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The Settlers of Catan and a Study of Trade in Non-cooperative Games

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Abstract

Free trade has long been hailed as the world's answer to increased competitiveness, greater overall wealth and a higher standard of living. Adam Smith's ideas on the foundations of capitalism assert that open market policies lead to global economic growth, and conversely that protectionist measures stunt growth and inflate prices. Critics argue that protectionism helps protect developing markets and industries and prevents unfair competition. But in the debate over trade which economic policy is actually best?

To answer this question I conducted an experiment using the board game, *The Settlers of Catan*, as an economic model. I isolated trade as a variable and looked at what effect the frequency and magnitude of trade had on resource and point accumulation within the game. I collected data for 10 games where trade was allowed and 10 games where it was forbidden, attempting to identify an empirical contrast between the two versions.

What I found is that no-trade games consistently out produced free-trade games in terms of both point and resource accumulation, and that there was no correlation between trade and either total points or total resources. I also found that despite being given the option to trade, players would frequently reject seemingly fair offers and instead pay a higher price for resources through the in-game bank. I reasoned that this behavior was a result of players trying to maintain or extend their competitive advantage, which they were able to do by maximizing their utility, or value gained, for the game as a whole rather than at any one specific stage in the game. This explains why trading was so rare and why no-trade games outperformed full-trade games in the experiment.

The significance of this result can be especially felt in the labor market, where labor is a resource traded by workers to their employers. I use the recent NFL and NBA lockouts as case studies to show how utility maximization behavior can be applied to real world economic situations.

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Preface

Games are an ancient pastime and occupy a special place in every culture in the world. From the Roman Coliseum to the Olympics to the high-stakes poker tables in Las Vegas, games provide a pleasant distraction from the everyday life and help bring diverse communities and cultures together.

But games can serve an educational purpose, too. Today's most popular board games, such as *Monopoly* and *Risk,* can teach us about risk management, resource allocation and negotiation. But one other game has the potential to teach us even more about how individuals approach basic economic problems: *The Settlers of Catan*.

The Settlers of Catan, once dubbed the "great board game of this era," is an increasingly popular multiplayer game that features three or more players competing on a fictional island in a battle for survival and supremacy. Unlike most battles, however, this battle involves no guns or soldiers. Instead, the weapons at each player's disposal are resources, which they may use to trade, build and expand.

The three central aspects of the game are, not incidentally, three of the most important facets of modern economics. Trade especially is the foundation of today's capitalist system, and around which all market activities are dependent. We see how trade functions in the real world—facilitating the exchange of goods between buyers and sellers—but how

does trade work in *The Settlers of Catan*? Could the game serve as a valid economic model for examining how individuals behave when given the option to trade, and how they behave when that option is taken away? What could this simple game tell us about one of the most studied topics in economics?

This paper will attempt to answer these questions, in addition to many others. By constructing a simple experiment around *The Settlers of Catan* I will attempt to empirically show a relationship, or lack thereof, between trade and success in the game.

In the first chapter, Literature Review, I will look at recent and relevant studies in the fields of game theory, experimental economics and international trade theory. These three fields comprise the backbone of the overall study.

In the second chapter, The Settlers of Catan, I will introduce the game at the center of this study and validate it as a functioning economic model by comparing aspects of game play to real world principles.

In the third chapter, The Experiment, I will discuss the inspiration for the study and how I organized an economic experiment to isolate trade in the game.

In the fourth chapter, Data and Discussion, I will present the data collected in the experiment and then discuss its significance and

relevance to prior and future economic ideas. I will also discuss potential sources of experimental error.

In the fifth chapter, Case Studies, I will look at two real-world situations and attempt to show how my experimental findings can be applied to the labor market. I will then present my conclusions by summarizing my findings and exploring questions for future study.

1. Literature Review

This study will touch on various aspects of game theory, experimental economics and international trade theory. Each of these disciplines has its own place in economic literature, but together they can help paint a vivid picture of modern economics with tremendous implications for the real world.

Before introducing the game and experiment that will be the focus of this study, it is helpful to first review what ideas and theories already exist. It will then be possible to build on past research and present new ideas.

1.1. Game Theory

Games have been a part of civilization for as long as anyone can remember, but it wasn't until the early 20th century that the world's greatest mathematicians realized that game theory might have an application to economics. The Hungarian mathematician John von Neumann is best known as the father of modern-day game theory thanks to his iconic 1944 study, *The Theory of Games and Economic Behavior.*[1] Von Neumann and the economist Oskar Morgenstern looked at parlor games like chess and poker and speculated that the theory of games might have an application to economics. They are together credited with

[1] John von Neumann and Oskar Morgenstern: *Theory of Games and Economic Behavior*, Princeton University Press (1944)

introducing the min-max theorem, which provides a way for players in zero-sum games to minimize their utility losses (or maximize their utility gains).

Perhaps the man most responsible for turning game theory into a serious discipline is John Nash. Nash, while as a student at Princeton University, came up with a theory for games in which there was a possibility of mutual gain. His first paper, "The Bargaining Problem," published in *Econometrica* in 1950 explained his reasoning:

> A two-person bargaining situation involves two individuals who have the opportunity to collaborate for mutual benefit in more than one way…no action taken by one of the individuals without the consent of the other can affect the well-being of the other one. A 'solution' here means a determination of the amount of satisfaction each individual should expect to get from the situation, or, rather, a determination of how much it should be worth to each of these individuals to have this opportunity to bargain.[2]

This one-on-one bargain is at heart of the capitalist marketplace, where individuals, governments and corporations come everyday to exchange their goods. Yet, there was no economic principle to demonstrate how the bargain might work and which party would reap the most benefits.

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[2] Nash, *The Bargaining Problem*

Nash was not the first to attempt to address this problem. Francisco Edgeworth, an Irish philosopher and political economist, speculated that "parties to a bargain were acting on the expectation that cooperation would yield more than acting alone".[3] Nash took this idea and, using the axiomatic approach, reasoned that how two individuals split the gain in a trade depends entirely on how much the deal is worth to each individual. Nash postulated that a unique solution existed that maximized the product of the players' utilities on "the notion that the bargain depended on a combination of the negotiators' back-up alternatives and the potential benefits of striking a deal".[4]

Nash was also responsible for introducing the "Nash equilibrium point" by proving that every non-cooperative game has a mixed strategy equilibrium, meaning there is a dominant strategy for each player. In doing so, he put an end to the circular reasoning that dominated game theory at the time and defined a strategy whereby each player picks his best response to what the others do.

This idea is perhaps best personified by the "Prisoner's dilemma," developed in 1950 by two mathematicians working at RAND, where Nash also briefly worked. The dilemma is described as follows:

> Two men are arrested, but the police do not possess enough information for a conviction. Following the separation of the two

[3] Nasser, p. 89
[4] Nasser, p. 93

> men, the police offer both a similar deal—if one testifies against his partner (defects/betrays), and the other remains silent (cooperates/assists), the betrayer goes free and the cooperator receives the full one-year sentence. If both remain silent, both are sentenced to only one month in jail for a minor charge. If each 'rats out' the other, each receives a three-month sentence. Each prisoner must choose either to betray or remain silent; the decision of each is kept quiet. What should they do?[5]

Referring to the table below, regardless of what Prisoner A does, Prisoner B stands to benefit more by betraying his partner. The same is true for Prisoner A, so therefore the dominant strategy for each man is to confess. Interestingly the outcome, a three-month sentence, would be worse than if both men stayed silent and received only a one-month sentence. However, the nature of games and Nash's assumption that players are self-interested guarantees that both men will confess and, thus, suffer the consequences.

	Prisoner B stays silent	Prisoner B confesses
Prisoner A stays silent	Each serves 1 month	Prisoner A: 1 year Prisoner B: goes free
Prisoner A confesses	Prisoner A: goes free Prisoner B: 1 year	Each serves 3 months

This paradox "contradicts Adam Smith's metaphor of the Invisible Hand in economics. When each person in the game pursues his private

[5] Prisoner's Dilemma. *Stanford Encyclopedia of Philosophy*

interest, he does not necessarily promote the best interest of the collective".[6]

This is the takeaway that positions game theory at the forefront of economic analysis. The Prisoner's dilemma may be only one example of Nash's equilibrium point in action, but it does provoke some interesting questions. Do today's capitalist markets function as zero-sum games like, where one player's loss is another player's gain, or are they more closely linked to non-zero-sum games like *The Settlers of Catan*, where there is a possibility of mutual gain? How would players realize this mutual gain, and how much of it?

Games have a powerful way of translating complex economic transactions into simple, easy-to-understand models. Games like *Monopoly* and poker can help teach children the basics of risk management, resource allocation and negotiation. But they can also help economists understand the intricacies of international trade and exchange.

1.2. Experimental Economics

Experiments are an integral part in the study of any scientific discipline, including economics. Data collected from economic experiments can be used to answer complex questions, test theories and demonstrate market mechanisms.

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[6] Nasser, p. 199

One of today's most renowned experimental economists is Vernon L. Smith, a professor of Economics at Chapman University's Argyros School of Business and Economics. Smith, the winner of the 2002 Nobel Memorial Prize in Economic Sciences is best known for his work in designing experimental markets to study the behavior of buyers and sellers. He found that even with imperfect information and limited competition, the two parties converged on an equilibrium price that would have been predicted by the economic theory of perfect competition.[7]

Smith helped establish experimental economics as a legitimate tool in the study of the world's greatest problems and unanswered questions. In a 2005 lecture on "exchange and markets" and the "specialization that is the secret of all wealth creation and the only source of sustainable human betterment," Smith discussed the intrinsic beauty of the marketplace:

> In acts of personal exchange we usually intend to do good for others. In the marketplace this perception is often lost as each of us tends to focus on our own personal gain. However, our controlled laboratory experiments demonstrate that the same individuals who go out of their way to cooperate in personal exchange strive to maximize their own gain in a larger market. Without intending to do

[7] http://www.nobelprize.org/nobel_prizes/economics/laureates/2002/smith-autobio.html

so, in their market transactions they also maximize the joint benefit received by the group.[8]

This statement is a testament to the fact that what individuals *should* do and what they *actually* do can be two very different things. Nash's hypothesis suggests that the pursuit of private interest won't always translate into the realization of collective benefit, but in a controlled environment Smith's research shows the exact opposite. Both ideas are important in economic literature in that they can spur debate and fuel additional research.

One of the great values in conducting these experiments is that it can help account for social preferences, specifically things like altruism and spitefulness. Human beings, after all, are subject to human emotions, and economics is nothing if not the study of human interactions.

Smith's work is just one example of how experimental economics can be applied to solve real world problems and questions.

1.3. International Trade Theory

Free trade is the defining characteristic of modern economics. Ever since Adam Smith published *An Inquiry into the Nature and Causes of the Wealth of Nations* in 1776, free trade has been hailed by many as the world's answer to increased competitiveness, lower prices and greater overall wealth. His 'Free Trade' argument was founded on the idea that "If

[8] Vernon L. Smith – Autobigraphy, Nobelprize.org

a foreign country can supply us with a commodity cheaper than we ourselves can make it, better buy it of them with some part of the produce of our own industry, employed in a way in which we have some advantage."

This idea has seemingly withstood the test of time, and yet there is still much we don't know about trade. Why do some countries fully engage in the free trade system, and why do other countries go to extreme lengths to avoid it? Perhaps the most important question to grace the minds of today's economists is what is the true cost of trade?

1.3.1. The Case for Free Trade

The exact gains from trade are nearly impossible to quantify, but there is strong evidence that a positive relationship exists between trade and wealth. Jeffrey Frankel and David Romer, two well-regarded economists, attempted to isolate the relationship between trade and income and found that a 1 percent increase in trade subsequently increases per capita income by about 0.8 percent. Once geographic variables (countries in close geographic proximity to each other tend to benefit more from trade) are eliminated, income goes up by about 2 percent.[9] Other studies vary on the exact statistical relationship between trade and income, but nearly all studies found a positive correlation. The

[9] Frankel and Romer (1999)

conclusion, therefore, is that more open trade policies logically lead to higher per capita income.

We have seen economies make the transition from no trade to free trade at least a few times in modern history. In 1859 Japan opened its ports to international trade after 200 years of self-imposed economic isolation, otherwise known as autarky. Economists measured the gains from this act by looking at the prices of Chinese goods before and after the removal of trade restrictions. They found that Japan's national income rose by 4 percent thanks to more efficient allocation of resources and access to cheaper goods.[10] This figure does not include, however, Japan's growth from acquiring better technology and becoming more productive, which is estimated to be much greater than 4 percent.

The United States, perhaps best regarded as the champion of modern capitalism, offers an example of the opposite scenario. In 1807 in response to a military conflict, President Thomas Jefferson ordered an economic embargo by shutting down American ports to international commerce. During the time of the embargo the domestic price of imported goods rose by 33 percent and the domestic price of exported goods fell by 27 percent. Altogether, the 15-month embargo cost the country about 5 percent of U.S. GDP.[11]

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[10] Bernhofen and Brown (2005)
[11] Irwin (2005b)

Protectionist measures, such as tariffs, quotas and embargos, tend to have a negative effect on wealth. Conversely, free trade policies tend to have a positive effect. One study found that removing all trade barriers on agricultural and manufactured goods would net the world $287 billion, or 0.7 percent of world income.[12] This seems hardly worth the trouble of lobbying the world's governments for more favorable trade policies, but the number may seriously underestimate the effect of free trade on domestic economic growth. Romain Wacziarg and Karen Horn Welch responded to some of the flaws in trade research by compiling a panel of each country's per capita income, investment and trade share. They found that the average within-country growth rate is 1.5 percentage points higher after periods of trade liberalization.[13] This says nothing about what would happen if a country went from a complete autarky to capitalism, as Japan did in 1859, but it does suggest a positive correlation between trade and growth.

1.3.2. The Advantages of Free Trade

These figures, while telling, fail to capture the full effect of trade on an economy. John Stuart Mill, a leading economist from the nineteenth century, attempted to identify the "direct economical advantages of foreign trade" in his book, *Principles of Political Economy (1848)*. Mill lists "specialization,"the practice of more efficiently allocating limited productive

[12] Anderson, Martin and van der Mensbrugghe (2006)
[13] Wacziarg and Welch (2008)

resources (land, labor, capital), as a main advantage of trade because it creates a higher real national income. Trade also opens up new markets for a firm's goods, thereby allowing the firm to increase production and decrease marginal costs. This increase in productivity, thanks in large part to improved technology and greater division of labor, ultimately raises the standard of living and per capita income.

Another understated benefit from trade is increased competition in the domestic market. The entrance of more efficient firms into a market, and the exit of less efficient ones, typically pushes the equilibrium price down and creates more efficient production scales. In addition, consumers now have access to a greater and cheaper variety of goods and can make more intelligent purchasing decisions. One recent study showed that the gains from variety alone were worth about 2.6 percent of GDP.[14]

Adam Smith came to this same conclusion more than 200 years ago: "In every country it always is and must be the interest of the great body of the people to buy whatever they want of those who sell it cheapest."[15] And yet, "not only the prejudices of the public, but what is much more unconquerable, the private, interests of many individuals, irresistibly oppose [free trade]."[16] This contrast has troubled proponents of free trade for centuries. Many individuals or countries may oppose free trade because they can't see how they could benefit from it, but are they

[14] Broda and Weinstein (2006)
[15] Smith (1976), p. 493.
[16] Smith (1976), p. 471.

wrong or just misinformed?. It seems that there are as many ideological differences between economic thought leaders as there are misconceptions.

1.3.3. Developing Markets

Some opponents of a free trade economy argue that, as in mercantilism, it's a system that allows the more productive countries to exploit developing markets. On the surface there is validity behind this idea. Small, developing countries suffer from a lack of production resources, specifically advanced technology and an intelligent labor force. How could these countries ever compete in the global economy?

David Ricardo, a powerful London stockbroker, attempted to answer this question in 1799 with the introduction of the theory of comparative advantage. After reading Smith's book, Ricardo wondered what would happen if one country had an absolute advantage in producing every good. Would that country still engage in trade?

Ricardo found that "international trade is not driven by the *absolute* costs of production, but by the *opportunity* costs of production."[17] To put it another way, a country has two options: producing a good at home or importing a good from abroad. Logically, a country would choose the cheaper of the two options. The cost of producing a good domestically has

[17] Irwin (2009), p. 32

nothing to do with the actual costs of production, but rather depends on what other goods a country could produce with its resources and the respective cost of those goods on the open market. This idea lies at the heart of international exchange and helps explain why free trade is mutually advantageous.

For an example of this theory in practice look no further than the trade relationship between the world's most robust economy, the United States, and the country that could soon surpass it, China. During the late 20th century the U.S. held an absolute advantage over China in the production of every good, in large part because the U.S. had access to advanced technology and an intelligent work force. But the industries in which China came closest to matching American productivity were apparel, textile mill products and rubber and plastics. These industries collectively represented almost all of China's exports to the United States.

These exports were so cheap for American consumers because Chinese workers were paid significantly less than their American counterparts. Although China couldn't match U.S. productivity, they could produce similar goods for a fraction of the cost. Thus, China had a comparative advantage in these industries.

This advantage has begun to disappear, however, as China advances from a developing economy into a world power. China risks losing its comparative advantage to other low-wage countries, such as

Vietnam and Cambodia, that can produce at nearly as high levels as China without having to worry about how to pay workers. This is the natural cycle of economic development. A country's position in this cycle has no bearing on whether it stands to benefit from trade; instead, a country's wage and productivity levels determine what products would be the most profitable on an open market. Ricardo's theory of comparative advantage helps explain why every party should benefit from a free trade system, and therefore sets the foundation for this study.

2. The Settlers of Catan

The Settlers of Catan was first introduced in 1995 by the German mogul Klaus Teber, maker of some of the world's most popular board games. A Euro-style game,[18] *The Settlers of Catan (SOC)* has since grown into one of the most popular international board games ever, joining the ranks of such household names as *Monopoly, Risk* and *Life*. More than 15 million sets have been sold as *SOC* has now evolved into an immensely popular pastime among both families and students. [19]

But *SOC* isn't just fun and games. Teber's brainchild is rooted in real world ideas and behavior, and is an innovative reflection of modern economic principles. According to the *Washington Post*, it introduces players to a world that "serves as a model for solving contemporary problems such as trade imbalances, nuclear proliferation, and climate change." [20] What else can we learn from this game that has been dubbed "the great board game of this era?"

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[18] Euro games, also known as German-style board games, are a categorization of games with relatively simple rules, short playing times, fairly high levels of abstraction and frequent player interaction.
[19] Curry (2009), *Wired Magazine*
[20] Eskin (2010), *The Washington Post*

SOC, at its core, is a game about growth and trade. The game is played on a board of 19 hexagonal pieces, with each piece representing one of five resources. Every hex also has a number, 2-12, which corresponds to the possible combinations from a roll of two six-sided dies. Players build two settlements on these hexes to begin the game and then on their turn roll the dice to determine what resources are produced. Players then use these resources to build, expand and trade for other resources. Points are earned for each additional building on the board as well as other special bonuses.

The goal of the game is to be the first player to reach 10 points. There is no dominant strategy to win so how a player gets to 10 points is largely a product of positioning and luck. *SOC* is also a non-cooperative game, meaning that players may not force each other to cooperate. Instead, players are forced to pick an optimum strategy depending on the set-up of the board and their position on it.

The board may change but the rules don't, which means that player behavior is often predictable. *SOC*, therefore, should hold up as an economic model because it is both consistent and logical. However, the similarities do not end there. To fully appreciate the validity of *SOC* as an economic model it's important to break down various nuances of the game and match each rule with a modern economic application.

2.1 The Model

This breakdown of the basic rules of *SOC* offers a detailed comparison between aspects of game play and real world economic principles or practices. [21]

	Rule	Model
Resources	There are five resources available on the island of *Catan*: ore, wheat, sheep, brick and wood. Different combinations of these resources may be combined to build, expand and trade.	There are thousands of natural resources available in the real world, including oil, cotton (textiles), metals, food and wood. These resources collectively represent the foundation of global trade.
Trade	Players each have the opportunity to trade their resources during their turn. They also have the option of trading four of a single resource for any one resource from the bank.	Most modern countries are also constantly engaged in trade. As in the game, each participant has the option of trading with multiple partners and/or accepting the best offer.
Specialization	Limited access to resources forces players to specialize in the production of one or more resources. The decision of which resources to	Specialization is the corner stone of international trade, allowing diverse economies to efficiently produce goods. Which

[21] *The Settlers of Catan* official rulebook.

	specialize in is determined by each player's respective position and strategy.	goods each economy produces is a product of geographic and socioeconomic factors.
Scarcity	There are four hexes each for wheat, sheep and wood. There are three hexes each for ore and brick. The set-up of the board and the distribution of the number tokens guarantees that some resources will be in more abundance than others.	Scarcity is the fundamental economic problem, defined as how to meet unlimited human demand in a world of limited resources. Economics is the study of how societies allocate these resources.
Odds	Each resource piece on the board has a number (2-12) on it that coincides with the possible combinations from a roll of two six-sided dies. The number 7 is excluded because it is the most common roll, and 2 are 12 are only represented once on the board. All the other numbers are represented twice. Players strategically place their buildings on the board to maximize their odds of producing the most resources. Some resources may be more valuable than others.	There are many variables that could affect economies and resource production, among them weather, natural disasters and political lobbying. It's impossible to predict exact resource production and economic growth each year, but market players can usually come up with a fairly close estimate. Differences between the estimate and the actual value help influence adjustments to strategy (produce more of one resource and less of another, pursue other trading opportunities, explore different growth strategies, etc).
Building / Expansion	Given sufficient resources, players have the option of building an additional settlement (worth one point) or replacing a settlement with a city	Economies depend on improvements in technology to continue to grow. Settlements and cities are a lot like factories and machinery,

	(worth two points). These extra buildings give players access to more resources and increase their odds. A city is worth double.	in that both help increase production and open up new distribution channels.
Development	Instead of building a settlement or a city, players have the option of using three specific resources to purchase one or more development cards . The action or reward on these cards varies from a soldier (move the robber), a monopoly (collect all of a single resource), a year of plenty (collect any two resources from the bank), road building (build two roads) or a victory point. Players may use only one of these cards per turn. Longest road (minimum 5 connected roads) is worth 2 victory points. Largest army (minimum 3 played soldiers) is also worth 2 victory points.	There is no “development card” in the real world, but there is government and trade policy. Politicians and lobbyists in many countries around the world have enough influence to impact local and international trade. There also global organizations like the World Trade Organization and the World Bank that can create incentives (subsidies) or penalties (tariffs) for trading specific resources. The exact influence of these trade measures is as unpredictable as the outcome from playing a development card, so a realistic comparison exists.
Ports	Players may also build settlements and cities on ports and use them to trade. A 3:1 port allows players to trade 3 of any resource for 1 of any other resource. A 2:1 port allows players to trade 2 of a specific resource for 1 of any other resource. This is cheaper than trading with the bank, which requires a 4-for-1 exchange.	Portsalso exist in the real world for the purposes of reducing the cost of a transaction. Without access to ports traders would have to go inland, increasing transportation costs and inflating the price of their goods.

Rolling a 7	Players holding more than 7 cards in their hand when a 7 is rolled must discard half their cards.	Companies with too much inventory risk having their goods devalued if they can't push them to market.
The Robber	The robber lives on the island of *Catan* and is moved from hex to hex whenever a 7 is rolled or the Soldier card is played. Once on a hex, the robber blocks production of that resource for the players with buildings on that spot.	As a protectionist tool, the robber functions similarly to an economic blockade. Blockades also block off the supply of certain resources and generally slow down overall economic growth.
Winning	The game ends once a player reaches 10 points—calculated by adding up his total number of settlements, cities and other victory points.	There is no "winning" in the real world, but the nature of competitive markets dictate that economies will always try to make as much money as possible in as little time as possible.

The model, like most economic models, is a gross oversimplification of the real world. However, this does not mean that *SOC* is ill-equipped as a basis for future economic thought and study. There is a great deal to be learned from looking at common problems or questions from an alternative perspective. Many of the greatest principles of economics have been discovered using just this approach. *SOC* is more than suitable as an alternative perspective and, as the remainder of this paper will show, a valuable addition to the field of economics.

3. The Experiment

3.1. Background

A friend first introduced me to *The Settlers of Catan* in 2005, while I was still in high school. After only playing a couple of times I quickly became enamored with the game. I was intrigued by the simplicity of the rules, but also by the complexity of the board and the game, one that generated different outcomes every time. It was a game that challenged my ability to plan long-term, to balance opportunity and risk and to negotiate with my opponents. In short, it asked me to step into a role as a fictional country's chief economist and trade minister.

Since I didn't actually own the board game, I often had to resort to playing online with like-minded aficionados from all over the world. While playing online I came across several variations of the game, the most popular of which was dubbed "NTRR7" for "No Trade Reverse Robber 7." What that meant is that trade was disallowed and that any time a 7 was rolled the robber had to be placed on an empty tile or, in the absence of an open spot, on your own tile. I was puzzled by this variation because I assumed that trading and robbing were both integral parts of the game.

However, after trying it a few times I became fascinated with how much the dynamics of the game changed.

Not only were NTRR7 games faster than the standard game, allowing users to play multiple games in a short period of time, but they were often more competitive too. This struck me as odd. In the standard game the robber is typically used to disrupt the leader's strategy and allow other players time to catch up, but ironically players had a better chance to compete when the robber's role was diminished and all players had equal access to the flow of resources.

The absence of trade in this variation was also interesting. I had assumed trade was a vital part of the game in that it allowed players to trade their surplus of resources for other resources that may have been in short supply. Yet, players in NTRR7 games had no trouble procuring the resources they needed, even though it took a few extra turns in the beginning to get going. What is the point of trade, then, if players can be self-sufficient and still win the game?

Later when I again played the standard game with full trade and a free robber I observed that trades were suspiciously rare. Players had needs, yes, but they often weren't willing to pay the price to get the resource they need. Instead, they were happy to wait until their number rolled or the price went down. They had no interest in doing anything that

might help an opponent gain an advantage, even if it involved inhibiting their immediate chances of winning.

These observations stimulated the main idea behind this paper. What, if any, were the real advantages of trade in a multiplayer, non-cooperative game such as *The Settlers of Catan*?

3.2. Set-Up

Using *SOC* as an economic model, I sought to answer this question. I wanted to know what players do when faced with the decision of whether or not to trade, and at what cost? Are players better off openly trading with their competitors, as international trade theory would suggest, or is protectionism a more valid strategy? Does a player with an absolute advantage in the production of every resource still engage in trade with other players? What statistical and empirical effect does trade have on the game both during and as a whole?

To determine what effect trade has on our economic model it's necessary to isolate trade as our only variable. This is possible by establishing a new style of game in which trade is restricted, and quantitatively and qualitatively comparing the original *SOC* (FT-free trade) and the adapted version (NT-no trade). Thus, there are two versions of the game where the only experimental difference is in a player's ability to trade.

The researcher then randomly determines which version to play and sets up the board. Each participant in the study played at least one FT game and one NT game, with many participants playing multiple games.

The players chosen for participation in this experiment are all experienced and familiar with the *SOC* rules. To ensure fair competition all participants signed a 'Participant Agreement' [Appendix A] whereby they agreed to abide by the rules set forth by the researcher, including the three-point rule, explained below.[22]

3.3. Assumptions

Any scientific experiment must be carefully designed and executed to guarantee the accuracy and validity of the data. To this end I made three strong assumptions about how participants would behave within an experimental setting. These assumptions are further outlined in the participant contract.

1. Each player will attempt to win the game as fast possible.

2. Players not in a position to win will attempt to prolong the game in order to earn more victory points.

[22] The three-point rule is a common variation of *SOC* in which players may not rob another player, whether by rolling a 7 or playing a soldier card, until that player reaches at least three victory points on the board. This adaptation is to ensure that all players have sufficient access to resources at the beginning of the game, thereby attempting to eliminate the element of luck.

3. Players will always prefer more resources at the end.

3.4. Data Collection

As the researcher, my role was as an observer and an administrator, organizing games between participants and ensuring that all rules were followed. I also collected data by observing several specific variables and recording the results on a spreadsheet [Appendix B]. I recorded the relevant data for each turn and then summed up the results to produce final game data. These variables were:

- Roll Number
- Total Resources Collected
- Total 2:1 Port Trades
- Total 3:1 Port Trades
- Total 4:1 Bank Trades
- Total Port/Bank Trades
- Number of Trades
- Number of Resources Traded
- Total Victory Points (VPs)

I also observed when a player reached 6, 7, 8 and 9 VPs to see if game behavior changed once a player was close to winning. Since each

player starts with two victory points on the board and needs 10 victory points to win, a total of six victory points represents the theoretical halfway point of the game. In addition to statistical observations I also made qualitative observations by writing down notes during and after the game.

These notes and data will be presented and discussed in the following chapter.

4. Results and Discussion

4.1. Presentation of Data

After collecting data for 10 full-trade (FT) games [Appendix C] and 10 no-trade (NT) games [Appendix D], my non-experimental observations held up as true.

	FT	**NT**
Turns/Game	61.9	70.6
Resources/Game	150.0	176.1
Trades/Game	5.6	N/A
Resources Traded/Game	14.2	N/A
Resources/Trade	2.54	N/A
Port Trades/Game	11.1	17.7
Total VP/Game	23.8	25.3
Resources/Turn	2.42	2.49
VP/Turn	0.384	0.358

Although NT games were generally longer than FT games (70.6 turns/game vs. 61.9 turns/game), NT games produced more total resources (176.1 vs. 150.0), more total victory points (25.3 vs. 23.8) and more resources per turn (2.49 vs. 2.42). Since resources and points were distributed between the three players, it can be inferred that NT games generated more overall wealth and were, on average, more competitive.

These results become even more pronounced when the data set is reduced to a smaller sample. I calculated the standard deviation of both

the FT set and the NT set in terms of total turns[23] and used the respective figures to eliminate the outliers in each data set, producing a new subset that included 7 FT games (FT7) and 7 NT games (NT7).

FT7 games still had the advantage in total turns (63.29 vs. 66.71), but the disparity shrunk by more than half from the original set. The NT7 subset, meanwhile, maintained its strong advantage over FT7 games in total average resources (173.86 vs. 152.43) and total average victory points (25.43 vs. 24.57), and nearly tripled its advantage in resources per turn (2.61 vs. 2.41).

So NT7 games were on average 3.42 turns longer than FT7 games and yet still managed to produce an additional 21.43 resources and 0.86 victory points. It should be expected that longer games would produce more total resources and therefore more victory points, but the rate at which NT7 games out produced FT7

	FT7	**NT7**
Turns/Game	63.29	66.71
Resources/Game	152.43	173.86
Trades/Game	5.71	N/A
Resources Traded/Game	14.43	N/A
Resources/Trade	2.53	N/A
Port Trades/Game	11.57	17.14
Total VP/Game	24.57	25.43
Resources/Turn	2.41	2.61
VP/Turn	0.388	0.381

[23] The reason I used the number of total turns to calculate standard deviation is because game length has the single biggest influence on other components of the game, including total resources produced and total victory points. This will be discussed in more detail on the following pages.

games (0.2 resources per turn) is evidence of an important finding.

The only statistic in which FT games were favored is victory points per turn. The FT set outpaced the NT set by a margin of .026 (0.384 vs. 0.358) points per turn. However, this margin was nearly eliminated when looking exclusively at the respective subsets. FT7 games produced 0.388 points per turn against 0.381 points per turn for NT7 games, for a margin of 0.007 points per turn. It makes sense that FT games would produce points at a more rapid pace because players tend to have more options to build and expand when trading is allowed. However, the disparity between the two data sets is so small as to almost be negligible.

The discussion of trade theory in Chapter 2 set forth the idea that free trade and overall wealth, measured in terms of GDP and standard of living, are positively correlated. Conversely, economies that restrict trade often suffer from poverty and a slow or negative rate of growth. So why then did FT7 games produce less victory points and less resources than NT7 games? Wouldn't we expect it be the other way around?

If we look exclusively at the FT set of data we see that there were on average only 5.6 trades per game and 14.2 resources traded per game. Perhaps more telling is the fact that in 9 out of the 10 games there were more port trades (2:1, 3:1, or 4:1) than player trades. On average, there were nearly twice as many port trades (11.1) as there were player trades (5.6).

The data from the FT7 subset is even more striking. There are slightly more trades (5.71) and more resources traded (14.43) per game, but port trades (11.57) still drastically outnumber player trades.

Part of this is a reflection of scarcity in the game. When certain resources are unavailable via the trade market, players have no option but to trade in their resources via their ports or the bank. However, it is curious that this occurs twice as often as a normal trade, especially since port trades tend to be more expensive from the perspective of optimal resource allocation. If it's cheaper to trade with their opponents, then why do players flock to the ports with such frequency? Why are there so few player trades in the first place?

Part of the answer may lie in looking at the FT games in more detail. I mentioned earlier that I recorded whenever a player reached six victory points[24] to see if game behavior changed once at least one player was close to winning. Let's call this instance the Point of Impact (POI).[25]

In nine out of the 10 FT games studied, there were more trades before the POI than there were after it. In total, 37 of 56 trades (66.1

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[24] Since players start the game with two victory points and need 10 to win, then a total of six victory points represents the theoretical halfway point of the game.

[25] The POI is measured by looking only at how many points a player has on the board, including settlements, cities and any other awards like Longest Road or Largest Army. It does not take into account points that may be hidden in a player's hand (i.e. VP's or Soldier cards) and may not fully reflect a player's strategic positioning or chances of victory within a particular game. As such, the player who is in the best position to win may not necessarily be the first player to reach six victory points.

percent) occurred before the POI, accounting for 66.9 percent of the total resources traded. In contrast, only 42.3 percent of the total port trades occurred before the POI.

On average, the POI occurred on the 40th turn (39.8) of the game. If we recall that an average FT game lasted 61.9 turns, then the POI occurs after 64.3 percent of the game has been played. As a result, the fact that 66.9 percent of the total resources traded came before POI falls roughly in line with how many trades we would expect for a game of any length. However, the more interesting result is how few port trades there are before the POI, and how many there are after it. Part of this is a reflection of how many turns it takes players to build on ports before they can be used, but players may also have less of an inclination to make a port trade earlier in the game if they can get a specific resource cheaper by trading with another player. The implications of this contrast will be discussed in the next section.

The results from the FT7 subset are similar in respect to POI. On average, POI occurs on the 42nd turn (41.7) of the game, about 65.9 percent of the way through. Trades before POI account for 67.5 percent of all trades, and 69.3 percent of all resources trades. The only significant difference is that 50.6 percent of port trades occur before POI in FT7 games, versus 42.3 percent in all FT games. This can best be explained by one unusual game (FT8) in which seven of eight port trades came before POI, in large part because POI occurred just seven turns before the

end of the game. If we eliminated the data from this game the final percentage of port trades before POI would be a more reasonable 46.6 percent. Thus, POI shows that players tend to utilize each other for trading resources early in the game; whereas late in the game players are more likely to exchange resources through their ports or the bank.

Finally, we attempt to measure the correlation between trade and the other factors in the game to see what, if any, relationships exist. By graphing two variables in a scatter plot and doing a simple regression analysis, we can calculate the coefficient of determination (r^2) and measure correlation.

Using this method I looked at the following sets of variables for both the FT and FT7 sets of data [Appendix E]:

- Number of Trades vs. Victory Points
- Number of Trades vs. Total Resources
- Number of Resources Traded vs. Victory Points
- Number of Resources Traded vs. Total Resources

	FT	**FT7**
# Trades vs. # Points	0.0443	0.0421
# Trades vs. # Resources	0.0124	0.0325
# Traded vs. # Points	0.0164	0.0111
# Traded vs. # Resources	0.0064	0.0135

What I found is that none of the graphs showed any kind of correlation. None of the

coefficients of determination approached even 0.1, indicating that no identifiable correlation exists between trade and point or resource accumulation. If neither the frequency nor the quantity of trades positively impacts the game, then what variable does?

Rather than doing a multi-variable regression analysis, it may be easier to pinpoint one specific variable: time. Time is measured in *SOC* by number of turns and there is evidence of a positive correlation between turns and point and resource accumulation within the experiment. [Appendix F]

Referring to the table below, the r^2 values for both the FT and NT data sets are significantly greater than anything we saw for the Trade graph analysis. Indeed, the experiment showed that a single turn was worth 2.42 resources and 0.384 points in FT games, and 2.49 resources and 0.358 points in NT games. Thus, we can infer that the variable most responsible for dictating in-game growth and success is Number of Turns.

	FT	**FT7**	**NT**	**NT7**
Turns vs. Points	0.3107	0.7586	0.4785	0.4904
Turns vs. Resources	0.4452	0.7780	0.7225	0.7260

We would expect longer games to generate more resources and points and, consequently, be more competitive. But the more interesting

statistical result is how little impact trade had on the outcome of the game. Why is this?

Let's explore this question and address the significance of trade, or the lack thereof, within the study.

4.2. Discussion

The majority of trade theory literature has hailed free market systems as harbingers of economic growth and longevity. Yet in the experiment, a model economy closed off to trade outperformed a model economy with free trade. What conclusions can we draw from this? For instance, does trade have no impact, or even a negative impact, on a country's economic health?

One perspective is that the existence of open markets doesn't always translate into equal access to those markets. The economic superpowers have a supreme advantage when it comes to conducting trade for reasons including, but not limited to, more advanced transportation technology, favorable political policies and a large consumer market. Trade allows the rich countries to get even richer. Meanwhile, the poor countries may exhibit some growth but at a far slower pace, thus creating a gap in wealth.

The question this raises is if free trade is a rational economic policy for disadvantaged, or developing, countries? We saw in the survey of

trade theory literature that the concept of comparative advantage allows developing countries to participate in and benefit from global trade. But perhaps this is not the right question to ask. Trade, for better or worse, is a staple of the global economy. Even countries that tend to be protectionist still participate in trade to some extent. The more interesting question, and one that has often puzzled economists, is how to reap the maximum benefit from trade?

We know that the main motivation behind any kind of transaction is utility – the total satisfaction received from consuming a good or service. We derive utility from everything we do—eating breakfast, going for a walk or playing games. This same principle holds true in the world of trade. We enter the marketplace of goods and services (think of it as a global Wal-Mart) where we seek to exchange our hard-earned dollars for something that will bring us utility. The foundation of trade depends on this idea. If we could generate the same amount of utility without ever entering the marketplace, we would simply obtain all the items for ourselves in a self-sufficient economy and no trade would occur. However, if we can gain even a minute amount of utility from participating in the open market, then trade becomes an absolute.

	Cory	**Shawn**
Pair of shoes	+6U	+4U
Watch	+8U	+12U
Jacket	+1U	+10U

Let's put this into mathematical terms. Say we have two individuals, Cory and Shawn, and they each have a basket of goods worth a certain

amount of utility (U). Each item in the baskets has a specific value to each individual. Let's say there is a pair of shoes in Cory's basket that is worth 6U to Cory, but only 4U to Shawn. Similarly, there is a watch in Shawn's basket that is worth 12U to Shawn and 8U to Cory. Cory would want to trade his shoes for Shawn's watch because that would increase his utility by 2U, yet Shawn wouldn't be interested in decreasing his utility by 8U. There would be no trade. However, what if Cory also has a jacket in his basket that was worth 1U to him and 10U to Shawn? He could package together the shoes and jacket for the watch, allowing both Cory (+1U) and Shawn (+2U) to add to their utility. This is a perfect win-win scenario in which both individuals benefit from a trade.

	Sends	Receives	Total Gain
Cory	Shoes (6U) + Jacket (1U)	Watch (8U)	+1
Shawn	Watch (12U)	Shoes (4U) + Jacket (10U)	+2

But what if we added a third individual to the mix? This is where it might be helpful to bring in *The Settlers of Catan* once again as our economic model. Let's suppose Cory and Shawn join Eric for a fun game of *SOC*. After a few rolls it is Cory's turn and he has a sheep that he would like to trade for a wheat. Both Shawn and Eric have a wheat that they can trade, but neither particularly wants a sheep. Shawn values a

	Cory	**Shawn**	**Eric**
Sheep	+1U	+2U	+1U
Wheat	+4U	+4U	+4U

sheep at 2U and a wheat at 4U, while Eric values a sheep at just 1U and a wheat at 4U. Cory also values a sheep at 1U and a wheat at 4U.

Under these circumstances, Cory would have a difficult time finding a trading partner since any deal would only help him. Suppose he increases his offer to two sheep? Eric still wouldn't be interested, but Shawn would receive equal value by either keeping his one wheat (4U) or accepting the offer for two sheep (4U). Cory, meanwhile, would up his utility by two. What happens?

In a benevolent world, Shawn would make the trade and help Cory expand on the board. But in a competitive world, like the one portrayed in *SOC*, Shawn would reject the trade and make a counteroffer that would allow him to also increase his utility.

Let's say that Shawn now demands three sheep for his one wheat. Cory would still benefit by doing the trade and increasing his total utility by one. Shawn, however, would be the big winner and increase his total utility by two. What happens?

	Sends	Receives	Total Gain
Cory	3 Sheep (1U) = 3U	Wheat (4U)	+1
Shawn	Wheat (4U)	3 Sheep (2U) = 6U	+2

At first, this may seem just like the win-win scenario described earlier. However, Cory and Shawn are now participating in a competitive market in which there can only be one winner. They both benefit from the

trade, but the deal helps Shawn more than it helps Cory. What should Cory do?

He has the option of taking the deal as is, bargaining to get the price down or holding on to all of his resources. Cory's decision will likely depend on his position within the game and each player's respective chances of winning. If Cory is in the lead then he is more likely to do the deal because it's unlikely to come back and hurt him. If, however, Shawn is in the lead, then Cory will likely reject the offer and wait for a better deal to come along.

I observed this exact type behavior on a regular basis during the experiment. Players were fiercely opposed to giving up their resources at the risk of potentially helping an opponent win. It didn't seem to matter if a trade was mutually beneficial to both parties. What mattered is how much *more* beneficial a trade was for one player than another player.

Utility theory teaches us that rational individuals should seek to maximize their total utility. John Nash identified five points in his definition of utility theory for a single individual, the most significant of which states: "An individual offered two possible anticipations can decide which is preferable or that they are equally desirable."[26] But are players in *SOC*, in fact, maximizing their utility?

The answer is yes. But how are they doing it?

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[26] Nash (1950), *The Bargaining Problem*

When ranking preferences, each player must also take into account the preferences of their opponents. Each potential trade involves an intricate analysis of how much a good is worth to one player versus how much it might be worth to another player. But unlike in the Prisoner's Dilemma, a game like *SOC* involves multiple decisions. While the decision a player makes at one stage in the game may not necessarily be in his or her immediate best interests, the decision will always be in his or her long-term best interests.

This distinction between single-stage and multiple-stage decisions is critical. Even though trades were relatively rare in FT games, trade negotiations occurred on almost every turn. Players were constantly forced to rank their preferences and think strategically about how much their resources were worth, both privately and on the open market.

I call this behavior *Utility Advantage Maximization (UAM).* In a competitive, multi-stage market, like the one presented by *SOC*, individuals engaging in trade negotiations should seek to maximize their utility *advantage* over others. Utility is not something to be measured on an individual basis, but rather something to be considered in the context of each player's respective utility at each stage in the game.

This idea, I believe, is the primary reason why FT games exhibited so little trade activity. Participants demanded such high returns for their resources that it was nearly impossible to find a trading partner, especially

late in games. As a result, resources became heavily concentrated and the trades that did occur were typically lopsided in the favor of the player with the best bargaining position, which usually means that player controlled the pivotal resource or resources. This explains why point and resource distribution in FT games was statistically worse than distribution in NT games.

I also observed that players who did frequently engage in trades often struggled to win the game. These players tended to be less experienced and, it seems, failed to properly value their resources throughout the game. Meanwhile, more experienced players could make more accurate valuations and, as a result, were more likely to win.

The conclusion to be taken away from these findings is not that trade is harmful, but rather that it should be approached differently from a bargaining standpoint. It's not enough to just benefit from a trade—it's also important to remain competitive in the open market. Trade shouldn't be regarded as merely a means of sustenance, but instead as an opportunity to profit. However, this is only possible when both sides of a potential trade are readily engaging in *UAM* behavior.

4.4. Experimental Error

Experimental economics is an inexact science and this experiment involving *The Settlers of Catan* is no exception. Despite efforts to control

as many variables as possible to improve accuracy and reliability, this experiment still had many potential sources of experimental error.

- *Strategy:* A player's individual strategy varies greatly from game to game depending on the specific circumstances of each game, making strategy perhaps the hardest part of the experiment to control for. There is no empirical way to show that players behaved drastically different in FT games than they did in NT games. Common sense suggests that players would approach NT games differently in order to compensate for not being able to trade by, for instance, relying on the robber more or settling closer to ports. Development cards in general would likely be used more in NT games because they represent the only way to acquire certain resources. This may partially explain why NT games were statistically more profitable and equitable.

- *Sample size:* A sample size of 10 FT games and 10 NT games is relatively small by experimental standards, especially since the results could be heavily influenced by luck . To collect a more reliable set of data it would be necessary to play each version of the game 50 or 100 times each. Unfortunately, time constraints surrounding this study made this impossible.

- *Participants:* As the study took place predominantly in Syracuse, NY, there was a limited pool of participants from which to draw

from. As a result, participants played the same players multiple times, eliminating any chance of a true random experiment. Participants who were familiar with each other's strategies and tendencies may have played differently than they would otherwise in a random game. For instance, some participants may have had a natural preclusion to trading that had nothing to do with the perceived or realized benefit of conducting a trade.

- *Correlation:* Although the experiment focuses on the relationship between trade and resource and point accumulation, there is no way to definitively prove that a direct correlation exists. There could be other factors that affect the results.

5. Case Study

The results of my experiment revealed some hidden secrets about *The Settlers of Catan,* but the real question is how can these findings be used in the real world? Is Utility Advantage Theory practical in today's free-market system and, if so, how can it be applied to improve human welfare and stimulate economic growth?

The reason why we may not see *UAM* behavior in the real world is because the buyer doesn't always have the luxury of renegotiating with the seller, or vice versa, and has no choice but to pay the marked price. For example, the United States is a major importer of oil from the Middle East. American policymakers can't suddenly refuse to pay the market price for oil because the U.S. relies too much on oil to power the country's cars and factories. Even if the Middle Eastern sheiks who control the oil refineries are keeping the price artificially high, the U.S. still can't decline the trade at the risk of creating a major shortage.

This is a reality that many consumers and countries face. Global trade is dominated by inelastic goods, meaning that price has little effect on demand. These goods include such everyday necessities as water, electricity, food and fuel. The corporation or nation in control of the good typically gets to dictate the price, creating an imperfect market exchange

in which the good is overvalued. This is the exact dilemma that players face in *SOC*—forced to choose between overpaying for a good or procuring it for themselves through other means. When no other means exist, the logical conclusion is that players must accept the price as is. My experiment showed that, more often than not, players rejected this idea and instead delayed the transaction until conditions were more favorable. Nations, of course, don't have the luxury of time any more than they have the luxury of renegotiation. Therefore, *UAM* has a limited place in today's traditional markets. However, there is one market where *UAM* behavior *can* help redefine modern economics—the labor market.

The field of labor economics is as broad and complex as international trade theory. Yet, in its simplest form labor is just a commodity that is traded between employers (the buyers) and workers (the sellers). So what would happen if workers used *UAM* to demand the highest price for their labor?

Here are two case studies of what happened last year when a group of employers collectively decided that they wanted to cut costs and increase profits, and how the workers fought back to get a fair price for their labor.

5.1. The NFL Lockout

The National Football League (NFL) is the most successful organization in the history of sports. The NFL makes $9 billion in revenue

each year, a big chunk of which comes from the country's most watched television program—the Super Bowl. In 1993, the NFL and the National League Football Players Association (NFLPA) signed a collective bargaining agreement (CBA) that gave players 57 percent of total revenue and gave the owners of the 32 NFL teams the remaining 43 percent, after the owners took more than $1 billion off the top for operating and development costs, such as stadium construction.[27]

Consider that dichotomy for a second. The players are the ones who are on the field every week sacrificing their bodies so the NFL can have something to sell to television networks, and yet they barely get half of the league's billions of dollars in revenue. The owners, meanwhile, spend their Sundays sitting in their luxury boxes and stuffing their wallets. In the past few years the owners have even begun complaining about losing money and publicly lobbying to extend the regular season from 16 to 18 players. They also wanted a bigger chunk of league revenue. In other words, they wanted to earn an even greater profit by reducing labor costs.

Naturally, when the CBA expired in 2010 the players refused to continue playing until they got a fair share of the revenue pie. Their demands were a higher percentage of league wide spending on player

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[27] Silver (2010), *Yahoo! Sports*

salaries, more benefits for former players and changes made to improve health and safety. [28]

When the owners rejected these demands, the players' union decertified and filed an antitrust lawsuit against the NFL, whereby the owners promptly locked the players out.[29] An important thing to remember about this lawsuit is that the NFL had already negotiated contracts with TV networks worth over $4 billion to broadcast football games that next season, regardless of whether any games were actually played.[30] The owners were actively colluding against the players until they got what they want, and the players refused to back down their demands. Thus began a long and heated lockout.

Unfortunately, this was never a fair negotiation. The players may be considered wealthy by most American standards, but very few of them could afford to miss a season's worth of paychecks. In fact, more than 20 percent of players still live paycheck to paycheck, according to a report by MSNBC.com.[31] No other professional football leagues paid anywhere near what the NFL paid. The owners, meanwhile, belonged to a different income bracket, occupied almost entirely by multi-billionaires. A lost year of ticket sales and advertising revenue would've been merely a minor bump in their annual income. The owners could withstand the lockout for

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[28] Maske (2010), *The Washington Post*
[29] Trotter (2011), *Sports Illustrated*
[30] Associated Press (2011), *ESPN*
[31] Briggs (2011), *MSNBC*

many years without worrying about how they were going to be able to pay their bills. The players, however, were not so lucky.

Given these circumstances, it seems illogical that the players would even threaten to lockout. But these players weren't as concerned about their next paycheck as much as they were worried about how they would maintain a living once their playing careers were over and medical bills began to pile up. Players wanted to tighten the financial gap between themselves and the owners, not just for active players but also for the thousands of retired players and the thousands of players yet to be drafted.

Let's compare this to *The Settlers of Catan*. Like in the game, the NFL players are prioritizing their future income and benefits over their immediate economic interests. In fact, every labor negotiation is almost like every *SOC* trade negotiation, with both parties jockeying to get the best deal. Labor negotiations such as these may only occur every few years instead of every few turns, but the principles applied are very much the same.

So by sacrificing multiple paychecks, players were forcibly raising the market price for their labor and actively cutting into the NFL's margins, attempting to capture a bigger and more equitable share of the financial pie. Therefore, they were applying *UAM behavior to* maximize their earning potential.

The players' strategy worked. When the lockout ended in July 2011, just two months before the scheduled start of the regular season, the players walked away with $1 billion in additional benefits for retired players, an opportunity to stay on a medical plan for life, increased minimum salaries, unrestricted free agency after four years, a true salary floor, increased rosters and additional measures to improve player safety, including the continuation of the 16-game schedule. The players also won 55 percent of national media revenue, 45 percent of all NFL Ventures revenue and 40 percent of local club revenue.[32]

The new CBA included some concessions for owners as well, including a rookie wage scale that prevented players with zero games of NFL experience from getting paid more than established veterans.[33]

The NFL and the NFLPA came to an agreement because both sides eventually got what they wanted, or at least most of what they wanted. But neither side had much of an alternative. The players couldn't make enough of an income playing elsewhere, and the owners couldn't sell enough tickets with replacement players. Consequently, an agreement was inevitable.

But what if there was another market for the players' labor?

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[32] Judge (2011), *CBS Sports*
[33] Clayton (2011), *ESPN*

5.2. The NBA Lockout

As NFL players clung to their demands, the National Basketball Association (NBA) was mired in a lockout of its own after the expiration of its CBA. Many of the same issues that plagued NFL negotiations were at the table once again, including the division of $4.2 billion in revenue and the structure of the salary cap and luxury tax.[34]

Under the previous CBA, players received 57 percent of basketball-related income (BRI). The owners felt like this was too much and publicly complained about losing money with a couple of franchises even on the verge of bankruptcy. The league estimated that it was losing $300 million a year with 22 out of 30 teams posting a loss last season, in large part because the aftermath of the financial recession continued to negatively affect ticket sales. Small-market teams in particular struggled to turn a profit because, they argued, player salaries were too high.[35]

The players, of course, disputed this claim and rejected an offer that would decrease their share of BRI and cut $2 billion over the next two years. They also rejected a hard salary cap that would reduce spending by at least $13 million per team. The players' agents also got involved and

[34] Aschburner (2011), *NBA.com*
[35] Broussard (2011), *ESPN*

encouraged their clients to decertify from the National Basketball Players Association (NBPA). After months of failed negotiations and an ultimatum by the commissioner David Stern, the players dissolved the union and sued the NBA in a class action antitrust lawsuit.[36] Thus, sports fans were treated to yet another lockout.

The circumstances surrounding the NBA lockout were very similar to what happened to the NFL—with one important difference. The NBA was not the only league in the market for basketball players.

Basketball had grown into a major international sport and there were competitive professional leagues all over the globe. Even better, many of these leagues could afford to pay comparable salaries to what players received in the NBA. Thus, more than 90 players signed with foreign teams during the lockout, with the majority agreeing to an opt-out clause in the event the lockout ended.[37]

Deron Williams, a perennial All-Star, was offered $5 million to play for a Turkish team.[38] Kenyon Martin, a former first overall draft pick, signed a contract with the Chinese Basketball Association that would pay him $500,000 a month.[39] Other stars like Kobe Bryant[40] and Kevin

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[36] Cacciola and Schechner (2011), *The Wall Street Journal*
[37] HoopsHype (2011), *HoopsHype.com*
[38] Mazzeo (2011), *ESPN*
[39] Associated Press (2011), *ESPN*
[40] Bresnehan (2011), *Los Angeles Times*

Durant[41] were also offered lucrative multimillion offers to play in Europe. Players who didn't want to go overseas had the option of participating in organized exhibition tournaments all over the country. There was even an extensive plan for a team of NBA superstars to tour the world[42], much like the Harlem Globetrotters have been doing for the better part of a century.

It's true that most players would've been taking a pay cut by going overseas, a migration that *The New York Times* called "one of the most overblown stories of the lockout."[43] Even where there were sufficient paychecks, there may not have been jobs. Many foreign teams had already filled their rosters by the time NBA players came calling, and they didn't necessarily want to risk disrupting team chemistry by acquiring a rental player. But enough outside opportunities existed, both abroad and domestically, that the players didn't have to take the league seriously until they got a good offer.

The league also came to this unfortunate realization and so on November 15, the NBA canceled all games through December 15. The players stood to lose $350 million for each month of the season, with the average player sacrificing $220,000 on their first paycheck.[44] The losses would mount, of course, as the lockout dragged on. But the players could make back at least part of their losses through other contracts and

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[41] Lealos (2011), *Yahoo! Sports*
[42] Broussard (2011), *ESPN*
[43] Beck (2011), *The New York Times*
[44] Stein (2011), *ESPN*

endorsement deals, while the barely solvent owners had to lay off 200 workers, in addition to another 200 jobs shed by the league office.[45]

Even worse, the league was facing heavy criticism from fed-up fans, without whom there wouldn't be any revenue at all. A lost season would threaten to destroy the NBA's brand, especially coming off one of the most exciting seasons in league history. The players' brands were not nearly as susceptible and could be developed in external markets. Thus, the players held the edge in negotiations.

As it were, the players played their hand a little too quickly and agreed to a deal that was not much different from what was initially proposed before the lockout. The NBPA accepted a reduction in BRI to 51.2 percent for the 2011-12 season, and a reduction to 49-51 percent (depending on league growth) in future seasons. They also agreed to a provision that allowed each team to waive one player and remove him from the team's salary cap. There was another rule, dubbed the "Derrick Rose Rule" that allowed young, premier players to get paid more during their rookie contracts. Player salaries otherwise remained unchanged.[46] The two sides also agreed to a shortened season of 66 games starting on Christmas Day.

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[45] Beck (2011), *The New York Times*

[46] Coon (2011), *ESPN*

In the end, negotiations weren't as much about money as they were about respect. The players wanted to get paid, yes, but they also wanted to be treated like equal partners of the NBA experience. The fact that Stern had issued an ultimatum struck the NBPA as insulting. HBO's *Real Sports* commentator, Bryant Gumbel, even went so far as to equate Stern with "some kind of modern plantation owner overseer, treating NBA men as if they were his boys..[showing] how he's the one keeping the hired hands in place."[47]

Issues of racism aside, the players nonetheless effectively utilized Utility Advantage Theory to strike a favorable deal. They treated their labor as an in-demand resource and used the free market system to drive up the price for their skills. They likely would have received an even better deal if the lockout lasted an entire season, but as in all transactions other factors also played a role.

5.3. Conclusions

Professional athletes don't belong in the same income bracket as the majority of Americans, but their struggles against the true financial elite reveal a deepening income gap and flaws in the labor system. In 2000, the top 1 percent of Americans took home 93 percent of national income, a frightening reality epitomized by the ongoing Occupy Wall

[47] Golliver (2011), *CBS Sports*

Street movement.[48] Income inequality is a growing problem not just in the U.S., but in the entire world. But why?

Open market economies are partially to blame, but free trade should not be the chief culprit. The underlying issue is the exploitation of workers and strict policies of wage control. Most of the world's workers are violently underpaid and, without the benefit of a union, they are powerless to do anything about it. *UAM* behavior represents a potentially effective solution, and one that is becoming increasingly popular.

In the U.S. alone there are $12 billion worth of goods and services traded very year without any currency changing hands. This comprises what is known as the *barter economy*, and according to one industry expert it is a business practice that is "on the cusp of exploding."[49]

As more people resort to bargaining the market exchange system should become more efficient, with trades optimized to generate the maximum utility. This behavior may not always be practical or even possible, but individuals and institutions are nonetheless constantly making trading decisions and assigning values to various commodities. Perhaps if they approached trade the way that players in *SOC* do, maybe they would over time be able to tighten the income gap.

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[48] Porter (2011), *The New York Times*
[49] Spitznagel (2012), *Bloomberg BusinessWeek*

These are some of the main takeaways from my experiment and discussion. But no scientific study should ever be considered complete. There are still many unanswered questions from my study of *The Settlers of Catan* that require further thought and examination. For instance, what if a game started as FT and then reverted back to NT halfway through? What if the game switched between the two styles at random? How would players alter their strategies and behavior if they didn't know whether or not trading was an option? What would happen if the game didn't end once a player reached 10 points? Would they players still be competitive? What if players didn't have access to ports or the bank? Would they reduce their trade demands without any alternatives for getting a specific resource?

The answers to these questions and many others are now the responsibility of future economists, who may choose to use my work as a stepping-stone towards new ideas and theories.

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Appendix A

Participant Agreement

By signing this agreement, participants agree to take part in a research experiment that will examine the role of trade in modern economies, using the board game, *Settlers of Catan*, as a model. Participants will play the game in one of two variations (defined below) while the researcher records statistical and empirical data. This data will then be used to complete a Capstone project through the Honors Program at Syracuse University.

This experiment will run for a predetermined period of time during which participants will play *Settlers of Catan* in a controlled environment under the supervision of the researcher. The researcher will not interfere with game play unless requested to do so by participant(s). Individual games may not exceed three total participants and will continue until a participant reaches at least 10 victory points. Participants will be granted access to data from the experiment at the completion of the thesis in April 2012.

Eligibility:

Participants must have played *Settlers of Catan* a minimum of 5 times (any variation), or otherwise shown mastery of the game and its rules as determined by the researcher.

Variations:

Participants will play *Settlers of Catan* according to the rules set forth by the researcher, which will be announced prior to the beginning of the game. Each individual game will either,

(1) Allow trade, according to the standard rules of the game.
(2) Disallow trade between participants. (Port and bank trades will still be allowed.)

Instructions:

Participants must try to accumulate as many victory points as possible by means of any conceivable strategy, including, if necessary, prolonging the game by way of targeting the probable winner. Alternatively, if in the lead then participants must try to end the game as soon as possible. Participants must also follow the three-point rule. * All other rules are as defined in the standard game rulebook.

** A player may not the place the robber (via a 7 roll or a soldier card) on any hex occupied by a player with less than three visible victory points.*

I, _____, hereby agree to abide by the terms of this contract. Furthermore, I understand that violation of this contract at any time will result in my removal from the experiment by the researcher.

_____

_____

Signature *Date*

Appendix B

Sample Data Sheet

Participants: Total VP's - 23

- DB – 10
- KR – 8
- RO – 5

Roll #	Ore	Wheat	Sheep	Brick	Wood	Total	# Trades	# Traded	2:1	3:1	4:1
8	2			1		3					
3		1			1	2					
11	1					1					
4	2	1		1	1	2					
10	1		1		2	3					
5			2			2					
5			2			2					
6		1	1	1		1					
7						0					
5			2			2					1
8	2			1		3	1	5			
9		4				4					
9		4				4					
12						0					
5			3			3					
4				2	2	4	1	2			
4				2	2	4	1	2			
9		4				4					
5			4			4					
8	4			1		5					

10			3		2	5	1	2			
9		4				4					
10			3		2	5					
7						-4					
4				3	2	5					
4				3	2	5	1	2	1		
11	4					4					
8				1		1					
10			4		2	6					

# Rolls	*# Total Resources*	*# Trades*	*# Resources Traded*	*2:1 Ports*	*3:1 Ports*	*4:1 Ports*	*Total Port Trades*	*Total VP's*	*Game #*
58	136	6	14	2	0	3	5	25	FT1
47	146	7	17	1	3	6	10	23	FT2

8				1		1					
11	4					4	1	2			
6			3	1		4					
9		5				5					1
6			3	1		4					
7				0	0	0	1	2			
7						0					
4					3	3					
8	4			1		5					
4					3	3					1
4					3	3					
8	4			1		5					1
7						0					2
10			4		2	6					
6			3	1		4				2	
6			3	1		4					
5			5			5					
8	5			1		6				1	

SUM **146** **7** **17** **1** **3** **6**

Appendix C

74	184	10	27	3	4	4	11	25	FT3
64	168	8	22	4	0	4	9	26	FT4
44	127	6	17	3	0	4	7	20	FT5
85	160	3	7	4	6	3	13	23	FT6
63	132	6	13	3	3	2	8	24	FT7
54	111	6	16	2	0	6	8	23	FT8
56	124	1	3	9	0	1	10	22	FT9
74	212	3	6	8	11	11	30	27	FT10
619	1500	56	142	39	27	44	110	**238**	FT TOT
61.9	**150**	**5.6**	**14.2**	**3.9**	**2.7**	**4.4**	**11.0**	23.8	**FT AVG**

Full Trade Data Set

FT Standard Deviation = 12.85 [calculated in Microsoft Excel]

61.9 +/— 12.85 = (49.05, 74.75)

Sub data set should only include games with between 49 and 75 rolls. This eliminates the following games: FT2, FT5 and FT6.

# Turns	*# Total Resources*	*# Trades*	*# Resources Traded*	*2:1 Ports*	*3:1 Ports*	*4:1 Ports*	*Total Port Trades*	*Total VP's*	*Game #*

Appendix D

NO Trade Data Set

# Rolls	*# Total Resources*	*# Trades*	*# Resources Traded*	*2:1 Ports*	*3:1 Ports*	*4:1 Ports*	*Total Port Trades*	*Total VP's*	
62	162			2	1	16	19	24	NT1
68	167			2	4	6	12	25	NT2
57	149			0	1	8	9	23	NT3
69	206			12	1	17	30	27	NT4
54	117			0	3	4	7	22	NT5
90	211			15	2	6	23	27	NT6
73	181			8	0	8	16	26	NT7
443	1067	40	101	31	18	31	80	172	FT7 TOT
95	216			14	6	7	27	26	NT8
80	183			10	9	3	22	27	NT9
63.29	**152.43**	**5.71**	**14.43**				**11.57**	**24.57**	**FT7 AVG**
58	169			7	0	5	12	26	NT10
706	1761			70	27	80	177	253	NT TOT
70.6	**176.1**			**7.0**	**2.7**	**8.0**	**17.7**	**25.3**	**NT AVG**

NT Standard Deviation = 14.02 [calculated in Microsoft Excel]

70.6 +/— 14.02 = (56.58, 84.62)

Sub data set should only include games with between 56 and 85 rolls. This eliminates the following games: NT5, NT6 and NT8.

Appendix E

Free Trade Correlation Graphs

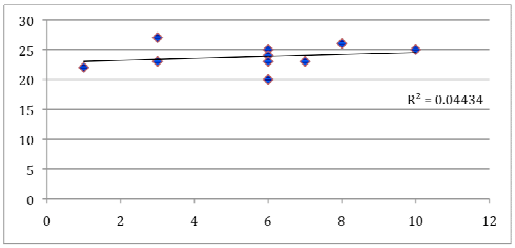
Trades vs. Victory Points

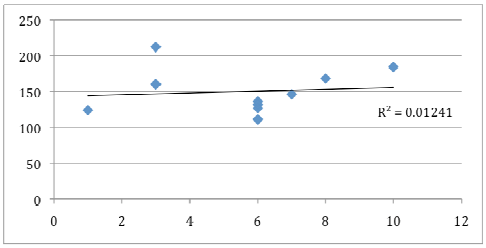
$r^2 = 0.04434$

Trades vs. Total Resources

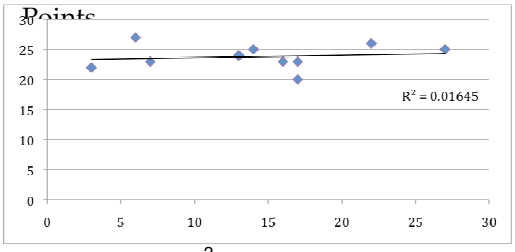
$r^2 = 0.01241$

# Rolls	*# Total Resources*	*# Trades*	*# Resources Traded*	*2:1 Ports*	*3:1 Ports*	*4:1 Ports*	*Total Port Trades*	*Total VP's*	
467	1217			41	16	63	120	178	NT7 TOT
66.71	**173.86**						**17.14**	**25.43**	**NT7 AVG**



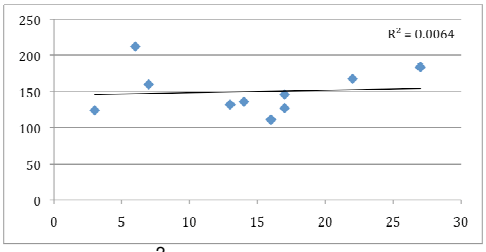


Resources Traded vs. Victory Points



$r^2 = 0.01645$

Resources Traded vs. Total Resources

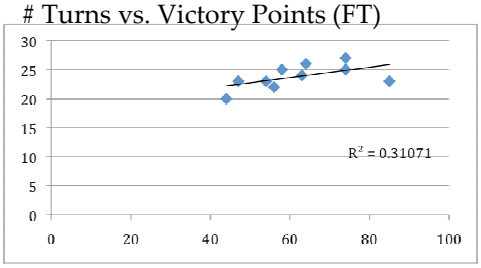


$r^2 = 0.00640$

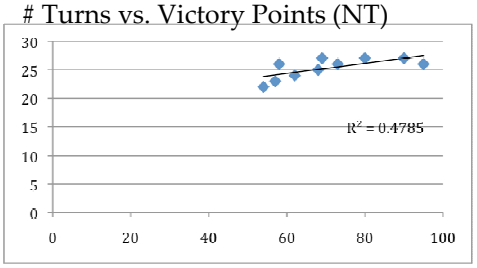
Appendix F

Time Correlation Graphs

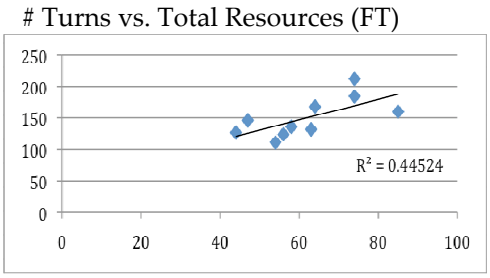
Turns vs. Victory Points (FT)

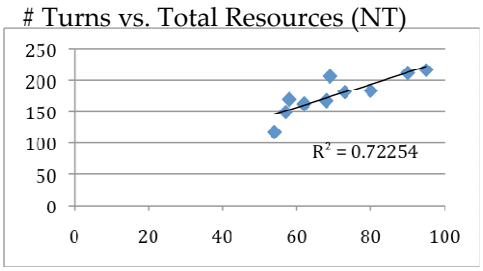


Turns vs. Victory Points (NT)



$r^2 = 0.31071$ $r^2 = 0.4785$





$r^2 = 0.44524$ $r^2 = 0.72254$

Summary of Capstone Project

Games have always been a part of our human culture. From cards to chess to Monopoly, games bring people together and challenge us to adapt and think strategically. In this project I sought to use economic literature and studies to see how one of today's most popular games might help us understand more about the world we live in.

The Settlers of Catan (SOC) is a Euro-style game that was released in Germany in 1995 and is today one of the most popular board

games in the world. *SOC* is essentially a game about growth and trade. The game is played on a fictional island of 19 hexagonal pieces, with each piece representing one of five different resources. Each piece also has a number token, 2-12, representing the possible combinations from a roll of two six-sided dies. Players build settlements on these hexes to begin the game and then roll the dice to produce resources. Players may then use these resources to build, expand and trade for other resources. The goal of the game is to be the first player to reach 10 points, with points awarded for each building as well as other bonuses.

The game was designed to closely model the real world, and it touches on such things as trade negotiations, economic growth and expansion, scarcity and specialization, resource management, government policy and even luck.

I decided to focus on trade. I wanted to know how trade functioned in the game and if it actually mirrored what we see in the real world. To do this I had to set up an experiment. I wanted to isolate trade as the only variable in the game and so I constructed an adapted version of *SOC* where trade was restricted.

I then recruited experienced players to play the original version (FT for free trade) and the adapted version (NT for no trade) as I recorded the results. Among the things I looked at were how many total trades there were, how many resources were traded, how many total resources were

produced and how many total points each player ended the game with. I collected data for 10 FT games and 10 NT Games, and then compared the two data sets.

What I found is that the NT games consistently out produced FT games in terms of both total resources and total points. Even though NT games were statistically longer, they still produced more resources per turn and nearly as many points per turn.

These results go against modern trade theory, which endorses free trade policies for their ability to stimulate economic growth and a higher standard of living. Likewise, economies that are isolated from trade struggle to grow. However, this is not what happened in the experiment.

Players in this study showed a remarkable unwillingness to trade, preferring to use other, more costly means to acquire a resource. I reasoned that this behavior was due to players putting a premium on their resources because they didn't want to help an opponent win. It didn't seem to matter how beneficial a particular trade was to any single player. What mattered is how much *more* advantageous the trade was, meaning how much a player gained versus how much other players gained.

This conclusion isn't any different from traditional utility theory, which states that individuals always seek to maximize their utility, but it does represent a new way of thinking about a typical situation. Instead of maximizing their utility at any one stage in the game, players instead seek

to maximize their utility for the overall game. This requires taking into account how much another player might benefit from any potential deal and, if necessary, rejecting what seems like a mutually beneficial trade.

To apply these findings to the real world I took a look at the labor market, where employers play the role of buyers and workers play the role of sellers, with labor as the prized commodity. I specifically focused on the recent NFL and NBA lockouts to illustrate how professional athletes were behaving like players in *SOC* by demanding the maximum price for their labor and refusing to work until they got the deal they wanted. By prioritizing their long-term interests over their short-term interests, the NFL and NBA athletes were able to coerce the owners into paying a fair price for their labor.

There are other potential applications of these findings, but the main takeaway is that individuals and institutions should approach trade negotiations from a competitive perspective rather than one dominated by sustenance. If enough economies emulate this behavior then gradually the income gap should narrow.