Digital Economics and AI Tutorial

Gustavo Nino
genino2@illinois.edu
University of Illinois Urbana - Champaign

I am a fifth-year Ph.D. student in Applied Economics and MS student in Statistics at the University of Illinois Urbana-Champaign, specializing in transportation, food markets, and environmental economics. My work includes projects related to analyzing ground freight transportation disruptions and evaluating transportation programs in digital contexts using ride-hailing services such as Uber.

Classes and Background

In the program's rigorous curriculum for the Statistics MS, I have taken courses in Data Science Programming, Geospatial AI, Statistical Modeling, Statistical Learning, and Machine Learning; Big Data Analytics; Stochastic Processes; and Deep Learning, which have significantly advanced my dissertation research. I apply big data techniques to model supply chain decisions using hierarchical algorithms to estimate the most likely trucker routes and employ machine learning techniques, including random forests, to analyze the heterogeneity of natural disaster impacts on supply chain networks. I have also developed predictive models such as neural networks, CatBoost, and random forests to estimate which types of riders are likely to accept programs related to ride-hailing services connected to rail stations in multiple cities in USA.

I have also taken advanced courses in econometrics, microeconometrics, empirical industrial organization models, and big data techniques in applied economics. The training from these courses has been instrumental in my research. I have applied these techniques to estimate average causal effects of supply chain disruptions, evaluate the effects of transportation programs in urban areas, and employ sampling techniques for randomized controlled trials. Additionally, I have used structural modeling to estimate marginal costs and markups in ground transportation markets and to estimate the welfare impacts of transportation programs.

Research Interests

My primary research focuses on the impacts of natural disasters on ground freight transportation networks. I study transportation disruptions and their consequences on food market integration, the strategies employed by transportation and production firms to cope with such events and the implication in market competition for the increase in marginal cost derived from these events. Additionally, I am engaged in policy analysis concerning digital experiments that use ride-hailing programs across various cities in the United States, with a particular emphasis on understanding whether policy programs utilizing Uber services can connect riders to the rail system, thereby increasing rail usage and reducing car dependency.

Urban Transport Policies

Mass transit infrastructure projects require scarce financial, time, land and administrative resources. On average, USA spends $25 billion per year on rail systems (AAR, 2023), which implies a high cost in the system. However, recent trends have shown that rail ridership has decreased in places like Chicago, Philadelphia and New Orleans over the past few decades (Freemark, 2021) . Ridehailing services, such as Uber, have the potential

to raise ridership on existing services without major capital investments. Cities are beginning to experiment with leverage complementarity by subsidizing Ride-to-Transit (R2T) services (Schwieterman and Smith, 2018). More than 20 local governments and companies have rolled-out R2T programs to facilitate linkages to mass transit stations (Shaheen and Chan, 2016).However, there is little rigorous evidence about how urban residents would actually respond to these types of supply-side interventions.

We are currently conducting research on the policy implications of utilizing ride-hailing systems to address the first-last mile problem within the context of a rail-based transportation system. To explore this, we have implemented an extensive digital experiment with support from the Uber platform and NSF funding in three major US cities: Chicago, Washington D.C., and the San Francisco Bay Area.

In this experiment, we provide subsidies to riders for trips to and from metro stations. Through this setup, we have been able to collect survey responses regarding the use of transportation systems and Google Timeline data detailing trip specifics from study participants. Our preliminary results indicate that riders are indeed utilizing the subsidy to connect to rail stations, substituting car trips. However, we have observed significant heterogeneity in the effects, with different types of riders benefiting in various ways.

Our ultimate goal is to focus policy efforts on those riders experiencing the greatest increase in welfare, while also addressing any instances of misuse or negligible impact on rail-transit usage.

Freight Transportation and Climate Change

My research interests in this area center around the effect of landslides, a high-frequency natural disaster, on the disruption of national transportation networks. I investigate how road closure affects price integration and how ground transportation companies cope to this event in the Colombian context. This topic is particularly relevant given the increasing frequency of high-impact natural disasters like floods and landslides(Sanderson and Sharma, 2016).

Landslides rank among the most prevalent hazards on Earth, resulting in thousands of fatalities, injuries, and causing billions of dollars in damage worldwide each year (Kjekstad and Highland, 2009). Among these challenges, a significant disruptor of economic activity is the obstruction of supply systems and transportation networks due to road blockages, preventing the transportation of goods from production zones to main markets (Davis et al., 2021).

In one branch of my research agenda, I quantify the impact of landslide-related road disruptions on food price differentials across various markets within a national context. I propose a model that uses a combination of the law of one price and a competition framework where firms decide where to trade. I implement the model in an empirical framework by using comprehensive data from Colombia's wholesale markets, including more than 230,000 transactions, a routing algorithm that connects origin-destination points of food transportation, information on over 1,200 landslide disruptions, and a shift-share IV approach that leverages landslides as a source of external variation. The main findings reveal that a single road disruption, on average, leads to a decrease in product transportation between 2% and 3% to the affected market. Consequently, this reduction in supply causes an increase in prices ranging between 0.5% and 0.9% over a one-week period. Conversely, unaffected markets experience a weekly price decrease of approximately 0.5% on average due to an influx of goods diverted to those markets. Using multiple heterogeneous analyses, including causal forest and linear heterogeneity

methods, this study reveals substantial variation in the impact of road disruptions. The heterogeneity is driven by two factors: the importance of the disrupted road within common transportation routes, shaped by geographic location, and by price elasticities that vary with city income levels and product specialization. In a contrafactual exercise, I show that investment in road network in peripheral areas highly reduces landslides' impact on price differentials at the country level.

In my ongoing research, I investigate the relationship between high marginal costs, economies of scale, and market power in freight transportation markets. I utilize a novel and extensive dataset of truck movements from the year 2019, comprising more than 7 million observations, along with route estimates from a routing algorithm that integrates OpenStreetMap data to precisely calculate over 1 million optimal truck routes. This approach incorporates landslide information to account for routes affected by natural disaster disruptions as a measure of a context with high marginal costs.

I estimate the effects of increased marginal costs on transportation prices, quantities traded, and competition. My main results show that the average increase in trip prices is 2.9%, and the number of companies operating decreases by 13.5%. Additionally, my findings provide evidence that companies with economies of scale (large trucking firms) are less affected by the increase in marginal costs, leading to an increase in their market share.

Moreover, reduced-form calculations show that an additional freight company operating in the market reduces the price of trips by 10.9%. Currently, I am using a structural model that incorporates a nested logit demand framework with a supply-side model where companies operate under Bertrand competition. This model estimates how much of the 10.9% price increase, due to higher marginal costs and reduced competition, is attributable to a full transfer of costs by companies versus an increase in market power.

Intersection with AI

I have a profound interest in applying machine learning techniques to economics, particularly focusing on prediction algorithms and causal inference. Recent literature underscores the significant relevance of this field to cutting-edge research (Athey and Imbens, 2019; Athey, 2017) and it will be very valuable to improve my research agenda in various ways.

Moreover, I am intrigued by the application of machine learning techniques to analyze supply and demand dynamics, particularly within discrete choice frameworks. Recent advancements, such as the utilization of matrix completion or other ML techniques, have facilitated the identification of elasticities and cross-elasticities(Ruiz et al., 2020; Athey, 2017; Wan et al., 2017). This holds relevance in understanding consumer decision-making processes, particularly in contexts where consumers are presented with numerous options based on factors such as distance and pricing. I am eager to explore how these models can be integrated into my research, where economic actors, such as riders and truck drivers, navigate hundreds or thousands of choices, posing computational challenges for conventional approaches.

Furthermore, as I aim to conduct more digital experiments, I am eager to understand the multi-armed bandit optimization techniques (Dimakopoulou et al., 2019; Scott, 2010). These methodologies hold promise in predicting the most effective treatment during the pilot phase of digital experiments, optimizing resource allocation, and enhancing experimental efficiency.

References

AAR (2023): *Freight Rail Facts Figures*, Economics and Finance Department, Association of American Railroads.

Athey, S. (2017): "Beyond prediction: Using big data for policy problems," *Science*, 355, 483–485.

Athey, S. and G. W. Imbens (2019): "Machine learning methods that economists should know about," *Annual Review of Economics*, 11, 685–725.

Davis, K. F., S. Downs, and J. A. Gephart (2021): "Towards food supply chain resilience to environmental shocks," *Nature Food*, 2, 54–65.

Dimakopoulou, M., Z. Zhou, S. Athey, and G. Imbens (2019): "Balanced linear contextual bandits," in *Proceedings of the AAAI Conference on Artificial Intelligence*, vol. 33, 3445–3453.

Freemark, Y. (2021): "US public transit has struggled to retain riders over the past half century. Reversing this trend could advance equity and sustainability. Urban Institute," *The Urban Institute*.

Kjekstad, O. and L. Highland (2009): "Economic and social impacts of landslides," *Landslides–disaster risk reduction*, 573–587.

Ruiz, F. J., S. Athey, and D. M. Blei (2020): "SHOPPER," *The Annals of Applied Statistics*, 14, 1–27.

Sanderson, D. and A. Sharma (2016): "World Disaster Report 2016: Reseilience: saving lives today, investing for tomorrow," *International Federation of Red Cross and Red Crescent Societies*.

Schwieterman, J. and C. S. Smith (2018): "Sharing the ride: A paired-trip analysis of UberPool and Chicago Transit Authority services in Chicago, Illinois," *Research in Transportation Economics*, 71, 9–16.

Scott, S. L. (2010): "A modern Bayesian look at the multi-armed bandit," *Applied Stochastic Models in Business and Industry*, 26, 639–658.

Shaheen, S. and N. Chan (2016): "Mobility and the sharing economy: Potential to facilitate the first-and last-mile public transit connections," *Built Environment*, 42, 573–588.

Wan, M., D. Wang, M. Goldman, M. Taddy, J. Rao, J. Liu, D. Lymberopoulos, and J. McAuley (2017): "Modeling consumer preferences and price sensitivities from large-scale grocery shopping transaction logs," in *Proceedings of the 26th international conference on world wide web*, 1103–1112.