Carnegie Mellon University
Undergraduate Economics

Honors and Awards

The Undergraduate Economics Program is pleased to list the honors, awards, and achievements of our students and teaching awards of our faculty.   The breadth of awards won reflects the academic and community contributions of the economics majors on the Carnegie Mellon campus.

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Program-Level Awards

Best Senior Project (2007-2017)

The award for the Best Senior Project in Economics was established in the 2007-2008 AY. The Senior Project Course is a capstone course in the undergraduate Economics curriculum. The purpose of the senior project is to showcase the qualitative and quantitative skills that the undergraduate economics student has acquired while an undergraduate at Carnegie Mellon. The senior project coursework produces original empirical, experimental, and theoretical studies. This honor is annually awarded during the Faculty-Graduating Seniors Luncheon in May.

2017

"The Effects of EPA RVA Regulations on VOC Emissions" written by Raheela Ahsan, Lilia Bidzyan, Daniel Lee, and Dee Dee Paik

2016

"McDonald's vs. Chipotle: The Rise of Fast Casual Restaurants (A Comparison of the Net Rates of Entry for McDonald's & Chipotle)" written by Charlton Cheng, Michael Hsun, and Michelle

2015

"Examining the Relationship Between Education Inequality and Income Inequality" written by Kelsey Choing, Danielle McKinney, and Yasmin Venema

2014

"Consumer Behavior: Upgrading, who will do it and why?" written by Akwasi Brefo, Maya Geleroff, Zaneta Grant, and Michelle Lin

"A Model for Correlating Growth of GDP and Informality in an Economy" written by Paraj Tyle, Michael Shin, and Nikhil Tibrewal

2013

"The Rise of Green Cars in America: Examining the Price Elasticities of Gasoline and Green Vehicles in Light of the 2008 Recession" written by Irene Kim, Jongwoo Lee, David Sandor, Allen Song, and I-Ta Yang
Abstract: This paper analyzes the effects of the recession on consumer demand for automobiles, and then also compares the price elasticity of green vehicles to the price elasticity of gasoline vehicles after the recession. The motivation for this is to determine if the market share of green vehicles in America could be increased, as this is desirable from an economic and environmental standpoint. More specifically, we are testing the hypotheses that 1) the recession served to increase consumers' sensitivity to pricing of automobiles and 2) that the magnitude of price elasticity of hybrid cars is higher than that of gasoline cars, meaning the market share of green vehicles could be increased through lowering their price. To answer the first question we examined automobile prices and quantities sold for before, during, and after the 2008 recession. Analysis of this data demonstrated that consumers' sensitivity to automobile prices increased with the recession, consistent with our hypothesis. To answer the second question, we compared the prices and quantities sold of both gasoline vehicles and green vehicles for the year 2011. Analysis revealed that green vehicles were more price elastic than gasoline vehicles, consistent with our hypothesis. This paper concludes with ideas to further extend our research and also policy recommendations to help to achieve a larger market share of green vehicles in America.

2012

"Drowning in Economic Sorrow: The Effect of Business Cycles and State Monopolies on Alcohol Consumption" written by Prabhvir Anand, Claire Chin, Shomik Ghosh, Benjamin Gorman, Jennifer Sung, and Steven Yang
Abstract: This paper studies the relationship between alcohol consumption and economic conditions at the state level, in order to analyze the advantages or disadvantages of being a control state, a state in which the alcohol is distributed by the state government, during changes of macroeconomic conditions. The first part of the paper examines whether alcohol consumption is procyclical or countercyclical with

respect to the economy using state-level data series. The second part examines whether being a control state will impact alcohol consumption during macroeconomic changes. While our estimated effects predict somewhat contradictory trends and do not account for much of the variability of alcohol consumption, it is apparent that macroeconomic performance significantly affects alcohol consumption in the United States. This paper also addresses the need for further research, and considers strong policy implications that licensing alcohol sales would not be beneficial for control states.

2011

"Identifying the Factors Influencing Foreclosure in Pennsylvania" written by Claire Herdeman, Jean Hou, and Meredith Lusardi

Abstract: Our analysis examines the causes of foreclosure in Pennsylvania in the turbulent economic times surrounding the 2008 financial crisis. We extend the existing literature into the current economics landscape modifying previous methods and applying them to Pennsylvania. Using county-level demographic and foreclosure data, we use linear regression models to determine what factors affect foreclosure rates. The best predictor of foreclosure rate is high cost loan rate. Using new models, we find that race, education level, and geographic region are all significant determinants of the high cost loan rate.

2010

"How Effective is New Jersey's Council on Affordable Housing?" written by Erica Greenberg, Alexandra Kontopoulos, and Sunny Shen

2009

"Land Value Taxation", written by Johnathan Spiegel, John Sullivan, Angel Wang, Joel Weiss, and Jeremy Wong.

Abstract: Pittsburgh, Pennsylvania is the only large metropolitan area in the United States that has implemented (and rescinded) a land value tax. This paper studies the effects of the land value tax on Pittsburgh's downtown health and urban sprawl. Building data and population density are the primary measures used to observe changes in downtown health and urban sprawl, respectively. While the data is ultimately inconclusive on the effect of the land value tax on Pittsburgh's downtown health and degree of urban sprawl, the data indicates the existence of a "timing effect" of the land value tax. This paper also addresses the need for further research, and considers important public policy implications.

2008

"Smoking Bans: An Analysis of State Smoking Bans and the Potential Effect of a Smoking Ban on the State of Pennsylvania" written by William Lutz, Robert Patenge, Ann Stieh, and Xiao-Lan Wong.

Abstract: This study is designed to determine the expected economic effect of a smoking ban on bars and restaurants in Pittsburgh. In addition, the study explores the current effects of smoking ban in states that have already banned smoking. The former was achieved by a survey of Pittsburgh area bars and restaurants. The results show a discrepancy between bar owner's beliefs and historical data. The latter was formed by data collected from states that have enacted their smoking bans. Further, we have found that enacting a smoking ban has had a significant effect on stopping people from smoking in relevant areas.

2007 (Awarded in 2008)

"A Case Study on Pennsylvania's Economic Landscape after Legalizing Slot Machines" by Jack Kocerka, Michal Lementowski, and Eugene Shiu.

Abstract: This study is designed to determine the revenue, both private and public, that will be generated by "The Pennsylvania Race Horse Development and Gaming Act," which, upon its passage in 2004, legalized electronic gaming devices (EGDs) in Pennsylvania. In addition, the study explored the affects of any potential plan that would legalize table games in Pennsylvania. This was achieved by creating two regression models that were based on data collected from a host of states that have legalized EGDs and table games. The tax portion of the 2004 law was applied to the prediction to determine the public revenue brought in through the legalization of the EGDs. The results show that the revenue brought in by the new law will exceed the expectations of the state. However, the results also show that a proposal to legalize table games would not be as successful.

*2006 (*Awarded in 2008)

"How Much Do International Students Contribute to Diversity on the Carnegie Mellon University Campus?" by Selim Baykal, Marcus Chen, John X. Gu, and Dmitry Nulman.

Abstract: In 2005, CMU had the third largest international student population (2071 international students) in Pennsylvania, and was ranked 37th in the nation. 591 of those students were undergraduate scholars, constituting about 20% of the CMU undergraduate population. Increasing diversity has been the one of the top priorities of CMU's strategic plan; CMU President Jared L. Cohon has personally taken up the responsibility in leading the effort in this area.

Diversity hereby does not only refer to the variety, but also encompasses how well different people mix together as one body. Our main question is how much do international students contribute to diversity in campus? How well do international students socialize with different nationalities and different ethnicities? To answer these questions two surveys were produced: one for international students and the other for American Students. Both surveys were done on surveymonkey.com.

A diversity metric that measures cross-nationality cross-ethnicity socialization and interaction is used to quantify diversity. The metrics includes factors such as "Number of hours spent with American friends weekly", "number of American friends out of 6 closest friends", etc. A regression model is then devised using the diversity scales as the dependent variable. Finally the regressions were analyzed to rank the ethnicities, majors, genders etc according to their sociability and thus diversity in the university. This was done by using hypothesis testing. Indeed, our results highlight the most and least diverse groups on campus as well as social barriers and social catalysts. The information gained from this project will hopefully help the university community better plan for activities promoting diversity in CMU and thus offer a better learning environment for the multi-cultural community.

Best Tepper Senior Honors Thesis in Economics (2007-2017)

The award for the Best Tepper Honors Thesis in Economics was established in the 2007-2008 AY. The Tepper Senior Honors Program in Economics provides qualified students with the opportunity to engage in original research during their senior year at Carnegie Mellon. For many, this process of intellectual inquiry and knowledge creation is the highlight and culmination of their undergraduate academic experience.

2017

"Bitcoins in the Black Market: Criminal Currency in the 21st Century" written by Charlotte Townsend (Advisor: Prof. Stephen Spear)

Abstract: The rising price of the cryptocurrency Bitcoin has resulted in a surge in curiosity to understand the drivers of Bitcoin price. While Bitcoin prices are correlated with many measures, such as gold price and total number of Bitcoins in circulation, Bitcoin still remains a partially speculative asset. Cybercriminals favor cryptocurrencies as a form of payment. Research has shown relationships between criminal activity and Bitcoin interest, and separately Bitcoin interest and Bitcoin price. However, no previous work has shown the direct relationship between criminal activity and Bitcoin price. This research examines the relationship between Bitcoin price and criminal activity and whether the inclusion of criminal activity creates a more predictive model of Bitcoin price.

2016

"Do Women Have a Say: Explaining Variation in Female Participation in Household Decision-Making" written by Richa Mohan (Advisor: Prof. Laurence Ales)

Abstract: We analyze a select set of demographic features that influence women's power in household decision-making, in rural India. Estimates of causal factors are generatued using a large-scale, six-year panel dataset, composed of over 1500 households from eight Indian states. We create a novel composite measure of gender-wise division of household decision making power, reflecting the extent to which women contribute to choices regarding children, contraceptives, healthcare and household assets. We examine variatation in decision-making power across a wide range of social and economic variables, including education, age, caste, and religion.

"Google's Antitrust lawsuits in the EU: Using Microsoft's Past to Predict Google's Future" written by David Moss (Advisor: Prof. Joachim Groeger)

Abstract: Google, one of the largest and most valuable companies in the world, is being sued for allegedly anticompetitive practises regarding two of its most popular products: its eponymous search engine and the phone operating system Android. The verdicts in these cases have the potential to change Google's ascendant trajectory, much as it did for another firm that found itself in a similar position some twenty years ago – Microsoft. By analysing Microsoft's historical lawsuits and building models for specific features found in the technologies and actions of Microsoft, a framework for determining "guilt" in an antitrust case can be developed. Applied to Google, this framework predicts a successful conviction regarding Android, but an unsuccessful one for Google's search product.

2015

"An Econometric Estimation of Deadweight Loss in Pennsylvania's Water Market" written by Brent Heard (Advisor: Prof. Joachim Groeger)

Abstract: Industrial water demand in the state of Pennsylvania is anticipated to increase in the near future due to the expansion of hydraulic fracturing of the Marcellus Shale. Pennsylvania's water markets are increasingly operated by investor-owned water monopolies, and have prices regulated by the Pennsylvania Utility Commission (PUC). The PUC's decisions on whether to approve or deny changes in the price of water can take up to nine months. This thesis estimates the quantity of deadweight loss attributable to this regulatory lag in Pennsylvania's water markets in a scenario of increasing demand. In this work, the model for a natural monopoly facing a price ceiling is defined, followed by an estimation of the relevant cost and revenue curves for a representative Pennsylvania water monopoly, after which residential and commercial water demand were estimated, with deadweight losses then being calculated. Demand is then increased such that market price would exceed the PUC-approved maximum price, which is then charged while the hearing and petitioning process occurs. This analysis calculates increases in estimated deadweight loss of 92.83% for the residential water market, and 40.46% for the commercial market. This finding indicates that if maintaining market efficiency is a goal for the PUC, this commission should aim to respond as dynamically as possible to changing market conditions when regulating monopoly water pricing.

"Examining Applications of Fourier Transforms to Financial Data and Covariance Estimation" written by Stanley Krasner (Advisor: Profs. Karoslav Kryukov and Lars-Alexander Kuehn)

Abstract: Fourier transforms project functions and signals onto a space of orthogonal trigonometric functions. The transform preserves all the information contained in a function and gives insight into the spectral components, or different frequency components, that make up the function. As a result, Fourier trans- forms have been useful in many fields of engineering, mathematics, statistics and finance. This paper will discuss some potential new uses of Fourier transforms in financial time series analysis. First, we show that traditional autoregressive models omit information that is captured by a Fourier transform. We then apply spectral decomposition to obtain better parameter estimates for an autoregressive process with a new estimation technique. For a certain set of parameters, the spectral decomposition estimator is more accurate and more precise than a traditional maximum likelihood estimator. We conclude with a discussion on extending this method to covariance estimation.

2014

"Public Health and Tuberculosis Mortality During the Framingham Tuberculosis Demonstration?" written by Avery Calkins (Advisor: Prof. Karen Clay)

Abstract: Between 1900 and 1940, tuberculosis declined rapidly in the United States, even though there was no effective medical treatment or vaccine for tuberculosis until after the Second World War. Public health improvements are often used to explain the decline in tuberculosis, and studying what public health improvements helped in the United States can help combat tuberculosis in the developing world today.

Little quantitative research has been done on the decline of tuberculosis in the United States. My project investigates the little-known Framingham Community Health and Tuberculosis Demonstration, during which several public health improvements were made on the small town of Framingham, Massachusetts to reduce tuberculosis incidence and mortality, to find which public health improvements were effective in reducing tuberculosis

2013

"Diversity Considerations in School Choice: Developing Fair and Effective Mechanisms" written by Karthik Nagarajan (Advisor: Prof. Isa Hafalir)

Abstract: Controlled school choice policies aim to provide families a choice as to which school their child will attend while maintaining diversity in schools. These policies are often implemented in the form of minimum and maximum quotas on student types (that can be based on race, ethnicity or socioeconomic factors). When these quotas are interpreted as hard bounds, standard fairness and non-wastefulness properties are compromised, imposing a cost on student welfare. By interpreting the minimum quota as a flexible guideline (a "soft" bound), I employ a mixed interpretation of these quotas to formulate a modified version of the student-optimal deferred acceptance algorithm that guarantees fairness. Furthermore, I show that both this and a purely soft interpretation of the diversity bounds can be used to formulate effective mechanisms that ensure fairness, even in settings with notionally hard bounds.

2012

"The Determinants of Self-Employment in Mexico and Household Transitions Between 2002 and 2005" written by Yaqi Niu (Advisor: Prof. Rebecca Lessem)

Abstract: The study of self-employment has been an intriguing factor in many developing countries. However, not many empirical studies analyze self-employment on a household level. This research focuses on Mexico in 2002 and 2005 and investigates the determinants of self-employment, transitions between self-employment and the labor market, and these transitions across asset levels all from the household perspective. The results show that high school education, asset level, previous self-employment experience and household size are important determinants of self-employment. The transition between self-employment and labor market is not homogenous across asset levels, because higher asset level increases chances of self-employment. Lastly, self-employment status decreases income, suggesting that a self-employed household will earn higher income if it were to enter the labor market.

2011: Not awarded

2010

"Finding Nash Equilibria in Asymmetric Auctions with Resale: Numerical and Analytical Developments" written by Richard M. Katzwer (Advisor: Prof. Isa Hafalir)

2009

"Do Special and Charter Schools Help Attainment in Public Schools?" written by André Tartar (Advisor: Prof. Maria Ferreyra)

2008

"Anti-Foreign Sentiment in the California Gold Rush" written by Robert L. Jefferson (Advisor: Prof. Karen Clay)

Abstract: In this paper, I provide a quantitative and historical analysis of the "California thesis" of anti-foreign legislation (Sandmeyer 1991; Gyory 2000). In other words, were the conditions during the Gold Rush a significant precursor to federal policies starting with the Chinese Exclusion Act of 1882? While there are competing theories for the development of anti-immigrant legislation, most notably the political influence of unions and a racist social and political climate, I suggest that these are not immediately contrary to the Gold Rush argument.

The Gold Rush provides a context for mass migration into California that otherwise would not have occurred to such a strong degree. That influx of immigrants, especially Chinese, provided a significant labor base for the Transcontinental Railroad, which became a primary vector for Chinese migration from California to the rest of the United States. By examining voting patterns in light of conditions in California during the Gold Rush compared to the national patterns over subsequent decades, I attempt to shed light on the similarities between the California and national experiences.

Meeting of the Minds

The annual celebration of undergraduate research, Meeting of the Minds - Undergraduate Research Symposium, is one of the most exciting events on our campus; it is a day when undergraduate students come together and present their research to their peers and faculty. We encourage everyone to attend - play with a new robot, hear a concerto, listen to a poem, consider the effects of poverty on primary education achievement in third world countries, find out about emerging technologies....and more. Each year, student projects are recognized for their innovation, creativity, and contribution to the discipline. Below you will find a list of competitions in which Undergraduate Economics Program students have been recognized.

Meeting of the Minds: Undergraduate Economics Program Competition (2010-2015)

A goal of the Undergraduate Economics Program is to encourage students to think creatively and bring together their formal training with their passions. Eligibility: Open to any undergraduate student pursuing a degree in Economics or team of undergraduate students enrolled in an UEP course. Eligible prospects include students writing a senior thesis in Economics and projects developed in UEP courses (including independent study Students meeting the eligibility requirements must participate in the "Oral Presentations" category during Meeting of the Minds in order to be considered for the award. Participating in the "Poster Sessions" is not sufficient. Judging is based on the following factors: a) the quality of the abstract; b) intellectual process and results described in the presentation; and c) presentation skills (including Q&A) during the Meeting of the Minds.

2015

*First Place (tie): Brent Heard (Economics, Class of 2015): "*An Econometric Estimation of Deadweight Loss in Pennsylvania's Water Market*"*
Abstract: Industrial water demand in the state of Pennsylvania is anticipated to increase in the near future due to the expansion of hydraulic fracturing of the Marcellus Shale. Pennsylvania's water markets are increasingly operated by investor-owned water monopolies, and have prices regulated by the Pennsylvania Utility Commission (PUC). The PUC's decisions on whether to approve or deny changes in the price of water can take up to nine months. This thesis estimates the quantity of deadweight loss attributable to this regulatory lag in Pennsylvania's water markets in a scenario of increasing demand. In this work, the model for a natural monopoly facing a price ceiling is defined, followed by an estimation of the relevant cost and revenue curves for a representative Pennsylvania water monopoly, after which residential and commercial water demand were estimated, with deadweight losses then being calculated. Demand is then increased such that market price would exceed the PUC-approved maximum price, which is then charged while the hearing and petitioning process occurs. This analysis calculates increases in estimated deadweight loss of 92.83% for the residential water market, and 40.46% for the commercial market. This finding indicates that if maintaining market efficiency is a goal for the PUC, this commission should aim to respond as dynamically as possible to changing market conditions when regulating monopoly water pricing.

First Place (tie): *Stanley Krasner (Economics and Mathematics, Class of 2015) "Examining Applications of Fourier Transforms to Financial Data and Covariance Estimation"*
Abstract: Fourier transforms project functions and signals onto a space of orthogonal trigonometric functions. The transform preserves all the information contained in a function and gives insight into the spectral components, or different frequency components, that make up the function. As a result, Fourier trans- forms have been useful in many fields of engineering, mathematics, statistics and finance. This paper will discuss some potential new uses of Fourier transforms in financial time series analysis. First, we show that traditional autoregressive models omit information that is captured by a Fourier transform. We then apply spectral decomposition to obtain better parameter estimates for an autoregressive process with a new estimation technique. For a certain set of parameters, the spectral decomposition estimator is more accurate and more precise than a traditional maximum likelihood estimator. We conclude with a discussion on extending this method to covariance estimation.

2014

First Place (tie): Paul Ko (Mathematics, Economics, Class of 2014): "Controlled School Choice with Mixed Bounds Approach: A Balance Between Stability and Diversity Considerations"

Abstract: Controlled school choice over public schools has been an important concern for both the parents of students and school. It gives numerous options for how fairness and diversity consideration can be balanced. The notion of diversity is often imposed by limiting the number of admitted students who have the same type (quotas), or by reserving seats for each student type (reserves). The controlled school choice rule that we explore in this paper is the combination of "reserves" and quotas," where schools implement minimum reserves (a "soft" bound) and maximum quotas (a "hard" bound) together. In this paper, we provide a full characterization of the mixed bounds approach, and show that it satisfies the requirements for the existence of a student-optimal stable matching.

First Place (tie): Avery Calkins (Economics, Class of 2014): "Public Health and Tuberculosis Mortality During the Framingham Tuberculosis Demonstration?

Abstract: Between 1900 and 1940, tuberculosis declined rapidly in the United States, even though there was no effective medical treatment or vaccine for tuberculosis until after the Second World War. Public health improvements are often used to explain the decline in tuberculosis, and studying what public health improvements helped in the United States can help combat tuberculosis in the developing world today.

Little quantitative research has been done on the decline of tuberculosis in the United States. My project investigates the little-known Framingham Community Health and Tuberculosis Demonstration, during which several public health improvements were made on the small town of Framingham, Massachusetts to reduce tuberculosis incidence and mortality, to find which public health improvements were effective in reducing tuberculosis

2013

First Place: Jung Moon Jang (Economics and Statistics, Class of 2013): "The Relationship Between the Unemployment Rate and Birthrate in Korea"

Abstract: Through this research, I have looked at the relationship between the unemployment rate and the birth rate with a focus in Korea. For past few decades, despite the high volume of students obtaining undergraduate degrees, the unemployment rate has constantly increased, bringing about a critical social issue. On the other hand, families have been giving birth to fewer children or no child at all despite the government's efforts to financially aid parents to raise their children. Because of this phenomenon, a new term called 'Sampo generation' has emerged, describing people in their 20s and 30s giving up on three things since they can't economically support themselves: dating, marriage, and giving birth. It has been hypothesized that since the unemployment rate is high, more people are having fewer kids as a consequence because it costs money and time to raise kids which parents in nowadays can't afford with their own incomes. Believing there are many other factors behind this issue, I have selected other variables such as political perspectives, income levels, and education levels of parents etc. from the Korean Statistical Information Service between 1990 and 2011 to include in a panel dataset. I have discovered that there is a negative relationship between birth rate and unemployment. In addition, parents' education levels, political perspectives, activity rates, and income levels are also significant variables.

Second Place (tie): Oliver Haimson (Economics, Class of 2013): "Where are They Now? Analyzing Gender Differences in Executive Exit Patterns"

Abstract: One of the main reasons that the representation of female executives is lower in top ranks relative to lower ranks is that female executives exit the market at a higher rate than male executives. In particular, one hypothesis is that discrimination against females exists in this market, while another hypothesis is that female executives exit more frequently for other reasons, such as family. This project aims to examine the reasons why female executives leave their positions at a significantly higher rate than male executives. While some explanations can be ruled out by observing promotion and compensation of executives who remain in the occupation, it is not possible to directly address issues of discrimination without observing the outcomes of executives after they leave.

To address this question, I research a data set of female and male executives, using databases and web searches to collect data on their exit reasons and next steps after exiting their positions. An analysis of the data finds that female exit reasons differ significantly from male exit reasons in several important ways.

Female executives were found to be more likely to be fired, less likely to retire or resign, and more likely to move onto a public company than their male counterparts, even when controlling for human capital and job-related variables. While these results suggest the possibility of workplace discrimination against female executives, more research would be needed to argue this conclusively.

Second Place (tie): Karthik Nagarajan (Economics, Class of 2013): "School Choice: Diversity Constraints"
Abstract: Controlled school choice policies are often implemented in the form of "hard" quotas on student types (e.g. race, gender, location). Results from literature show that the standard fairness property is not satisfied under such "hard" quotas. As a compromise between fairness and diversity restrictions, I employ a mixed interpretation of these quotas (in which the minimum quotas are "soft" and maximum quotas are "hard") to formulate a modified version of the student-proposing deferred acceptance algorithm that satisfies the desired fairness property. This algorithm also provides an improvement in controlled diversity over a purely "soft" quotas approach, but at the cost of non-wastefulness, reflecting the welfare-diversity trade-offs inherent in controlled school choice.

2012

First Place (tie): Ashish Thakrar (Economics, Class of 2012): "The Rising Cost of Diabetes Care: Annual and Geographic Variations in Expenditures, Decomposed by Price and Utilization"
Abstract: This project aims to analyze health care spending for patients with diabetes from 2006 to 2010. We begin by reviewing descriptive data on rising health care costs and the rising prevalence of diabetes nationwide, with a focus on the state of Florida. In our analysis, we use inpatient hospital data from Florida to construct an index that measures changes in health expenditures for diabetics. Based on these calculations, inpatient hospital spending on diabetes increased 23% for those insured by Medicaid, 25% for those insured by Medicare, and 10% for those with private insurance. We decompose these expenditure indexes into price and quantity components to understand whether increased spending is driven by higher prices or increased utilization. These indices are further broken down into age and sex cohorts. Overall we find significant variation in price and quantity changes, with the highest price increases for Medicaid recipients and greatest utilization increases for those with private insurance. Shifts in expenditures for females were generally driven by increased utilization, while shifts in expenditures for men were driven by price increases.

First Place (tie): Lyubov Zeylikman (Economics, Class of 2012): "What's the Deal with Free Shipping?"
Abstract: E-commerce giants like Amazon Prime and Zappos are known for their offering of unconditional free shipping on purchases. However, while the results are clear, the reasons why this phenomenon occurs are not. We develop an experimental model based on Michael Lewis' and Yinghui Yang's findings which support that medium thresholds for free shipping incentivize consumers to buy higher quantities of goods more than low, high, and free shipping thresholds. In our model we also include a fixed shipping rate condition with no option to earn free shipping. We report the results of an experiment to test the effects of offering varied schedules for earning free shipping in a simulated online shopping environment. 34 Carnegie Mellon students participated in an experiment with a given endowment and shopping list, to purchase items across 3 periods, per 6 different conditions. The performance during the experiment was judged based on whether the participant performed optimally. Results are in agreement with the model, supporting that the medium threshold condition incentivizes participants to buy higher quantities of goods more than other conditions.

Second Place: Alisa Deychman (Economics, Class of 2012): "Merger Retrospective: Examining Kimberly-Clark and Scott Paper Company Merger"

2011

First Place: Dina Megretskaia (Economics, Class of 2011): "Investigating the Effect of Payment Medium on Consumer Spending"
Abstract: Much interest has been directed towards the credit card industry in the past several years, in part because of households' increasing debt levels. I am interested in whether credit cards inspire higher spending, not for liquidity reasons but merely due to lack of salience of the amount being spent. It is my hypothesis that method of payment affects how much consumers spend, specifically that paying with credit card leads to higher spending than paying with cash. By conducting a field experiment with random

assignment of payment medium, I intend to study whether there is a causal relationship between payment medium and spending amount.

Second Place: Sebastian Wai (Economics, Class of 2011): "Tracking Semiconductor Inventors in Silicon Valley and Beyond"
Abstract: This project is a methodical, in-depth study on the origins of inventors in the semiconductor industry. Inventors are identified through patent data, then tracked using both patents and biographical sources. Data collected on inventors is then used to profile the hiring patterns of a variety of semiconductor firms across the country and across the history of the industry. The analysis focuses on geography, education, and employment history, as well as a defining feature of the industry: interplay between parent and spinoff firms.

Third Place: Shweta Suresh (Economics, Class of 2011): "Impact of Social Risk Aversion and Audience Effects on Generosity to the Poor"
Abstract: This paper is focused on understanding the impact of social risk aversion and audience effects on generosity from the relatively well-off to the poor. By conducting dictator games, I have collected data that measures how much people decide to donate to a disabled person or a drug or alcohol user under different situations. My experiment modifies Christina Fong and Felix Oberholzer-Gee's prior experimental design in order to better identify how the two separate phenomena of social risk aversion and audience effects work to alter donors' decisions, especially when they are given the option to purchase information about the welfare recipient. Understanding these motivations behind people's decision to donate is important because this information allows governments and NGOs to better structure transfer programs.

Fourth Place: Akshay Upadhyay (Economics, Class of 2011): "Increasing Reliability: Attracting More Clients to Microfinance Institutions"
Abstract: Dr. Muhammad Yunus was awarded the Nobel Peace Prize in 2006 for his efforts to break large population groups out of poverty, through the formation of Grameen Bank. Grameen Bank provided small loans to the poorest of the rural population in Bangladesh. Its goal was to spur economic development from the bottom of the income chart. Dr. Yunus felt that making this credit available to the poor would serve as a catalyst for improving their socio-economic conditions. Economists say that, "Bottom-up initiatives like microcredit allow rural-based development," which will help halt the cycle of poverty that the poor are forced to deal with. October 2, 1983 marked the formation of the Grameen Bank, the first official bank for the rural poor. Since then, the industry has grown to approximately 10,000 microfinance institutions serving over 113 million clients worldwide. Approximately 32.6% of the world population, or 2.2 billion people, are below the poverty line. The availability of microfinance institutions is known by close to 750 million of these people. But only approximately 15% of these people are actually clients of microfinance institutions despite the arising of financial needs. This presentation provides an analysis of existing policies on microfinance loans. Also, behavioral economic anomalies will be used to propose a new policy on microfinance loans in the hope of attracting more clients to microfinance institutions

2010
First Place (tie): Engin Levent Altinoglu (Economics, Class of 2010): "Do Zoning Ordinances Affect the Distribution of Housing?"
Abstract: In his 1975 paper in Urban Affairs, Bruce Hamilton wrote about how his extension of the Tiebout model of housing predicts the institution of zoning ordinances effect the distribution of housing. However, not much is known about how well Hamilton's predictions explain real world data. It is often assumed that the implementation zoning ordinances has the desired effect of producing individual communities characterized by a range of lot sizes, but few empirical studies have been conducted examining if this is true, or if an effect of their implementation on the distribution of housing really exists. This study examines data collected from Arizona's Maricopa County to see if the implementation of minimum lot size zoning in ten of its largest municipalities has an effect on the distribution of housing, and if so, the nature of the effect. Using the Hamilton's paper as a guide, the researcher's hypothesis is that the zoning restrictions have a significant effect on the distribution of housing, resulting in bunching of housing near the minimum lot sizes within each municipality and a high ratio of variance across municipalities to variance within municipalities. The data included information about all lots in each

municipality including lot size, property type, municipality to which it belongs, and property value. The results were somewhat mixed, but overall, the analysis suggests that the zoning restrictions have little, if any, effect on the distribution of housing. To summarize the important results, we do not see bunching of housing near the minimum lot size values in each municipality. The method of decomposition of variance indicated that, for certain regressions, the variance across municipalities is much smaller than that within municipalities. In conclusion, there is not sufficient evidence to conclude that the implementation of minimum lot size zoning has any effect on the distribution of housing in Maricopa County.

First Place (tie): D. Scott Taylor, (Economics and Statistics, Class of 2010): "Modeling the Price Dynamics of Catastrophe Bonds"
Abstract: This work modifies the assumptions of Burnecki, Kukla, and Taylor's paper "Pricing of Catastrophe Bonds" to build a pricing model for indemnity-based catastrophe bonds, allowing for the possibility of partial default.

Meeting of the Minds: Statistics Department Competitions (2009-2017)

This competition is sponsored by the Department of Statistics. Its purpose is to encourage undergraduate projects and research in statistics, and to inform faculty and students about these projects. The competition is open to any student or team of students who have completed a project under supervision of a Statistics faculty member. A panel of judges will rate the projects according to the following criteria: quality of abstract; clarity of objective; organization of thoughts; general quality of work; significance of work; oral presentation skills; visual presentation quality; appropriate use of statistical methods; and responses to questions.

Oral Presentations
2017
Second Place Oral Presentations: Blaine Cole (Economics and Statistics, Class of 2017), "Why do People Retweet? An Analysis of the Effect of Sentiment and Rhetorical Devices on Retweeting"

Honorable Mention Oral Presentation: Honorndrew Bryan and Shichen Yang (Economics and Statistics, Class of 2017); Apoorva Havanur, Emily Helfer, and Naveen Shankar), "Identifying Donor Trends for the Pittsburgh Civil Light Opera"

Harit Agrawala (Economics and Statistics, Class of 2017), Jack Kroger (Economics and Statistics, Class of 2017), Sameer Dhavalikar, Megan Fu), and Barbara Samaniego (Economics, Class of 2017), "Post-Consumer Food Waste"

2016
Honorable Mention Oral Presentation: Meghna Baskar (Economics, Class of 2017), Kiersten), Suvrath, Rohit Srungavarapu Skye Toor), "Port Authority Bus Reliability Across Pittsburgh Neighborhoods"

Honorable Mention Oral Presentation: Timothy Fitzgerald (BHA in Economics and Music Technology, Class of 2016), Dee Dee Paik (Economisc, Class of 2017), Daniel Park (Economics and Statistic, Class of 2017s), Siqi Yang, Derek Young "Optimization of Spaces in Hunt Library"

2014
First Place Oral Presentations: Emily Wright (Economics and Statistics, Class of 2014): "Artist Music Discovery: The Digital Road to the Top of Radio"
Abstract: Radio is a powerful medium with a vast and all encompassing audience reaching about 244.5 million consumers a year (Nielsen, 2014). Consequently, a music artist's position on the top radio charts is a primary measure of success in the music industry. It is of particular interest to record labels to identify artists whom are most likely to hit the top charts of radio. One way to do so is to monitor artists' activity on online streaming services and social media. It is believed artists with the highest activity are expected to reach radio's merit of success. This paper is a formal inquiry and analysis examining the relationship between an artist's online presence and their appearance on the top charts of radio. A Cox Proportional Hazards model was fit predicting an artist's presence on radio with usage on Facebook, Wikipedia, Twitter, Youtube, Vevo and Soundcloud as explanatory variables. The final findings can be used to inform

artists how best to promote themselves and further can aid record labels in choosing which artists to sign and promote.

Honorable Mention Oral Presentations: Zachary Branson (Economics and Statistics, Class of 2014): "Comparing Propensity Score Methodologies for Analyzing High School Class Assignment"
Abstract: Students' class assignment is extremely relevant to their academic achievement, but the problem of assigning a student to the correct class is difficult to assess. It may not be clear whether a student should be placed in remedial, regular, or advanced math classes, but it could greatly affect how a student does in school. All school districts face this problem, but the solution is not readily apparent. This project assesses several methodologies – focusing on propensity scores – to analyze this problem, and determines which one is most effective for analyzing school data.

One can view class assignment as a causal inference problem, where class assignment is a treatment. In reality a student is assigned to only one class difficulty, and we want to determine how their academic achievement would be affected if they were, counterfactually, assigned to a different class. Thus, we want to determine the treatment effect of class assignment. Propensity scores are a common way to analyze observational data to assess treatment effects when the treatment is nonrandom. Class assignment is nonrandom because school districts likely use students' test scores, grades, and other information for their class assignment.

There are several methodologies for utilizing propensity scores, but it isn't clear which one is the most useful for analysis. This project compared methodologies such as (1) including hierarchy in modeling propensity scores, (2) matching, and (3) stratifying propensity scores to determine which was the most effective with the purpose of analyzing real-world data from Pittsburgh Public Schools.

2010: Not Awarded

2009
First Place Oral Presentations: Michael Albrecht (Statistics, Class of 2009), Vinith Annam (Economics and Statistics, Class of 2010), and Nicole Mattison (Economics and Statistics, Class of 2009): "Brain Activity of a Sedated Cat"

Abstract: We are interested in determining the neural effects of an external visual stimulus on a sedated domestic cat. In this study, researchers make a cat look at a television screen with bars moving across the display, while filming the cat's brain to look for changes. However, the largest changes in the video are not caused by neural activity, but rather by the direct effects of respiration and circulation, which interfere with the cat's brain activity. Our objective is to remove these extraneous effects from selected parts of the original data, so that others can study the relationship between the external visual stimulus and the "corrected" data. Our approach uses Fourier analysis to isolate and filter out the periodic effects of respiration and circulation.

Poster Presentations

2014
Honorable Mention Poster Session (tie): Daniel In (Economics & Statistics, Class of 2014), Karn Mishra (Economics and Statistics, Class of 2015), Joseph Pane (Statistics): "De-Duplication of Civil War Killings in El Salvador"
Honorable Mention Poster Session (tie): Aashna Singh (Economics & Statistic, Class of 2014s), Hannah Worrall (Economics & Statistics, Class of 2014), Tony Zhang (Mathematics), Ruiqi Zhao (Business Administration): "Stress Level at CMU and Solutions"

2013
Third Place Poster Session: (Economics and Statistics, Class of 2014), Shaina Mitchell (Mathematics), and Sarah Peko-Spicer (Economics and Statistics, Class of 2013): "Absence and Achievement in Pittsburgh Public Schools"

2012

First Place Poster Session: Brandon Ngiam (Mathematics), Carl (Ted) Sturges (Economics and Statistics, Class of 2012), and Anna Svirsko (Mathematics): "Anti-Piracy Laws and Box Office Sales: A Case Study in France"

Second Place Poster Session: Michael Pane (Economics and Statistics, Class of 2013), Nicholas Rock (Economics and Statistics, Class of 2013), and George Volichenko (Statistics): "Reducing Costs for the Port Authority"

Honorable Mention Poster Session (3-way tie): Benjamin Gorman (Economics, Class of 2012), Chelsea Grindle (Mathematics), and Jongwoo Lee (Economics, Class of 2013): "Internet Piracy at CMU: Student Behavior and Options"

Honorable Mention Poster Session (3-way tie): Nancy Geronian (Economics and Statistics, Class of 2013), Jung Moon Jang (Economics and Statistics, Class of 2013), Jeff Lee (Economics and Statistics, Class of 2012), Kaylee Makel (Economics, Class of 2013), and Victor Wilczynski (Economics, Class of 2013): "Census on Parking Meters at CMU"

Honorable Mention Poster Session (3-way tie): Elizabeth Lorenzi (Economics and Statistics, Class of 2013), Joon Su Min (Economics and Statistics, Class of 2013), and Laura Patzer (Statistics): "Analysis of Film Distributor's iTunes Promotion"

2011
First Place Poster Session: Yi Xiang Chong (Mathematics), Christine Ibaraki (Statistics), Chun Wa (Davy) Mok (Mathematics, Economics, Class of 2012): "Classroom Salon: Text Mining and Clustering"

Second Place Poster Session: Brittanie Boone (Economics & Statistics, Class of 2012), Erica Choi (Chemistry), Thomas Todd (Statistics): "Investigation of the Results from the Content Focusing Coaching Study and Evaluating the Alternative Hierarchical Models.

Third Place Poster Session: Emily Boncek (Mathematics and Statistical Sciences), Yinglu Yao (Statistics), Xiaoyu Zhu (Economics & Statistics, Class of 2012): "Exploring Learning Rates: Do Students Learn at Different Rates?"

2010
First Place Poster Session: Emily Butler (Statistics), Argi Harianto (Economics and Statistics, Class of 2010), Christopher Makris (Statistics): "Teaching Assessment of Fourth and Fifth Grade Teachers"

Third Place Poster Session: Joseph Burgess (Information Systems, Economics, Class of 2010), Alexandra Lecompte (Economics, Class of 2010), John Lee (Economics, Class of 2010), Benjamin McGrath (Economics, Class of 2010): "CMU Students' Perceptions of Distribution of the Mandatory Fees Across Non-Academic Resources"
Abstract: Carnegie Mellon University has compulsory activities fees as part of its tuition. However, the student's participation in deciding how to spend the funds is limited by institutional constraints. This research study will analyze CMU student's awareness and perceptions of how funds are distributed for non-academic resources. Moreover, the survey will evaluate to what degree CMU students might want to participate in the decision-making process. In order to make inferences about our target population most accurately, we will use the complete list of names of undergraduate students form the most recent copy of the student directory (C-Book) as our sampling frame. We will draw an SRS without replacement from this frame to form our sample.

Fourth Place Poster Session: Da Jeong Ha (Mathematics), Hyemin Lee (Economics and Statistics, Class of 2010), Kunho Lee (Mathematics): "Correcting Aperture Bias for Star Formation History Estimates"
Abstract: The method of using spectra to estimate various star formation history ("SFH) parameters for distant galaxies is often insufficient for usage in astronomical research. For some galaxies, the spectral aperture is smaller than the angular extent of the galaxy, meaning that the spectrum will fail to capture some of the galaxies' light. In this case, the SFH parameters measured using such spectra will often be

inaccurate, and such discrepancy between the true SFH parameters and their spectral estimates is called aperture bias in SFH estimates. In this project, we present a method that corrects aperture bias in three SFH estimates: the current star formation rate of each galaxy, the average ages and the average metallicities of the stars within the galaxy. Specifically, we model each SFH parametwe that was estimated from the spectrum as a function of the four photometric colors measured in the regions seen by the spectrum. Using this model, along with the photometric colors of the light missed by the spectrum, we correct the SFH estimates for their aperture bias. We use the spectral SFH estimate and the Sloan Digital Sky Survey photometry from a sample of 50,000 galaxies.

2009
First Place Poster Session: Michael Albrecht (Statistics, Class of 2009), Vinith Annam (Economics and Statistics, Class of 2010), and Nicole Mattison (Economics and Statistics, Class of 2009): Brain Activity of a Sedated Cat"
Abstract: We are interested in determining the neural effects of an external visual stimulus on a sedated domestic cat. In this study, researchers make a cat look at a television screen with bars moving across the display, while filming the cat's brain to look for changes. However, the largest changes in the video are not caused by neural activity, but rather by the direct effects of respiration and circulation, which interfere with the cat's brain activity. Our objective is to remove these extraneous effects from selected parts of the original data, so that others can study the relationship between the external visual stimulus and the "corrected" data. Our approach uses Fourier analysis to isolate and filter out the periodic effects of respiration and circulation.

2008
Second Place Poster Session: Mike Carney (Statistics), Grace DeForest, Kenneth Ip (Economics and Statistics, Class of 2008), Katherine Kardaras (Mathematics), and Eileen Tucker (Mathematics): "Using Assistment Measures to Predict Student Proficiency"

Omicron Delta Epsilon ($O\Delta E$), The International Honor Society
In 1969, a Carnegie Mellon University chapter was admitted to Omicron Delta Epsilon, the International Honor Society in Economics. As written in its philosophy statement, "Omicron Delta Epsilon is dedicated to the encouragement of excellence in economics. It encourages devotion on the part of its members as economists to the advancement of their science and to the scholarly effort to make freedom from want and deprivation a reality for all mankind."

2016-2017 Nominees
Andrew Affable (Clase of 2018)
Mohin Banker (Class of 2017)
Eric Coolbaugh (Clase of 2018)
Jian Chao Huo (Class of 2017)
Colleen Fang (Clase of 2018)
Stanley Goldcer (Clase of 2018)
Apoorva Haanur (Clase of 2018)
Yong Hwan Kim (Clase of 2018)
Jack Kroger (Class of 2017)
Daniel Lee (Class of 2017)
Eric Lee (Clase of 2018)
Eric Li (Class of 2017)
Fei Lu (Clase of 2018)
Ari Mapua (Clase of 2018)
Dorsa Massihpour (Class of 2017)
Michael McCaffrey (Class of 2017)
Mohak Nahta (Class of 2017)
Manvendu Najeevan (Clase of 2018)
Noshin Nova (Class of 2017)
Daniel Park (Class of 2017)

Benjamin Pierce (Clase of 2018)
Shaan Phagura (Class of 2017)
Joshua Ragen (Clase of 2018)
Mrinalini Samanta (Clase of 2018)
Mark Saporta (Clase of 2018)
Yoona Seon (Class of 2017)
Aashl Shah (Class of 2017)
Gujri Singh (Class of 2017)
Aileen Tan (Clase of 2018)
Frances Tso (Clase of 2017)
Kunal Wadwani (Class of 2017)
Suren Wanasundera (Clase of 2018)
Shichen Yang (Clase of 2018)
Siqi Yang (Class of 2017)
Qiutong Ye (Class of 2017)
Boyan Zhang (Clase of 2018)
Marianne Zhao (Class of 2017)

2015-2016 Nominees
Eric Alpert (Class of 2016)
Brendan Badia (Class of 2016)
Peter Brady (Class of 2017)
Jiaqi Chen (Classs of 2017)
Yitian Feng (Class of 2016)
Max Goetschel (Class of 2016)
Rishab Khemka (Class of 2016)
Ryan Lapre (Class of 2017)
Michelle Ong (Class of 2016)
Anwesha Patnaik (Class of 2016)
Theodore Peterson (Class of 2017)
Michael Rosenberg ((Class of 2017)
Aaron Tian (Class of 2017)
Charlotte Townsend (Class of 2017)
Vaasavi Unnava (Class of 2017)
Steven Wang (Class of 2016)
Jiayin Yuan (Class of 2016)

2014-2015 Nominees
Patrick Brown (Class of 2015)
Anushi Chawla (Class of 2015)
Nivedita Chopra (Class of 2015)
Justin Fischler (Class of 2015)
Brent Heard (Class of 2015)
Shreya Jhawar (Class of 2015)
Radowan Khan (Class of 2015)
Anusha Kukreja (Class of 2016)
Richa Mohan (Class of 2016)
David Moss (Class of 2016)
Michael Spinelli (Class of 2015)
Samuel Walters Class of 2016)

2013-2014 Nominees
Adrian Botta (Class of 2015)
John Cusick (Class of 2015)
Shivika Dhar (Class of 2014)
John Foo (Class of 2014)

Ronald Fudala (Class of 2015)
Sung Jin (Kevin) Hong (Class of 2015)
Kyongche Kang (Class of 2014)
Radowan Khan (Class of 2015)
Stanley Krasner (Class of 2015)
Mei Chun Kuo (Class of 2014)
Jonghwan (Brian) Lee (Class of 2015)
Danielle McKinney (Class of 2015)
Ian Meeker (Class of 2015)
Robert Mohan (Class of 2014)
Dong Jin (Michael) Shin (Class of 2014)
Hannah Worrall (Class of 2014)

2012-2013 Nominees
Vladislav Bouchouev (Class of 2013)
Kevin Bao (Class of 2013)
Zachary Branson (Class of 2014)
Avery Calkins (Class of 2014)
Nancy Geronian (Class of 2014)
Jung Moon Jang (Class of 2013)
Kidong Justin Kim (Class of 2013)
Ela Kulkarni (Class of 2013)
Elizabeth Lorenzi (Class of 2013)
Joon Su Min (Class of 2013)
Karthik Nagarajan (Class of 2013)
Eunhyun (Erin) Ryu (Class of 2014)
Sarah Peko-Spicer (Class of 2013)
David Sandor (Class of 2013)
Ahmad Shamsuddin (Class of 2013)
Nikhil Tibrewal (Class of 2014)
Paraj Tyle (Class of 2014)
Emily Wright (Class of 2014)
Lydia Yi (Class of 2013)

2011-2012 Nominees
Prabhvir Singh Anand (Class of 2012)
Victoria Baggio (Class of 2013)
Michelle Berman (Class of 2012)
Jae-Eun (Jenny) Chang (Class of 2013)
Zhijun Huang (Class of 2015)
Rohan Kalra (Class of 2012)
Sang Yup Kim (Class of 2012)
Margaret Kowalski (Class of 2013)
Oshamimi Mayaki (Class of 2013)
Jen Sung (Class of 2012)
Justin Wang (Class of 2012)
I-Ta Yang (Class of 2013)
Steven Yang (Class of 2012)
Cen (Kayco) Zhou (Class of 2013)
Xiaoyu (Jecky) Zhu (Class of 2012)

2010-2011 Nominees
Blake Artushin (Class of 2012)
Nicole Bayley (Class of 2012)
Brittanie Boone (Class of 2012)
Courtney Chin (Class of 2012)

Theodore Dasher (Class of 2012)
Alisa Deychman (Class of 2012)
Mary Carmen Easterwood (Class of 2012)
Shomik Ghosh (Class of 2012)
Oliver Haimson (Class of 2012)
Bing-Chun (Jean) Hou (Class of 2011)
Hanny Kamal (Class of 2011)
Karen Khalaf (Class of 2012)
Chun Wa (Davy) Mok (Class of 2012)
Yaqi Niu (Class of 2012)
Sonam Rajpal (Class of 2011)
Risa Shen (Class of 2012)
Kyra Singh (Class of 2011)
Ashish Thakrar (Class of 2012)
Akshay Upadhyay (Class of 2011)
Brandon Wirakesuma (Class of 2011)
Abbas Zaidi (Class of 2012)

2009-2010 Nominees
Bryce Aisaka (Class of 2010)
Kevin Bachovchin (Class of 2010)
Marinos Bernitsas (Class of 2010)
Thais Canedo (Class of Dec 2009)
Atishe Chordia (Class of 2010)
Christina Eng (Class of 2010)
Claire Herdeman (Class of 2011)
Gabriel Herman (Class of 2011)
Luke Johnson (Class of 2010)
Utku Karagoz (Class of 2010)
Alexandra Kontopoulos (Class of 2010)
Christopher Lako (Class of 2010)
Zhi Yang Lim (Class of 2011)
Jai Woo Lee (Class of 2011)
Dina Megretskaia (Class of 2011)
Bassem Mikhael (Class of 2011)
Gabriella Moskowitz (Class of 2010)
Seung Park (Class of 2010)
Michael Rednor (Class of 2011)
Lauren McMicken (Class of 2010)
Lindsey Reese (Class of 2010)
Shweta Suresh (Class of 2011)
D. Scott Taylor (Class of 2010)
Sebastian Wai (Class of 2011)
Karolos Waldron (Class of 2011)
Sean Wu (Class of 2011)

2008-2009 Nominees
Engin Levent Altinoglu (Class of 2010)
Vinith Annam (Class of 2010)
Akshaya Jha (Class of 2009)
Richard M. Katzwer (Class of 2010)
Smita Kumar (Class of 2010)
Dongmin Lee (Class of 2010)
Brian Moon (Class of 2010)
Daniel Park (Class of 2010)
Hon Ming (Robin) Quek (Class of 2010)

Vivek Raval (Class of 2009)
Athip Tantivorawong (Class of 2009)
Alexandra Tronetti (Class of 2009)
Calvin Wong (Class of 2010)
Shawn Yoon (Class of 2009)

2007-2008 Nominees
Tsun Wah (Terence) Chang (Class of 2007, M.S.Q.E. 2008)
Iulia Degeratu (Class of 2009)
Robert L. Jefferson (Class of 2008)
Akshaya Jha (Class of 2009)
Gerardo Laperal (Class of 2008)
Christine Lee (Class of 2009)
David Mirsky (Class of 2009)
André Tartar (Class of 2009)
Nate Tower (Class of 2009)

2006-2007 Nominees
Gagandeep Anand (Class of 2007)
Justin A. Berka (Class of 2007, M.P.P.M 2008)
Matthew C. Corbett (Class of 2006, M.S.Q.E. 2007)
Deniz Duygu (Class of 2007)
Randall Jones (Class of 2007)
Gerardo Laperal (Class of 2008)
Michael C. Lee   (Class of 2008)
Han Chun Lim (Class of 2006)
William Lutz (Class of 2008)
Sudeep Paul (Class of 2007)
Rebecca H. Radkoff   (Class of 2008)
Seng Keat Teh (Class of 2007)
Brandi M. Tish (Class of 2007)
Henry Tsai (Class of 2007)
Sara Wille (Class of 2008) (Class of 2008)
JoE Wong (Class of 2006)

2005-2006 Nominees
Andy Butler (Class of 2006)
Mercy Chang (Class of 2007)
Tsun Wah (Terence) Chang (Class of 2007, M.S.Q.E. 2008)
Tathagata Chaudhury (Class of 2006)
Vickie Chiang (Class of 2006)
Matthew C. Corbett (Class of 2006, M.S.Q.E. 2007)
Maxwell Egan (Class of 2006)
Dana Guffey (Class of 2007)
Sheila H. Ip (Class of 2007)
Randall Jones (Class of 2007)
Rahul Kapur (Class of 2006)
Jack Kocerka (Class of 2006)
Michal Lementowski (Class of 2006)
Andrew Leung (Class of 2006)
Aileen Ma (Class of 2006)
Eugene Shiu (Class of 2006)
Lin Tian (Class of 2006)
Seng Keat Teh (Class of 2007)
Raz Tirosh (Class of 2006)
Brandi M. Tish (Class of 2007)

Minghong Toh (Class of 2006)
Maria Veronica Urenda Valdes (B.S. 2005, M.S.Q.E 2006)
Charles Wright (Class of 2007)
Marie Yetsin (Class of 2006)
Chris Zhang (Class of 2006)

Richard M. Cyert Award for Excellence in Teaching (1985-2017)

Description of Award: The Richard M. Cyert Award for Teaching Excellence is given annually to a faculty member who is recognized by economics students and the Undergraduate Economics Program Administration for outstanding pedagogy in economics courses. This honor is awarded during the Undergraduate Economics diploma ceremony

Eligibility: Faculty teaching in UEP who have not received the award within the past five years.
Criteria: Outstanding pedagogy will evaluated based on the following measures: FCEs, class size, innovation in the classroom/syllabus, grade distribution, whether the class is required or not, and contributions to extra- and meta-curricular activities.
Selection Committee: Head of Economics (non-voting member), Head of UEP Curriculum Committee (voting member), past three Cyert Award Winners, Senior Associate Dean of Education (voting member), and UEP Executive Director (non-voting member)

Faculty titles are current at the time of the award.
2017*: Karam Kang, Assistant Professor of Economics*
2016: Joachim Groeger*, Assistant Professor of Economics*
2015: *Ariel Zetlin-Jones, Assistant Professor of Economics*
2014*: Chris Sleet, Professor of Economics*
2013*: Christoph Mueller, Assistant Professor of Economics*
2012: *Laurence Ales, Associate Professor of Economics*
2011*: Not Awarded
2010*: Karen Clay, Associate Professor of Economics*
2009: *Onur Kesten, Assistant Professor of Economics*
2008: *Stephen E. Spear, Professor of Economics*
2007: *Marvin Goodfriend, Professor of Economics*
2006: *George-Levi Gayle, Assistant Professor of Economics*
2005: *Stanley E. Zin, The Richard M. Cyert and Morris H. Degroot Professor of Economics and Statistics, and Professor of Economics and Finance.*
2004: Not Awarded
2003: *Ronald L. Goettler, Assistant Professor of Economics*
2002: *Stephen E. Spear, Professor of Economics*
2001: *Cheng Wang, Associate Professor of Economics*
2000: *H. Scott Matthews, Research Scientist*
1999: *W. Robert Dalton, Associate Teaching Professor of Economics*
1998: *Harold Zhang, Assistant Professor of Economics*
1997: *Keith Poole, Professor of Politics and Political Science*
1995: *Stanley E. Zin, Associate Professor of Economics and Finance*
1993: *Anthony Smith, Assistant Professor of Economics*
1992: *Kathryn Shaw, Associate Professor of Economics*
1991: *Robert Miller, Associate Professor of Economics*
1990*: W. Robert Dalton, Associate Teaching Professor of Economics*
1989: *Stephen E. Spear, Associate Professor of Economics*
1988: *Barton Lipman, Assistant Professor of Economics*
1987: *Praveen Kumar, Assistant Professor of Economics*
1986: *Guilherme Sedlacek, Assistant Professor of Economics*
1985*: Thomas Palfrey, Assistant Professor of Economics and Political Economy*

Undergraduate Economics Program Academic Achievement Award (1991-2017)

The Outstanding Academic Award is given to a graduating student by the Undergraduate Economics Program in recognition of exemplary academic achievement. This recognition is announced during the Undergraduate Economics diploma ceremony.

2015: *Danielle McKinney*
2014: *Nancy Geronian* and *Zachary Branson*
2013: *Oliver Haimson* and *I-Ta Yang*
2012: *Ashish Thakrar*
2011: *Bassem Mikhael , Shweta Suresh , and Karolos (Charlie) Waldron*
2010: *Richard M. Katzwer*
2009: *Akshaya Jha and André Tartar*
2008: *Rebecca H. Radkoff*
2007: *Tsun Wah (Terence) Chang*
2006: *Lin Tian*
2005: *Maria Veronica Urenda Valdes*
2004: *Maxim Dolgosheev*
2003: *Carl R. Peterson*
2002: *EE Thian Lim*
2001: *Choon Hong Tey*
2000: *Francis Goh*
1999: *Yakov Arnopolin*
1998: *Mindy Marks*
1997: *Vittorio D. Bernardino*
1996: *Aidan E. Palmer*
1995: *Christa M. Sober*
1994: *Marisa A. Fisher*
1993: *John D. Sabo*
1992: *John R. Rosenberger*
1991: *Charles H. Daniels*

Undergraduate Economics Program Distinguished Pedagogical Service Award (2013-2017)

The Distinguished Pedagogical Service Award is given annually to a student who has demonstrated excellence and dedication in their instructional responsibilities for the Undergraduate Economics Program.
2016: Richa Mohan
2015: *Danielle McKinney*
2014: *Hannah Loo*
2013: *Sarah Peko-Spicer* (Awarded in 2014)

Undergraduate Economics Program Distinguished Service Award (2006-2017)

The Distinguished Service Award is given annually to a graduating Economics student in recognition of outstanding service to the Undergraduate Economics Program. This recognition is announced during the Undergraduate Economics diploma ceremony.
2017: *Gujri Singh*
2016: *Jillian Ward*
2015: *Stanley Krasner*
2014: *Dong Jin (Michael) Shin*
2013: *Sarah Peko-Spicer*
2012: *Abbas Zaidi*
2011: *Karolos (Charlie) Waldron* and *Brandon Wirakesuma*
2010: *Richard M. Katzwer*
2009: *Vivek Raval*

2008: *Robert Jefferson, William Lutz,* and *Sara Wille*
2007: *Dmitry Nulman*
2006: *Eugene Shiu*

Undergraduate Economics Program Outstanding Leadership Award (2005-2017)

This Outstanding Leadership Award is given by the Undergraduate Economics Administration to a graduating economics student in recognition of leadership in all areas of university life. This recognition is announced during the Undergraduate Economics diploma ceremony.
2017: *Vaasavi Unnava*
2015: *Anusha Kukreja*
2015: *Andres Anzola*
2014: *Zachary Branson*
2013: *William Weiner*
2012: *Blake Artushin and Courtney Chin*
2011: *Shweta Suresh*
2010: *Smita Kumar*
2009: *Daria Maximov and David Mirsky*
2008: *Olivia J. Ostrand*
2007: *Justin A. Berka*
2006: *Matthew C. Corbett*
2005: *David Michael Ebersole*

College-Level Awards

Dietrich College Summer Internship Stipend

Each year, the Dietrich College of Humanities & Social Sciences is able to award stipends for summer research. Awards are based on a competitive process open to all H&SS students. Selection is based on academic record and internship purpose. Preference is given to students who find positions in government or non-profit agencies.
Summer 2012: *Victoria Baggio   (Class of 2013) - Project Yele ((Yele,) Sierra Leone)*
Summer 2009: *Aneesha S. Despande   (Class of 2010) - Legal Aid Society (New York City)*

Jeffrey and Gloria Holtman Dietrich College of Humanities and Social Sciences Dean's Innovation Fund for Undergraduate Research (2013-2014)

Summer 2014: *Brent Heard   (Class of 2015*)
Summer 2013: *Paul Ko   (Class of 2014)*

Luke Edwards Undergraduate Summer Research Grant (available 2009-2012)

Summer 2012: *Karthik Nagarajan   (Class of 2013)*
Summer 2010: *Gabriel Herman   (Class of 2011)*
Summer 2009: *Richard M. Katzwer   (Class of 2010)*

University-Level Awards

Andrew Carnegie Society Scholars

The Andrew Carnegie Society Scholars are selected by their deans and department heads. These undergraduate seniors embody high standards of academic excellence combined with multi-dimensional characteristics such as volunteerism, involvement in student organizations, participation in sports or the arts and leadership.
2016-2017: *Gujri Singh*

2014-1015: *Stanley Krasner*
2013-1014: *Zachary Branson*
2011-2012: *Brittanie Boone and Mary Carmen Easterwood*
2010-2011: *Bassem Mikhael and Shweta Suresh*
2009-2010: *Smita Kumar*
2007-2008: *Olivia J. Ostrand*
2006-2007: *Brandi M. Tish*
2005-2006: *Sheila H. Ip*
2004-2005: *Maria Veronica Urenda Valdes*
2002-2003: *Jeffrey Crilley*

Carnegie Mellon University ProSEED/Crosswalk Grants (2015)

Interdisciplinarity, collaboration, innovation and an entrepreneurial spirit are elemental core values of Carnegie Mellon University. The curricular and metacurricular experience of the university hosts many examples of this ethos, ranging from interdisciplinary majors to project courses to shared community programs hosted by multiple student organizations. In order to further opportunities for students to pursue their interdisciplinary and boundary-breaking initiatives in and out of the classroom, Crosswalk seed funding has been created within the overall ProSEED initiative established by the Office of the President. While there is no set amount for Crosswalk grants, typically they will be in the $500-$5000 range. These funds, primarily planned for students, will seed greater connections and collaborations across campus. We want to inspire bold creativity and entrepreneurial action throughout the campus community.
2014: *Moneythink CMU (Anusha Kukreja , Satvika Neti, and Jillian Ward ; Advisor: Kathleen Conway)*

Carnegie Mellon Senior Leadership Awards (2006-2015)

Carnegie Mellon University Senior Leadership Awards are presented annually to graduating seniors who have demonstrated extraordinary leadership and made substantial contributions to the Carnegie Mellon community in the following categories: academics, arts, athletics, campus involvement and community service.
2015
Andres Anzola
Manuel Garber
Brent Heard
Radowan Khan
Stanley Krasner
Jonghwan (Brian) Lee
Tammy Lew
Karn Mishra
Danielle McKinney

2014
Zachary Branson
Avery Calkins
John Foo
Joseph Frick
Nancy Geronian
Hannah Loo
Kit Ying (Stephy) Wong

2013
Victoria Baggio
Aditya Goyal
Abhi Jain
Margaret Kowalski
Elizabeth Lorenzi

Alexander Murray-Watters
Sarah Peko-Spicer
Bryan Wade
William Weiner
Crystal Wray

2012
Blake Artushin
Nicole Bayley
Brittanie Boone
Claire Chin
Courtney Chin
Alisa Deychman
Mary Carmen Easterwood
Benjamin Guterman
Karen Khalaf
Risa Shen
Ashish Thakrar
Crystal Wray
Abbas Zaidi
Lyubov Zeylikman
Xiaoyu (Jecky) Zhu

2011
Jack Anderson
Eduardo Benatuil
Siddhartha Gupta
Hanny Kamal
Mark Hepburn
Claire Herdeman
Sumegha Koppolu
Dina Megretskaia
Michael Rednor
Shweta Suresh
Sebastian Wai
Karolos (Charlie) Waldron
Brandon Wirakesuma

2010
Vinith Annam
Eshna Bhaduri
Claire Bouffard
Richard M. Katzwer
Shweta Kumar
Andy Lee
Lauren McMicken
Seungjin Park

2009
Iulia Degeratu
Akshaya Jha
Tarun Bhan
Sophie Chen
Jesse Chorng
Alexander DiClaudio
Christopher Donelan

Kendal Fowler
Christine Lee
Daria Maximov
David Mirsky
Mansour Nehlawi
Vivek Raval
Athip Tantivorawong
André Tartar

2008
Robert L. Jefferson
Scott Kuppe
William Lutz
Olivia J. Ostrand
Sudeep Paul
Colin Sternhell
Ann Stieh
Sara Wille

2007
Deniz Duygu
Dana Guffey
Dmitry Nulman
Sagar Shah
Heinrich Te
Seng Keat Teh
Henry Tsai

2006
Vickie Chiang
Michal Lementowski
Aileen Ma
Shedisha Matthias
Tommy Oliver
Omar Parris-Dione
Eugene Shiu
Marie Yetsin

Carnegie Mellon Women's Association Award (Fall 2006 – present)

The CMWA Awards began in 1964 to "honor an outstanding girl at the university." The tradition continues today and each year, the Carnegie Mellon Women's Association Scholarship Fund awards scholarships to selected graduating senior students, with a preference for students who demonstrate a commitment to the advancement of women in their academic pursuits.

The awards are presented by CMWA Honorary President at the end of the academic year in April at the Annual CMWA Award Reception.

2017

Vaasavi Unnava (Class of 2017)

Carnegie Mellon University Small Undergraduate Research Grants and Summer Undergraduate Research Fellowships (Fall 2006 – present)

The Small Undergraduate Research Grant (SURG) program and Summer Undergraduate Research Fellowship (SURF) program awards grants to undergraduates at Carnegie Mellon for research in all fields of study.

Summer 2012
Victoria Baggio (Class of 2013), "Project Yele"
Oliver Haimson (Class of 2012), "Where are they Now? Analyzing Gender Differences I Executive Exit Patterns", Mentor: Carol Goldburg (Undergraduate Economics Program)

Spring 2012
Jonathan Francis, Zhijun Huang (Class of 2015), Kenneth Wong, "Creating Virtual Marketplaces for the Commoditization of Rental Spaces", Mentor: Carol Goldburg (Undergraduate Economics Program)

Fall 2011
Tadas Zolynas (Class of 2013), "Real Time Fluid Simulations", Mentor: Adrian Treuille (Computer Science)

Spring 2011
Shweta Suresh (Class of 2011), "Impact of Social Risk Aversion and Audience Effects on Generosity to the Poor", Mentor: Christina Fong (Social and Decision Sciences)

Spring 2007
Robert L. Jefferson (Class of 2008), "Anti-Foreign Sentiment in the Calif. Gold Rush" Mentor: Karen Clay (Heinz School)

Fall 2006
Pauline Law (Class of 2007), "Exploring Boston's Chinatown" Mentor: Donald Sutton (History)
Sagar Shah (Class of 2007), "Estimating Price Distributions for the US Vehicle Fleet: Why Isn't Quality Job 1?" Mentors: Paul Fishbeck (Social and Decision Sciences) and David Gerard (Social and Decision Sciences)

Meeting of the Minds: Alcoa Undergraduate Research Awards
Alcoa Inc. is accepting project submissions in Information Technology, with a focus on mobility. Mobility is a key future state for all computing, where connectivity from anywhere to anywhere with myriad devices and for unlimited uses will be expected...and needed. How can we prepare to connect any-to-any seamlessly and securely, and how can this new paradigm add value for companies like ours?We are looking for project ideas that offer creative, innovative solutions.
2014
Third Place: Rachel Cohen (English), Marko Hudak (Economics & Statistics, Class of 2015), William Sanders (Economics, Class of 2015), Stephanie Stern (Social and Decision Science), Olga Zubashko (Economics & Statistics, Class of 2014): "Salary Expectations for Carnegie Mellon University Students"

Meeting of the Minds: Dietrich Humanities Prize
2017
Blaine Cole (Economics and Statistics), "Why do People Retweet, an Analysis of the Effect of Sentiment and Rhetorical Devices on Retweeting"

Milton and Cynthia Friedman Fellowship
The Friedman Fellowship program was endowed by Mrs. Cynthia Friedman, a trustee of Carnegie Mellon, in memory of her husband, Milton Friedman, a Carnegie Mellon alumnus. The fellowship enables students to serve in internships in the public and non-profit sectors in Washington, D.C. to enhance their exploration of a career in public policy and contribute to their education at Carnegie Mellon.

Summer 2015
Vaasavi Unnava (Class of 2017; Internship: U.S. Senator from Ohio Sheerod Brown's Congressional Office)

Fall 2011
Mary Carmen Easterwood (Class of 2012; Internship: Millenium Development Corporation)
Caroline E. Roper (Class of 2012; Internship: U.S. Department of Commerce)

Spring and Summer 2010
Bassem Mikhael (Class of 2011; Major: Economics; Internship: Center for Health Transformation)

Summer 2009
Lindsey Reese (Class of 2010, Internship: U.S. Census Bureau)

Phi Beta Kappa Society

Phi Beta Kappa was founded on December 5, 1776, at the College of William and Mary. Since then, Phi Beta Kappa has evolved to become the nation's leading advocate for the liberal arts and sciences at the undergraduate level. The Society's distinctive emblem, a goldenkey, is widely recognized as a symbol of academic achievement.

2015
Danielle McKinney (Class of 2015)
Stanley Krasner (Class of 2015)

2016
Richa Mohan (Class of 2016)
David Moss (Class of 2016)

2015
Danielle McKinney (Class of 2015)
Stanley Krasner (Class of 2015)

2014
Wan Xin Teo (Class of 2013)

2013
Zachary Branson (Class of 2014)
Margaret Kowalski (Class of 2013)
Karthik Nagarajan (Class of 2013)

2012
Brittanie Boone (Class of 2012)
Mary Carmen Easterwood (Class of 2012)
Karen Khalaf (Class of 2012)
Caroline E. Roper (Class of 2012)

2011
Dina Megretskaia (Class of 2011)
Ashish Thakrar (Class of 2012)
Sebastian Wai (Class of 2011)

2010
Smita Kumar (Class of 2010)
Bassem Mikhael (Class of 2011)
Shweta Suresh (Class of 2011)

2009
Richard M. Katzwer (Class of 2010)
Akshaya Jha (Class of 2009)
Christine Lee (Class of 2009)
Dongmin Lee (Class of 2010)
André Tartar (Class of 2009)

Nate Tower (Class of 2009)

2008
Michael C. Lee (Class of 2008)
Rebecca H. Radkoff (Class of 2008)
Sara K. Wille (Class of 2008)

2007
Sheila H. Ip (Class of 2007)
Randall C. Jones (Class of 2007)
Seng Keat Teh (Class of 2007)
Brandi M. Tish (Class of 2007)
Charles Wright (Class of 2007)

2006
Andy Butler   (Class of 2006)
Aileen Ma   (Class of 2006)
Lin Tian   (Class of 2006)
Minghong Toh   (Class of 2006)
Marie Yetsin   (Class of 2006)
Chunhua Zhang   (Class of 2006)

Phi Kappa Phi Honor Society

The Honor Society of Phi Kappa Phi is the nation's oldest, largest, and most selective all-discipline honor society. Membership is by invitation only to the top ten percent of seniors and graduate students and 7.5 percent of juniors. The Society's mission is "To recognize and promote academic excellence in all fields of higher education and to engage the community of scholars in service to others."

2017
Peter Brady (Class of 2017)
Charlotte Townsend (Class of 2018)
Kunal Wadwani (Class of 2017)

2015
Danielle McKinney (Class of 2015)
Ronald Fudala (Class of 2015)
Jonghwan (Brian) Lee (Class of 2015)
Richa Mohan (Class of 2016)
David Moss (Class of 2016)
Mei Huey (Michelle) Ong (Class of 2016)
Samuel Walters (Class of 2016)

2014
Zachary Branson (Class of 2014)
Avery Calkins (Class of 2014)
Stanley Krasner (Class of 2015)
Ian Meeker (Class of 2015)
Dong Jin (Michael) Shin (Class of 2014)
Emily Wright (Class of 2014)

2013
Victoria Baggio (Class of 2013)
Jae-Eun Chang (Class of 2013)
Margaret Kowalski (Class of 2013)

Cen (Kayco) Zhou (Class of 2013)

2011
Nicole Bayley (Class of 2012)
Brittanie Boone (Class of 2012)
Carmen Easterwood (Class of 2012)
Oliver Haimson (Class of 2012)
Risa Shen (Class of 2012)
Ashish Thakrar Thakrar (Class of 2012)
Steven Yang (Class of 2012)
Xiayu (Jecky) Zhu (Class of 2012)

2010
Vinith Annam (Class of 2010)
Gabriel Herman (Class of 2011)
Alexandra Kontopoulos (Class of 2010)
Bassem Mikhael (Class of 2011)
Shweta Suresh (Class of 2011)
Karolos (Charlie) Waldron (Class of 2011)

2009
Engin Levent Altinoglu (Class of 2010)
Richard M. Katzwer (Class of 2010)
Smita Kumar (Class of 2010)
Dongmin Lee (Class of 2010)
Brian Moon (Class of 2010)
Daniel Park (Class of 2010)
Vivek Raval (Class of 2009)
Calvin Wong (Class of 2010)
Hon Ming Robin Quek (Class of 2010)

2008
Iulia Degeratu (Class of 2009)
Akshaya Jha (Class of 2009)
Christine Lee (Class of 2009)
David Mirsky (Class of 2009)
AndréTartar (Class of 2009)
Nate Tower (Class of 2009)

2007
Sudeep Paul (Class of 2008)
Rebecca H. Radkoff (Class of 2008)
Brandi M. Tish (Class of 2007)

2006
Tsun Wah (Terence) Chang (Class of 2007)
Dana Guffey (Class of 2007)
Sheila H. Ip (Class of 2007)
Aileen Ma (Class of 2006)
Seng Keat Teh (Class of 2007)

2005
David Ebersole (Class of 2005)
Maria Veronica Urenda Valdes (Class of 2005)

2002

Ee Thian Lim (Class of 2002)
Pikkwan Wong (Class of 2002)

Richard Schoenwald Phi Beta Kappa Undergraduate Research Prize (available 2009-2017)

2010

Richard M. Katzwer (Economics Mathematical Sciences, Class of 2010): "Finding Nash Equilibria in Asymmetric Auctions with Resale: Numerical and Analytical Developments"

Abstract: This paper was written as a Tepper School of Business Senior Honors Thesis in Economics. The paper discusses new methods for solving for Nash equilibria bid-functions in several different types of related auctions: first-price auctions, first-price auctions with resale, first-price auctions with reserve prices, first-price auctions with reserve prices and resale, and second-price auctions. Particular emphasis is placed on the new methods for solving auctions with a post-bidding resale stage. The first section details the game theory underlying the Nash equilibria in each auction type discussed. The next section compares and contrasts the author's auction solving software, AuctionSolver, with previous contributions. Specifically, discussion is given to the numerical methods employed in solving auctions with resale. The penultimate section discusses several numerical examples and results in support of several conjectures made by the author as well as Isa Hafalir and Vijay Krishna. Special attention is paid to revenue comparisons between differing auction mechanisms. The last section discusses future avenues of improvement for Auction Solver. The theoretical motivation for the work here is primarily given by prior research on resale auctions by Dr. Hafalir and Dr. Vijay Krishna.