically this claim that the presence of inclusive institutions governs long-run economic growth. Empirical evidence shows that sharp drops in economic growth after 1975 are attributable to divided societies (high income inequality, ethnic, racial or caste segmentation etc.) and weak measures of what Acemoglu and Robinson refer to as inclusive political institutions (Rodrik 1999). Other work shows that democratic governments are positively associated with economic growth (Milanovic 2005). Rodrik echoes Acemoglu et al's qualification of their theory as to how it applies to real world policy applications, noting that economic growth in the twentieth century cannot be seriously attributed to the successful application of a 'Washington Consensus'-style package of neoliberal policies. Rather, policy regimes that successfully adapt to a country's already existing societal structure and successfully promote "first-order economic principles" such as property rights, contract enforcement, sound money, etc., tend to be legitimate economic growth strategies (Rodrik 2005, Rodrick 2006). Institutions which successfully achieve higher-order economic principles, or goals for inclusivity, are those that succeed. How these aims manifest themselves in a policy package depends greatly on the individual country. There is no silver bullet for growth which can be applied across countries and across time. We now discuss how individuals make decisions when interacting with different institutional arrangements.

To get a better understanding of what may be more attractive to micro-economic actors across different economic environments it is helpful to review the literature on ambiguity aversion. Ellsberg found that people prefer conditions of defined risk versus *ambiguity. Ambiguity* being a situation where an agents' expected utility calculations are highly uncertain, whereas with risks those utility calculations are much more certain. The aversion part of the theory is that people empirically prefer non-ambiguous risk scenarios over ambiguous ones (Ellsberg 1961). Additionally, mbiguity aversion has been found to be a comparative phenomenon. In a series of empirical studies, subjects have been shown to only favor non-ambiguous events when directly comparing them to ambiguous alternatives (Fox and Tversky 1995). Interestingly, a so-called *uncertainty affect* has also been discovered in another series of behavioral experiments. Under certain conditions, people value a risky opportunity as a whole less than they value the opportunity's worst possible outcome when it is presented in isolation (Gneezy et al 2006).

Naturally the question arises whether or not a behavioral experiment calibrated to mimic decisions faced by micro-economic actors will be able to provide evidence for how ambiguity in a country's economic institutions affects economic growth. Lab experiments provide a rigorous and controlled way to analyze individual behavioral patterns from which causality can be directly interpreted (Angrist and Pishke 2014). Indeed, abstractions of more complicated behavioral decisions can be performed in the laboratory setting to still provide meaningful insight (Barron et al 2005). That being said, the results of an individual level experiment do not prove macro-results. It will mainly provide evidence for potential legitimacy of the theory, and as an indication that further empirical work should be performed to better investigate the proposed theory.

The framing of an ambiguity aversion behavioral experiment to closely proxy the decisions faced by micro-economic actors facing different risk environments has not yet been performed in the literature. Thus, analyzing micro-economic actors as they make investment decisions to understand how investment rates differ between ambiguous and non-ambiguous investment environments, would be a unique contribution to economics. The results of the experiment would, if found to be significant, open the door for further study, and provide another angle from which to analyze policies. They would suggest that a policy's potential ambiguity effect should be considered when economic growth is of concern.

Section III

III.1 Theory Proposal

Is it really the case that inclusive political economic institutions are the fundamental basis of long-run economic growth? Could there be some underlying, even higher-order, mechanism which inclusive economic institutions happen to usually possess which is the true driver of economic growth? Could such a mechanism be identified to better analyze recent growth under authoritarian regimes like Franco's Spain, Pinochet's Chile, and Park Chung-He's South Korea (Lieberman 2005, de la Escosura et al 2011, Valdes 1995, Huneeus and Sagaris 2007, Chun 2018)?

I propose that a fundamental mechanism for economic growth is having non-ambiguous economic and political institutions where risks are generally tractable and clear.

Note that the inclusive institutions proposed by Acemoglu et al would almost always be expected to deliver less ambiguous risk environments than extractive institutions, yet if an extractive regime created tractable economic expectations with potential for growth[3] we would perhaps expect to see more growth from that country. That is, countries grow more when individual gain is allowed, and the economic and political environment presents tractable, non-ambiguous risk conditions. Inclusive institutions simply happen to produce these pro-growth conditions much more reliably. In alignment with this proposed theory, high-order economic principles that Rodrik outlines are effective because the make economic risk more tractable and less ambiguous[4]. The proposed theory does not contradict these leading institutional theories, rather it provides a higher-order mechanism which explains why they are affective.

Ambiguity aversion, being a behavioral phenomenon, is primarily expected to affect micro-economic actors within an economy. As a result, if the ambiguity affect is to affect overall economic growth, it would do so through the influence it has on the decisions that microeconomic actors make when deciding when to invest in either physical or human capital. This leads to the use of a behavioral experiment to determine if ambiguity aversion materially affects microeconomic actor's willingness to invest.

III.2 Description of the Experiment

A behavioral experiment was conducted using a Qualtrics[5] survey distributed to subjects via Amazon's Mechanical Turk platform. The population completing tasks on the platform tends to be younger, more unemployed, and more highly educated than the general global population. The large majority of "Turkers" are from the United States and India (Ross et al 2010). It is possible recruit high-quality subjects (attentive and responsive) through Mechanical Turk's

[3] It is possible to have tractable economic expectations, where expectations are set to zero or negative levels of utility for economic risk takers. One may point to North Korea as an example, or colonial institutions in Latin America and Africa. This is notably a trivial, and not-particularly interesting case as economic agents would optimize by simply not taking risks or investing in businesses or research.
[4] Strong, rigorous contract enforcement and private property rights allow micro-economic actors to operate without the ambiguity of bribe-based licensing and variable IP and contract enforcement, or the ambiguity of whether or not the next day their investments will be expropriated.
[5] Appendix section 1 contains information on how to view the survey in its entirety.

Master specification[6] and a rigorous experimental design[7]. Collecting relevant demographic data on the Turkers to better understand how the different sampled backgrounds could have affected the results is also straightforward (Goodman et al 2013 and Paolacci et al 2014). The subject pool I was able to obtain from Mechanical Turk is larger and more diverse than what I would have been able to obtain from the Wharton Behavioral Lab. Importantly, multiple key experiments which used Mechanical Turk have had their results successfully replicated within a lab setting (Berinski et al 2012).

It was estimated that the survey would take between 5 and 10 minutes to complete. Average response time was roughly 4 minutes, and compensation for participating in the study was $1.00. This is far above the estimated median hourly Mechanical Turk wage of roughly $2/hour (Hara et al 2018). Apart from the question of interest, subjects provided basic demographic information which includes Sex, Income, Country of Origin, Industry of Occupation, Employment Status, as well as information about their Mechanical Turk usage.

In the experiment's question of interest, subjects were asked to make a decision within a risk environment. For this decision subjects were presented with the option to "work", for which they would receive a guaranteed $10.00 payout, and the option to "invest", for which they would receive a payout from a probabilistic scenario determined by their treatment. All treatment options had an investment payout of $11.00 in expectation. Subjects were told they had a 10% chance of their work vs. invest choice being carried out and rewarded as a bonus payment. In the reviewed literature, random bonus allocation is a common way to illicit genuine responses from participants, while being efficient with finite research funding. Since the bonus payment represents approximately 5 hours of work time for the median workers, it provides a non-trivial incentive to take the question of interest seriously[8].

[6] From https://www.mturk.com/worker/help, on what a mechanical Turk Master Worker is: "These Workers have consistently demonstrated a high degree of success in performing a wide range of HIT[Human Intelligence Task]s across a large number of Requesters."
[7] In the experiment deployed, respondents were asked an attention-capture question to ensure that they were actually reading through questions as opposed to selecting random response. 17 respondents failed the attention-capture questions and were removed from the study results.
[8] Likely representative of how significant this incentive was, one worker emailed me a thank you directly after receiving her bonus.

The question of interest generally reflects the decisions made by a microeconomic actor, albeit on a much smaller scale. Microeconomic actors often can choose between continuing on a guaranteed, well known path like continuing to work an hourly, entry level retail job, or making an investment with some unknown but generally higher payout later on. In this case, the entry-level retail employee might have the opportunity to invest in their education. As an example within developing countries, the more guaranteed payout might come from continuing to work on the family farm, whereas the risky investment would be moving into the city to open a new small business. While there are clear limitations in extrapolating from a survey question which people generally spend less than one minute thinking about, to decisions which potentially months and years of reflection go into, the question accurately captures the general decision *form* which microeconomic actors frequently face.

Subjects were randomly exposed to one of four treatment types. Treatments varied along two different conditions, each with two different dimensions. The first condition, which we will refer to as the loss structure, had to do with whether or not the investment had a potential loss associated with it. That is, whether or not if the worst-case scenario in the investment was realized, the payout from choosing to *work* was higher. We refer to the treatments where the worst-case investment outcome is worse than the *work* alternative as Potential Loss (PL) treatments. Treatments where the worst-case investment outcome is better than or equal to working is referred to as Always a Winner (AW). The second condition, which will be referred to as the risk structure, defines whether the investment has a non-ambiguous payout structure or an ambiguous one. The Non-Ambiguous payout (NA) structure is one where the investment payout is defined for subjects as yielding X payout with 50% chance, and Y payout with 50% chance. In this treatment, the payout is not ambiguous, clearly tractable, and it is easy for subjects to calculate expected returns. On the other hand, in the Ambiguous payout (A), the investment payout is defined for subjects via the provision of the "results" of the previous 20 people who invested. Subjects are shown a random list of numbers from an underlying density function. This is an ambiguous risk scenario, with no tractable way of defining expected outcomes.

All treatments have one of the loss structures, and one of the risk structures as traits. Differences across treatments are summarized in Table 1. Figure 1 contains shows the four treatments as seen by subjects in the survey.

Investment Treatment Matrix	**Potential Loss (PL)**	**Always a Winner (AW)**
Non-Ambiguous Payout (NA)	PL-NA	AW-NA
Ambiguous Payout (A)	PL-A	AW-A

Table 1: Treatment Matrix. Each subject faced one of the four treatments described when making their decision to work or to invest.

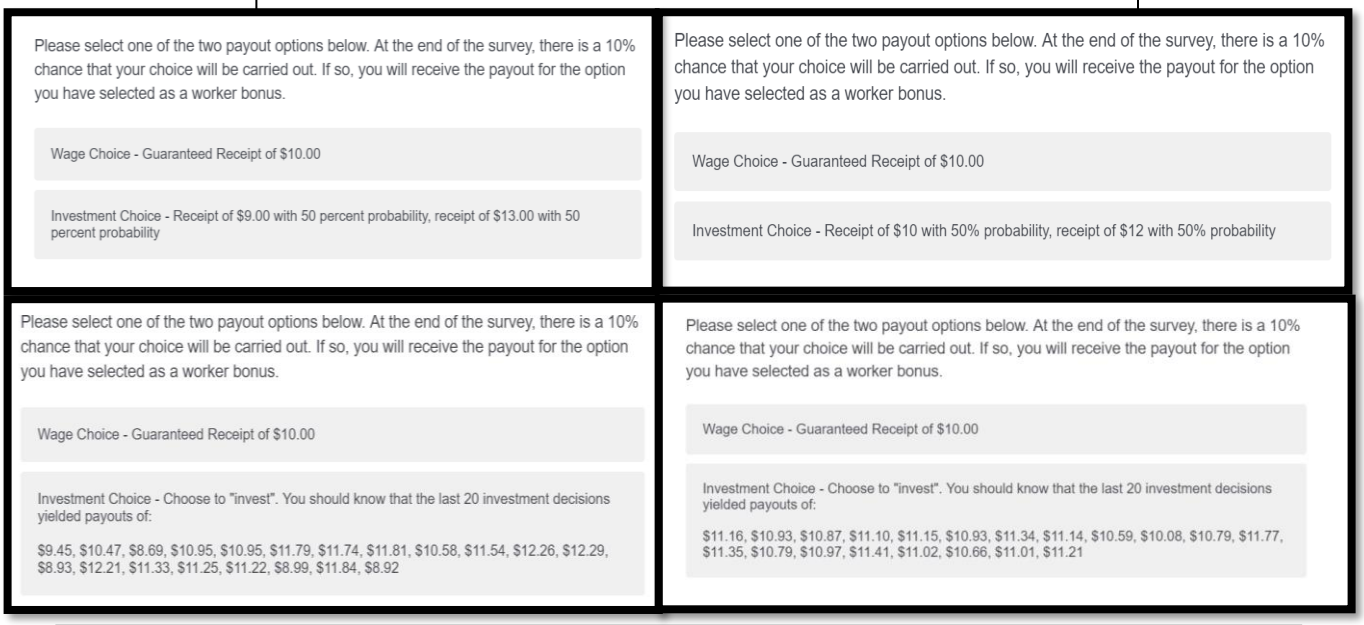

Figure 1: What the survey question of interest looks like for each treatment type. From left to right and top to bottom we have screenshots of the PL-NA, AW-NA, PL-A, and AW-A treatments.

Before running the experiment, I had three hypotheses as to how people would respond to the different treatments:

1. Those facing ambiguous risk environments would choose to invest at a lower rate than those facing non-ambiguous risk environments. That is, there is an ambiguity effect present.
2. Those facing loss structures with potential loss would choose to invest at a lower rate than those facing loss structure where they are always going to win. That is, the ambiguity effect is exaggerated when potential losses are involved
3. When faced with treatment which is non-ambiguous and there is no downside to investing (AW-NA), subjects will invest nearly 100% of the time.

Section IV:

Over the course of March 14th to April 4th, 415 valid[9] subjects participated in the study via the Mechanical Turk platform. Subjects were randomly assigned to the four different treatments, and distribution across different treatments was balanced. 102 subjects had AW-NA as a treatment, 109 subjects had AW-A as a treatment, 104 subjects had PL-NA as a treatment, and 100 subjects had PL-A as a treatment. Of all the valid participants, 55 ended up randomly receiving bonus payments, for a bonus payout rate of approximately 13 percent.

Because this was a randomly assigned trial, we can make these casual statements within the confines of this experiment. On the other hand, extrapolating causality to other experiments and real-world scenarios is not appropriate, as will be discussed more in the conclusion.

The core question of interest when analyzing the produced results is whether treatment caused different rates of investment. To test the articulated hypotheses from Section III, a bootstrapped comparison of means test was employed. Bootstrapped statistics are calculated by repeatedly sampling with replacement observations from the original data set and calculating a statistic of interest with each sample. These aggregated statistics, when compiled over asymptotically large samples, can be used for valid statistical inference (Berk 2008).

For this study results from two different treatments were compared. For each round of the bootstrapped statistic generation, samples were drawn with replacement from observations within each treatment. Then, from those samples, it was determined whether one treatment had a higher proportion of investment decisions than the other treatment. This is repeated for 10,000

[9] A "valid" subject is defined as one that passed the attention-capture question.

total rounds, providing statistical evidence for whether or not one treatment had its subjects invest more often than the other treatment. We now turn to the principal experimental results.

From our data, and using the bootstrap technique described above, there is moderately strong statistical evidence that PL-NA causes a higher population level investment rate than the PL treatment (P-value: 0.0511). Evidence that AW-NA causes a higher investment rate than the AW-A is present, but weaker, significant at the 0.1 level. Below in Figure 2 is a graph showing the different investment proportions versus treatment. The bar chart shows visually what the bootstrapped statistics were describing: that the ambiguity affect appears to be slightly stronger when potential losses are involved.

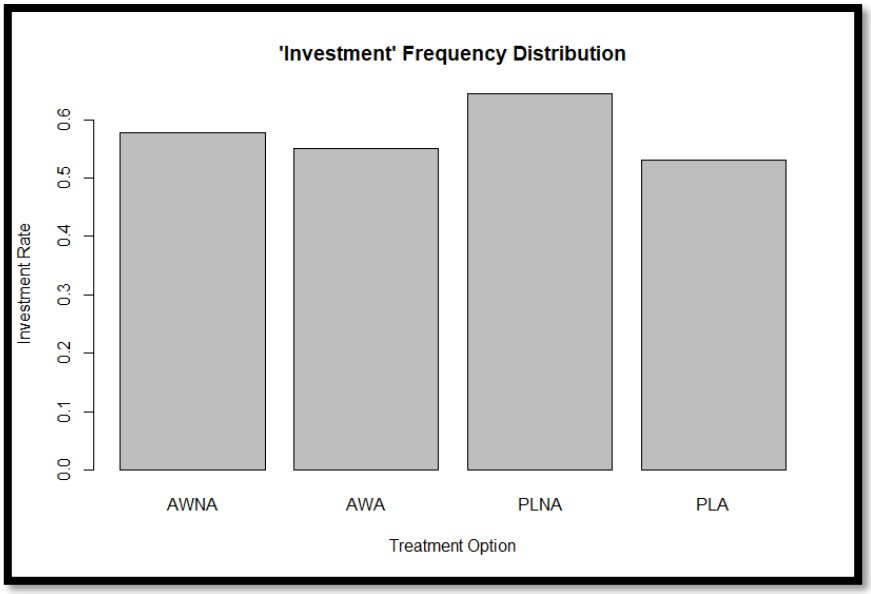

Figure 2: Investment frequency rate versus Treatment option. The ambiguity affect is noticeably larger with the Potential Loss (PL) loss structures than with the Always a Winner (AW) loss structures.

These results provide strong evidence for hypotheses one and some evidence for hypothesis two. We see that ambiguous risk structures lead to a lower proportion of the subject population investing, and that this affect is somewhat stronger when potential losses are involved. Very interestingly, in the AW-NA treatment, less than 60% of participants chose to invest. This completely refutes hypotheses three. It appears that people are behaving quite irrationally when faced with this treatment. While not the exact same scenario, this result supports those found by Gneezy et al 2006 in that when there is a risk involved, people will value the risky scenario less than they value the worst case outcome in isolation. The principal difference is that in my

experiment, subjects could directly compare the AW-NA investment option with the Work option, as opposed to Gneezy et al 2006 where this irrational behavior was only observed when options were shown to subjects in isolation. It is possible that if the AW-NA question was framed differently, with the investment option described as "Receipt of $10.00, with a 50% chance of an additional $2.00 bonus", then response to this treatment would be more in alignment with hypothesis three.

The following section assesses the robustness of these primary results to different potential concerns. Exploratory data analysis of the demographic data is discussed further in Section V.2 and in part 2 of the appendix.

Section V:

V.1 Robustness to Time Spent on Question of Interest

A primary concern while exploring the survey results was that a non-trivial amount of respondents were answering the question of interest in so little time[10] that it was highly improbable that all subjects were fully reading the question, and then thinking seriously about their response. These hasty subjects very well may be randomly selecting responses, adding noise to the underlying trend, or they may be systematically choosing a single option in the question of interest (say by always selecting the option that appears first). The primary analysis was repeated after removing from the data set any subject who answered the question of interest in less than 10 seconds. This resulted in 37 observations being dropped from the dataset.

[10] Qualtrics allows users to monitor how long a subject takes on a given survey page. Using this feature, I was able to monitor how long subjects took to answer the question of interest.

In Figure 3, we see continued graphical evidence of the trends observed in the main results. The statistical results from the bootstrap also replicate. PL-NA treatment causes a higher proportion of investment than PL-A treatment (P-Value: 0.0455), with evidence for the same relationship between AW-NA and AW-A, albeit still at the 0.1 level.

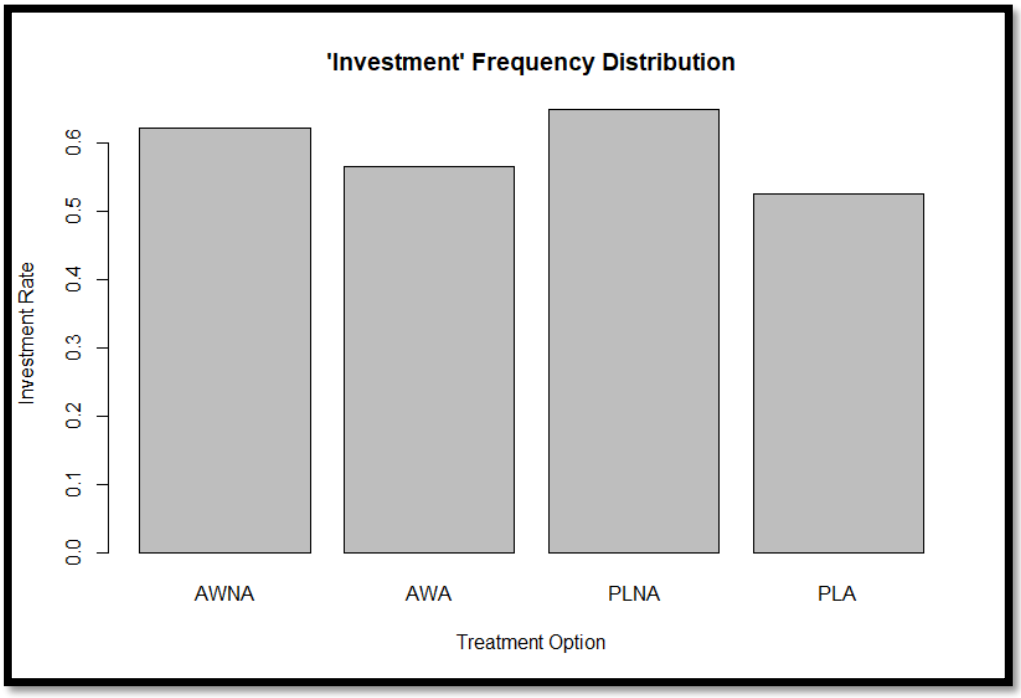

Figure 3: Investment frequency rate versus Treatment option, with only subjects that took more than 10 seconds to answer the question of interest included. The ambiguity affect is still noticeably larger with the Potential Loss (PL) loss structures than with the Always a Winner

Continuing in this vein, the primary analysis was repeated after removing from the data set any subject who answered the question of interest in less than 15 seconds. This resulted in 103 observations being dropped from the dataset. While the graphical results seen in Figure 4 seem to show slightly less noise within the AWNA and AWA treatments, this cutoff forced out nearly a quarter of our sample, reducing our statistical power and leaving no evidence of statistically significant differences between the previously discussed treatment pairs. Interestingly, with noisier responses removed, we see graphically that there does not appear to be a difference in the ambiguity affect between the different loss structures employed in treatment. Still excluding any responses to the question of interest who answered in less than 15 seconds, when we test whether investment rates are higher in all ambiguous treatment results compared to all non-ambiguous treatment results, the bootstrap produces evidence that the ambiguity affect still exists (P-value:

0.0641). Running this same test with the entire data set yields stronger evidence for the ambiguity effect (P-value: 0.0189).

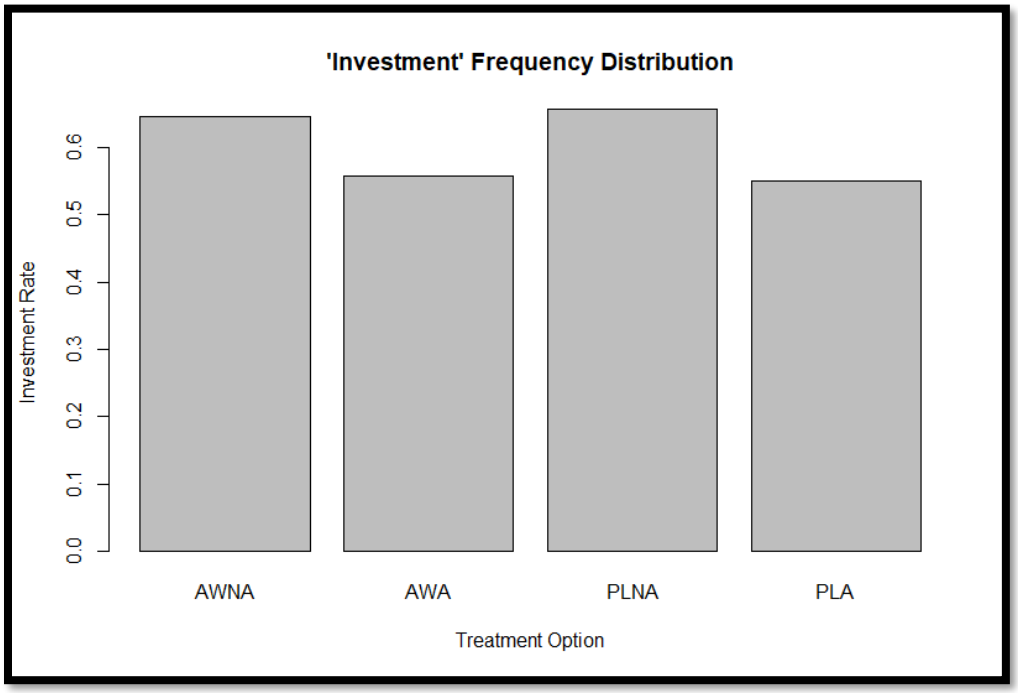

Figure 4: Investment frequency rate versus Treatment option, with only subjects that took more than 15 seconds to answer the question of interest included. The ambiguity affect appears to be virtually equal between Potential Loss (PL) loss structures than with the Always a Winner (AW) loss structures.

V.2 Robustness to Sex Distribution Differences

Another potential concern with the analysis is that different proportions of males and females across treatments may be driving the observed differences in treatment effects due to males opting to invest more aggressively than females. This phenomenon has been documented in the literature, and now I assess the prominence and relevance of this gender effect on the results (Bajtelsmit and Bernasek 1996). Across all treatments, roughly 55% of the study participants were male.

Complete OLS Linear Regression Model Specification:
$\gamma = \tau * \text{Treatment} + \beta X + \epsilon$

γ = Probability of Investment
τ = Treatment Effect Coefficients
β = Control Variable Coefficients
X = Control Variables
ϵ = Error Term

Figure 5: Regression specification used for assessing the affect of treatment at the individual level, and for assessing the effect of Sex on individual investment decisions.

A regression analysis of the gender effect on an individual's probability of investing is run with the specification as seen in Figure 5. The control variables included in the analysis are answers to how Mechanical Turk money affects their lifestyle, employment status, and household income questions. Treatment effect coefficients are a vector of length 4, and the *Treatment* term is a vector of length 4 which is one-hot encoded to represent the treatment received by the specific subject. Table 2, below, contains the output from this regression model.

	Probability of Investment		
	(1)	(2)	(3)
AW-NA	0.028	0.009	0.001
	(0.068)	(0.068)	(0.069)
PL-A	−0.020	−0.029	−0.044
	(0.069)	(0.068)	(0.069)
PL-NA	0.094	0.085	0.077
	(0.068)	(0.067)	(0.068)
Male		0.128***	0.151***
		(0.049)	(0.050)
Constant	0.550***	0.489***	0.353***
	(0.047)	(0.052)	(0.105)
Controls	No	No	Yes
Observations	415	415	415
R^2	0.008	0.024	0.100
Residual Std. Error	0.495 (df = 411)	0.491 (df = 410)	0.484 (df = 389)
F Statistic	1.045 (df = 3; 411)	2.522** (df = 4; 410)	1.731** (df = 25; 389)
Note:			*p<0.1; **p<0.05; ***p<0.01

Table 2: Regression model output. The first regression model (from left to right) includes only treatment variables, the second regression adds a control variable for subject sex, and the third regression adds the rest of the model's controls.

We note several things from the regression output. While the main analysis provides statistically significant evidence for population differences in proportions of investment across the different treatment pairs, we find no evidence that treatment has a statistically significant impact on an individual subject's probability of investment. This is an important qualification for understanding the main results. Of additional interest, when a dummy variable for sex is included in the regression along with the other controls, there is strong statistical evidence that being Male, all else being equal, increases the probability that an individual will choose to invest by 15 percentage points.

This result adds to previous evidence in the literature that men are more likely to be 'aggressive' and invest at a higher rate than women. At the same time, this outcome raises a concern about the population results; if a higher proportion of men comprised those that received ambiguous treatments versus the non-ambiguous treatment groups, it would invalidate the population results. In the side-by-side comparison, seen below in Figure 6, between investment rates versus treatment and proportion male versus treatment, it can be seen that within our data this is not actually a concern. In fact, significant population differences in investment proportions appear to have emerged, *despite* the fact that the PL-A treatment had a much lower proportion of males than the PL-NA treatment. If anything, had sex proportions been more equal across all groups, we might expect to have observed an even stronger population-level ambiguity effect.

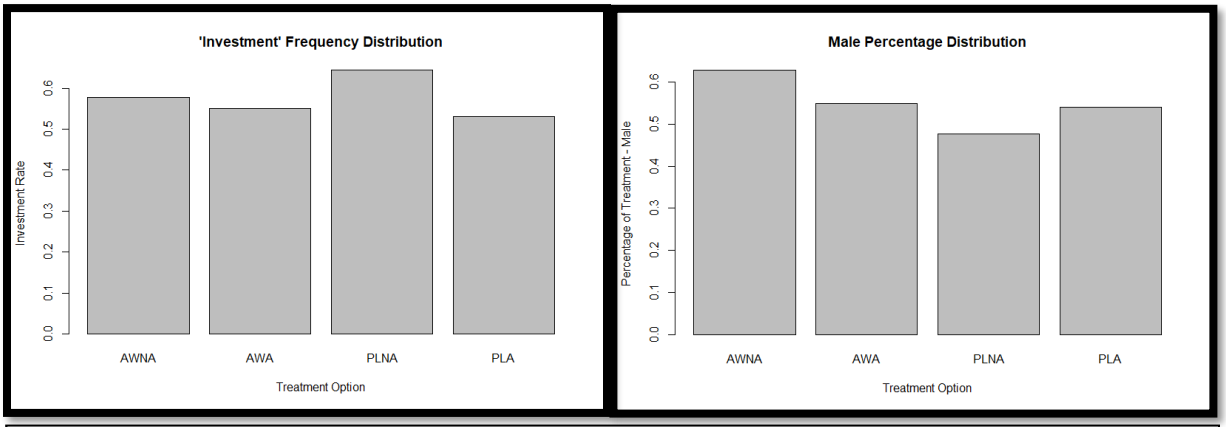

Figure 6: The histogram on the left shows the investment rate versus treatment group, whereas the histogram on the right shows the proportion of the treatment group that is male vs. treatment group. If gender distributional issues were impacting the global results, we would expect the two histograms to qualitatively have the same shape. That the treatment with the highest investment rate is also the treatment with the lowest percentage of male subjects, provides further evidence for the population-level ambiguity affect.

A complete description of population characteristics by treatment is presented in section 2 of the appendix.

Section VI:

In this thesis I motivated a proposed theory for why certain institutions are good for economic growth, and why others may not be so great. The proposed, higher-order theory is that economic and political institutions that provide tractable, clearly defined risks promote investment and economic growth whereas institutions that create ambiguous risk environments tend to under perform.

This proposal does not contradict leading institutional theories, rather it provides a higher order explanation for why countries with inclusive institutions have in generall greatly outperformed countries with exclusive institutions (Acemoglu and Robinson 2013). This higher order explanation more comfortably explains why certain countries over the past 70 years have been able to produce large amounts of wealth despite having what is traditionally thought of as extractive institutions. Neither does the proposed theory contradict work which advocates for policies and institutions adapted to local culture and societal structure to protect fundamental economic principles of private property, and contract enforcement, among others (Rodrik 2005, Rodrick 2006). Inclusive economic and political institutions, and securing fundamental economic principles both generally work, I would argue, because they successfully reduce ambiguous risk in the economic environment of the country[11]. With less ambiguous risk we might expect that a

[11] Consider the following thought experiment involving two new small businessowners living in different countries, where country Y has more inclusive economic institutions and country Z has more extractive economic institutions. Let us think of the new small business owner in country Y. To open her new business, she needs to obtain the requisite licenses, which all have fixed, publicly listed fees, collect sales tax on every sale at a fixed rate, and pay taxes at a rate commiserate with her company's income. Now we think of the new small business owner in country Z. To open her new business, she needs to obtain the requisite licenses, which will require bribing multiple local officials, and every once and a while she will need to pay local law enforcement to continue operating. We assume for simplicity that in expectation, both business owners will end up paying the same percent of their gross revenue to become licensed and remain open. We also assume that each business owner receives the same amount of direct transfers from their respective countries. At this point, what is it at this point that a rational economic agent would prefer about country Y to country Z? What makes people in general so much more likely to invest in country Y, than in country Z is that costs in country Y are clear, whereas in country Z they are ambiguously charged.

country's micro-economic actors as a whole would be more likely to make the growth-favoring choices of investment than when in an ambiguous environment.

Through the recruitment of subjects via Amazon's Mechanical Turk platform, I ran an experiment to collect empirical evidence for this theory. Subjects were placed within one of four treatments, which each had different combinations of loss and risk structures. Robust evidence was found in support of the hypotheses that ambiguous risk environments lead to less investment, even when the investments have an expected positive return even in their worst-case outcome. This effect is referred to as an *ambiguity effect.* Inconclusive evidence was produced over whether or not the ambiguity effect is larger when potential losses are involved. Lastly, the final hypothesis that subjects would nearly always choose to invest under the AW-NA treatment ended up being debunked. Even in this treatment, subjects only chose to invest slightly more than 60% of the time, despite the investment only having a clearly defined risk of in the best case receiving extra money, and in the worst case ending up no worse off than if they had chosen the work option.

Given these results, some implications, limitations, and potential areas for future research are now discussed.

This paper and the proposed theory of economic growth does not suggest a specific policy package geared towards economic growth. Rather, it presents another tool with which policymakers can analyze the potential effectiveness of a proposed package fine-tuned to their country's unique societal and cultural underpinnings. If two alternative policies are being proposed, following the ambiguity theory proposed, all else being equal, the policy which is perceived as creating a less ambiguous economic risk environment is likely the better choice. In a democracy, perhaps this yields an argument for policies which are formed via multi-party compromise. Such policies, which are less extreme, are more likely to be perceived as permanent changes due to the fact that when the power balance between competing ideologies and political

By considering the ambiguity effect, we have arrived at the root of why public corruption, an extractive institutional arrangement, may disincentivize investment.

parties shifts, they are less likely to be drastically changed as opposed to politically extreme policies.

In terms of the study's inherent weaknesses, empirical, microeconomic experiments cannot be cleanly extrapolated to explain macroeconomic trends. While this paper does not provide evidence of a macro-economic level ambiguity effect, its results do suggest that additional research on the proposed ambiguity affect as it relates to economic growth would be valuable. In addition to improving upon the experiment employed in this paper to address potential concerns[12], some macro-focused, econometric studies may be able to find evidence of the ambiguity effect. One potential example might involve analyzing stock market performance before and after close congressional elections in the US. Vast uncertainty in policy forecasts for the following several years is greatly dispelled after an election, and the financial sector may respond accordingly to the dispersion of this ambiguity. Another potential study would be to see if the indecisive aspect of the Brexit process, which creates and has created an ambiguous business climate for the past several years, negatively impacts the UK's GDP per capita above and beyond the economic impact from exiting a valuable trade union. For such an analysis, Brexit could be compared to other countries which have exited trade unions more cleanly in the past.

[12] Potential alterations to the deployed experiment include replicating it in a behavioral lab setting or with subjects that more closely mirror a global profile of microeconomic actors, increasing the seriousness of the question of interest by increasing the potential payout associated with it, and increasing the spread between the investment and work options (a decision with differences in payouts being $10 in expectation versus $1 in expectation would be potentially illicit more serious, well contemplated responses). Another way to illicit more serious responses could be to construct scenarios around the question of interest. For example, it could read "You are graduating from a degree program. You have a job offer for X, but if you stay for another year and complete additional coursework, the job offer you might receive could be Y with 50% probability, or Z with 50% probability." Such a description may put more emotional weight behind the question of interest, and potentially makes the question mimic decisions made in the real world more closely.

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Appendix:

A.1

To ensure replicability and of the results discussed within this paper, all collected data, survey code, analysis code, and bonus distribution code has been posted to the publicly available GitHub repository at https://github.com/bengooNETS/ECON-300-Thesis-Work.

A.2 Assessing Overall Demographic Balance

A key concern is that, although the sample size received was large, there might be demographic imbalances driving the observed results. While of primary concern was sex imbalance, which was addressed in the robustness section, other demographic data was collected to fully address potential imbalance concerns. Some random variation exists in demographic distribution, but any observed differences appear to be randomly distributed, and not the result of any particular systemic biases or patterns that are a cause for concern. Two trends that stand out in the data is 1) that across all treatments no more than 15% of all subjects has only a high school diploma or less, meaning that the Mechanical Turk population is much more highly educated than the U.S. as a whole, and 2) that less than a quarter of all subject respondents are not materially impacted by the income they receive from Mechanical Turk.

This demographic information may be valuable for future studies which are wondering whether Master Turkers are a demographic group which provides a valid sample for a desired population. Full demographic data across treatment groups can be found in the tables below.

Table 3: Subject Age Distribution by Treatment

Treatment	18 - 24	25 - 34	35 - 44	45 - 54	55 - 64	65 - 74	75 - 84
AW-A	0.0092	0.31	0.32	0.2	0.092	0.055	0.0092
AW-NA	0.0098	0.4	0.34	0.18	0.049	0.02	0
PL-A	0.04	0.45	0.3	0.1	0.09	0.02	0
PL-NA	0.038	0.36	0.36	0.14	0.077	0.029	0

Table 4: Subject Country Distribution by Treatment

Treatment	Another Country	Canada	India	The United States
AWA	0.0092	0.0092	0.17	0.82
AWNA	0	0.0098	0.14	0.85
PLA	0.03	0.01	0.1	0.86
PLNA	0.0096	0.0096	0.16	0.82

Table 5: Subject Employment Status by Treatment

Treatment	FT	Disabled	Not Seeking	Unemployed	PT	Under	No answer	Retired
AWA	0.71	0.0092	0.028	0.046	0.14	0.037	0	0.037
AWNA	0.76	0.02	0.049	0.0098	0.14	0.0098	0	0.0098
PLA	0.79	0.01	0.02	0.03	0.09	0.02	0.02	0.02
PLNA	0.7	0.0096	0.0096	0.029	0.21	0.0096	0.0096	0.019

Table 6: Subject Household Income by Treatment Part 1, Lower Bound Inclusive, Upper Exclusive

Treatment	< $10k	$10k-$20k	$20k-$30k	$30k-$40k	$40k-$50k	$50k-$60k
AWA	0.12	0.083	0.17	0.16	0.11	0.055
AWNA	0.049	0.11	0.11	0.2	0.17	0.12
PLA	0.05	0.11	0.12	0.15	0.11	0.12
PLNA	0.067	0.14	0.16	0.12	0.067	0.067

Table 7: Subject Household Income by Treatment Part 2, Lower Bound Inclusive, Upper Exclusive

Treatment	$60k-$70k	$70k-$80k	$80k-$90k	$90k-$100k	$100k-$150k	$150k <
AWA	0.073	0.046	0.073	0.018	0.083	0.018
AWNA	0.078	0.059	0.029	0.029	0.059	0
PLA	0.06	0.12	0.05	0.02	0.07	0.02
PLNA	0.087	0.067	0.038	0.067	0.077	0.029

Table 8: Subject Industry of Work by Treatment

Treatment	Construction	Gov.	Professional	Other	Transportation	Retired	Sales	Service	Unemployed
AWA	0.028	0.046	0.32	0.15	0.046	0.037	0.1	0.2	0.073
AWNA	0.02	0.0098	0.33	0.088	0.078	0.02	0.19	0.21	0.059
PLA	0.06	0.06	0.25	0.11	0.06	0.02	0.23	0.14	0.07
PLNA	0.038	0.048	0.28	0.12	0.067	0.019	0.22	0.16	0.038

Table 9: Subject Necessity to Make "Ends Meet" with Mechanical Turk Income by Treatment

Treatment	Only Extra Spending $	No Necessity	Always a Necessity	Sometimes a Necessity
AWA	0.28	0.22	0.24	0.26
AWNA	0.37	0.18	0.19	0.26
PLA	0.38	0.21	0.21	0.2
PLNA	0.36	0.21	0.18	0.25

Table 10: Subject Frequency of Use of Mechanical Turk

Treatment	2-3 times a week	4-6 times a week	Daily	Once a week	Once or twice a month
AWA	0.092	0.27	0.62	0.018	0
AWNA	0.088	0.35	0.56	0	0
PLA	0.14	0.28	0.57	0	0.01
PLNA	0.077	0.23	0.67	0.0096	0.0096

Table 11: Subject Time spent on Mechanical Turk Each Day They Use a Platform

Treatment	1-2 hours	3-4 hours	30-60 minutes	5-6 hours	< 30 minutes	7 hours <
AWA	0.37	0.25	0.1	0.14	0.028	0.12
AWNA	0.25	0.34	0.13	0.14	0	0.14
PLA	0.28	0.27	0.11	0.11	0.06	0.17
PLNA	0.23	0.35	0.087	0.19	0.029	0.12

Table 12: Subject Education Level by Treatment

Treatment	Associate's	Bachelor's	PhD	H.School Grad.	< H.School Grad.	Master's	JD or MD	Some college
AWA	0.11	0.45	0	0.12	0.0092	0.15	0.028	0.14
AWNA	0.13	0.46	0	0.12	0.0098	0.12	0	0.17
PLA	0.13	0.45	0.01	0.1	0	0.09	0	0.22
PLNA	0.17	0.36	0	0.11	0	0.16	0.0096	0.19