Research Statement

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My research fields are in public economics and industrial organization. I study how public policies affect the incentives of individuals and firms, and how they influence aggregate efficiency and distributional equality. My research interests can be grouped into two topical areas: human capital formation and economics of education, and market power in private sectors and mixed markets. In the sections below, I will describe my contributions.

1. Human Capital Formation and Economics of Education

My work in human capital formation and economics of education focuses on aspects related to both the education process and the education sector, including individuals' decisions (the demand side) and schools' choices (the supply side).

1.1 Applied Theory

Focusing on the hierarchical structure of the education process, my paper **"The Allocation of Public Funds in a Hierarchical Educational System"** (Su 2004) studies the effect of allocating a fixed public budget between basic and higher education. Within the hierarchical system, a student's human capital output from basic education becomes an input in higher education. More importantly, a minimal threshold requirement in higher education generates local increasing marginal returns to the human capital input, which leads to multiple steady states in the long run. I show that for Pareto efficiency, there is a lower bound on funding basic education. On the other hand, whether there is a corresponding lower bound on funding higher education or not depends on the development stage of the economy. While allocation policies favoring basic education lead to the usual redistribution from the top to the bottom, policies favoring higher education can result in reverse redistribution from the bottom to the top. Through inter-generational links, short-run allocation policies may have long-run effects. A simple rule-of-thumb for less developed economies is to focus on basic education for a sufficiently long duration, so that they can avoid the under-development trap and income polarization.

Interestingly, the policy implications delivered by this paper appear contrary to actual policies pursued by many less developed economies. To understand why this is the case, I examine the heterogeneous policy preferences across individuals in the paper **"Endogenous Determination of Public Budget Allocation across Education Stages"** (Su 2006). Thanks to the threshold effect discussed above, I show that high income individuals would prefer to under-fund basic education to exclude others from higher education, if their human capital endowment is much higher than the rest of the population, a condition typically satisfied in less developed economies. When these individuals hold disproportionately high political power, they will allocate the public budget to higher education at a share notably larger than the socially optimal level. On the other hand, even high income individuals would prefer a more balanced allocation policy that results in expanded participation in higher education, if their human capital endowment is only moderately higher than the rest of the population, a condition typically satisfied in developed economies. The model predictions are broadly consistent with observed policy differences both across countries and over time.

Asymmetric information can play an important role in both education and the labor market. Together with Tilman Klumpp, I examine the signal extraction and inference problem faced by individuals and employers. In the paper **"Second-Order Statistical Discrimination"** (Klumpp and Su 2013a), we extend the standard model of self-fulfilling statistical discrimination from the first moment to the second moment of the human capital distribution. We show the expectation where the human capital distribution of female workers exhibits a smaller variation than that of male workers can be self-fulfilling. In particular, the expectation of a thin right tail among female workers makes employers less likely to hire them in high-end jobs (a "glass ceiling" effect), which discourages high-ability females to invest in their human capital compared to their male counterparts. At the same time, the expectation of a thick middle section makes employers more likely to hire female workers in middle-level jobs, which encourages low-ability females to invest in their human capital compared to low-ability males. Putting both observations together, the human capital distribution of female workers will in fact exhibit less variation *ex post* than that of male workers, despite the fact that the innate ability distribution may have been *ex ante* identical for both groups.

A related paper **"A Theory of Perceived Discrimination"** (Klumpp and Su 2013b) examines the question of how individuals can maintain persistently different perceptions of whether or not discrimination exists in the labor market, despite observing the same outcomes. We use the term "perception" to denote an individual's belief about a parameter of the economic environment, which is not directly observable but can be confirmed or challenged when confronted with the equilibrium outcomes. For example, when individuals belonging to two identifiable groups (e.g., black and white, or male and female) invest in their human capital to compete for

a fixed pool of prizes (e.g., job offers or college admissions), discrimination *objectively* exists if a lower share of prizes is reserved for one group than the other. Now suppose individuals of one group *subjectively* perceive discrimination and believe that they have been allocated a lower share of the prizes, they will be discouraged from investing in their human capital and indeed win the prizes at a lower share. Their perceptions are thus not contradicted by actual outcomes, regardless of whether such a group quota actually exists or not. Since two different environments—with and without discrimination—lead to the same equilibrium outcomes, individuals may "agree to disagree" about whether discrimination exists, because their different perceptions are equally consistent with observed data.

Turning the focus to the supply side, I use industrial organization tools to examine strategic interactions among education providers. In the paper **"College Curriculum, Diverging Selectivity, and Enrollment Expansion"** (Kaganovich and Su 2019), Michael Kaganovich and I analyze the impact of college enrollment expansion on student outcomes. We model a college's choice of its curriculum as picking an education production technology out of a menu of horizontally differentiated technologies, each determined by a minimum threshold requirement and a corresponding progress rate. High-ability students learn better under a more demanding curriculum (higher threshold and faster pace), while low-ability students learn better under a less demanding one. In this context, when public policies promote "access" to college education, lower ranked colleges adopt less demanding curricula to accommodate the influx of less able students, but become less appealing to middle ability students. This reduces the competitive pressure faced by elite colleges, so they adopt more demanding curricula to better serve their most able students. The model offers an explanation to the diverging selectivity trends observed in American colleges.

In a follow up paper titled **"Grade Compensating Differentials in the Competition between University Majors"** (Kaganovich and Su 2021), we turn our attention to competition between academic units (departments or majors) for students within a university. We develop a model where two departments strategically choose their grade standards to attract students, and the grades obtained by these students signal their human capital attainment. We show that, when the wage rate differential between the two majors is above a moderate threshold, the Nash equilibrium features endogenous differentiation in grade standards, where department 1 (higher wage rate) sets a higher grade standard and attracts higher-ability students, and department 2 (lower wage rate) sets a lower grade standard and attracts lower-ability students. Moreover, an exogenous increase in the wage rate for major 1 makes it even more attractive to students, so department 1 adjusts its grade standard upward to better serve the highest-ability students without fearing losing middle-ability students. As a strategic response, department 2 lowers its grade standard to attract even-lower-ability students. Thus, a small increase in the exogenous wage rate

differential is amplified by endogenous adjustments of grade standards, and this endogenous amplification can occur regardless of any "intrinsic value" the underlying academic discipline may possess. This model offers an insight into the much-discussed "crisis of liberal arts."

Our work on competition among education providers has resulted in an invitation to contribute a chapter in the **Handbook of the Economics of Education** (forthcoming), edited by Brian McCall. In the paper **Competition in Higher Education** (Kaganovich, Sarpça, and Su 2020), Michael Kaganovich, Sinan Sarpça and I survey the theoretical literature on a range of issues related to the market structure and the functioning of higher education in the United States. Based on the mechanisms examined, we group the theoretical literature into three strands: models based on peer-group effects in the production of human capital, models highlighting the signaling value of academic standards, and models treating academic standards as features of competing education production technologies. We conclude with a discussion of the potential effects of online education on the higher education market.[1]

1.2 Empirical Analyses

A novel theoretical idea of Kaganovich and Su (2019) is to model academic standards as features of competing education production technologies, differing in their minimum threshold requirements and progress rates. Together with Vincenzo Andrietti, I also investigate the empirical implications of this model. We take advantage of an education reform in Germany that compressed secondary schooling for academic-track students from nine to eight years, while holding fixed the overall academic content required for graduation (the "G8 reform"). This reform implies a faster-paced curriculum, i.e., more material has to be covered in each school year. In the paper **"The Impact of Schooling Intensity on Student Learning: Evidence from a Quasi-Experiment"** (Andrietti and Su 2019a), we rely on policy variations across German states and over time to estimate a difference-in-difference model. We find that the G8 reform improves test scores on average, but the effects differ across subgroups of students. In particular, the improvement in test scores is larger for girls than for boys, for students with German born parents instead of immigrant parents, and for students having more books at home. These heterogeneous effects cannot be readily explained by changes in observed channels such as out-of-school activities for students, teacher quality, or class room environment, suggesting that unobserved heterogeneity may play an important role.

In a follow-up paper titled **"Education Curriculum and Student Achievement: Theory and Evidence"** (Andrietti and Su 2019b), we explicitly model this unobserved heterogeneity

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[1]This article was completed before the Covid-19 pandemic. Because the pandemic forced many institutions to adopt remote delivery for their courses, it is becoming even more important to understand how online education affects student learning and the higher education landscape.

as representing student preparedness. We derive theoretical predictions about the distributional effects of a curricular change across students, depending on their levels of preparedness. To account for the unobserved nature of student preparedness, we use two quantile methods for estimation: quantile difference-in-difference (QDiD) and recentered influence function difference-in-difference (RIF-DiD). These methods rely on different distributional assumptions for identification. The QDiD method requires a more restrictive distributional assumption but is directly linked to our theory; the RIF-DiD method relaxes the assumption but its link to our theory is less straightforward. Using both approaches, we find empirical patterns that are broadly consistent with our theoretical predictions. While the G8 reform improves students' test scores on average, such benefits are much more pronounced for well-prepared students (those located at middle and upper quantiles of the distribution). In contrast, less-prepared students (those located at bottom quantiles) do not benefit from the reform.

In addition to test scores, individuals' willingness to pay for attending different schools can also inform us about school quality. This is the idea I pursue in the paper **"How Much are Good Elementary Schools Worth? Evidence from School Acquisitions in Beijing"** (Su and Yu 2021), together with Huayi Yu. We use government-sanctioned school acquisitions in Beijing as a quasi-natural experiment, where each school acquisition is a merger between two public schools, one "good" and the other "regular." We also obtain confidential real estate transactions data from a large brokerage company in China, *Lianjia*, whose market share in Beijing is over 60%. By linking the transactions data to school acquisitions, we take advantage of the spatial and temporal variations in these acquisitions to estimate a hedonic pricing model in the difference-in-difference framework. We find that school acquisitions lead to an average price premium of 7% for regular schools acquired by good schools, compared to those that are not acquired. This price premium is both statistically and economically significant, translating into $280,000$ yuan on average (or over $40,000$ U.S. dollars).

2.   Market Power Issues

My research in industrial organization is partly motivated by my work experience as an economic consultant. Between 2006 and 2010, I interrupted my first tenure-track appointment at the University of Alabama for personal reasons and took an economic consulting job in Washington, D.C. This detour out of academia has generated several research ideas motivated by "real world" problems. It has also led me to apply industrial organization tools widely used in antitrust and regulation to issues in the education sector, which is my other research area.

2.1 Market Power in Private Sectors

In the energy sector, incumbents that own essential upstream facilities (natural monopolies) can extend their market power to potentially competitive downstream markets. A shift in the regulatory paradigm during the 1990s prompted policy makers, in the U.S. and elsewhere, to move away from traditional cost-of-service regulation of the vertically integrated firm, to access-based regulation of the upstream monopoly while opening the downstream market to competition. Open-access regulation forces incumbents to lease their essential facilities to competitors at regulated rates, leaving downstream prices to be determined through market competition. It is generally believed that open-access regulation improves static (allocative) efficiency due to increased downstream competition. However, one may be concerned that forcing firms to share facilities with competitors may discourage them from investing in these facilities, thus diminishing the dynamic efficiency of the market. I examine the validity of this concern in a series of papers.

In the paper **"Open Access and Dynamic Efficiency"** (Klumpp and Su 2010), Tilman Klumpp and I examine theoretically whether open-access regulation, such as that arising from the 1992 U.S. Energy Policy Act, weakens an incumbent's investment incentive. We explicitly model the regulation principles that access tariff should be fair, reasonable, and non-discriminatory, by imposing the following conditions: the incumbent must charge the same access rate to itself and all other competitors, it must earn a zero economic profit from its operation of the natural monopoly facility, and the cost recovery from each downstream firm (including itself) is proportional to the downstream firm's market share. We show that, under certain assumptions on costs and demand, the incumbent chooses a higher investment level in the open-access environment than that as a monopoly, and its optimal investment increases with the intensity of downstream competition. Our result stands in contrast to the conventional notion that dynamic efficiency must be sacrificed for gains in static efficiency when open-access regulation is implemented.

In a follow-up paper, **"Strategic Investments under Open Access: Theory and Evidence"** (Klumpp and Su 2015), we generalize this framework and test our model predictions empirically. We show that investment incentives can be decomposed into a non-strategic component and a strategic one. Under mild assumptions on demand, the non-strategic incentive implies a larger investment in a more competitive market, while the strategic incentive may strengthen or weaken the non-strategic incentive, depending on the competitive advantage of the incumbent relative to its downstream competitors. The assumptions made in Klumpp and Su (2010) guarantee that the strategic incentive never overwhelms the non-strategic incentive. Under more general conditions, however, the opposite may be possible. We estimate the presence and direction of strategic investment incentives using a panel dataset of vertically integrated electric utilities that are subject

to open-access regulation. We find evidence that investments in transmission facilities are indeed made strategically. Ceteris paribus, incumbent utilities are less likely to invest, and investment levels are lower, when competitors represent a larger share of the downstream wholesale market.

I have also examined the policy impact of restructuring the electricity retail market in the U.S. The focus of this work is on the implications of restructuring on allocative efficiency. Compared to traditional cost-of-service regulation, retail competition—facilitated by open access to the electricity distribution network—may lead to lower costs but higher markup rates, so that the net policy effect on retail price is ambiguous. In the paper **"Have Customers Benefited from Electricity Retail Competition?"** (Su 2015), I use a difference-in-difference approach to estimate the policy impact on average retail prices for U.S. states that restructured their electricity retail markets. I find that in restructured states, only residential customers have benefited from significantly lower prices but not commercial or industrial customers. Furthermore, this benefit is transitory and disappears in the long run. Thus, the overall evidence seems to suggest that retail competition fails to yield significant improvement in allocative efficiency.

Using a concept similar to the "rational perceptions equilibrium" developed in Klumpp and Su (2013b), I examine the different perceptions of litigants in monopolization cases, together with Andrew Eckert and Tilman Klumpp. In the paper **"An Equilibrium Selection Theory of Monopolization"** (Eckert, Klumpp, and Su 2017), we model the impact of monopolization as a sales quantity cap imposed by one firm (firm 1) on another (firm 2). We show that competition with or without monopolization may lead to the same asymmetric equilibrium outcome. When firm 2 believes that it is quantity constrained, its incentive to invest in either product design or cost-reducing production processes is weakened, which makes firm 2 less competitive than firm 1. Firm 2 will then attribute its low realized market share to monopolization by firm 1. At the same time, firm 1 may believe the opposite and attribute its large realized market share to coordination on an asymmetric equilibrium in which firm 1 happened to make a larger investment that resulted in a competitive advantage. Neither firm's perception of the nature of competition is challenged by the observed data. Furthermore, it is difficult for outside observers, such as antitrust authorities or courts, to distinguish one scenario from the other. Our results thus highlight the tension between committing type I errors (false positives) and type II errors (false negatives) in antitrust practice.

I have also worked on projects where the intended audience consists of policy makers, regulators, and industry practitioners. In the article **"Design of an Economically Efficient Feed-In Tariff Structure for Renewable Energy Development"** (Lesser and Su 2008), Jonathan Lesser and I propose a two-part feed-in tariff to meet the renewable policy goals of regulators. The two-part tariff consists of an auction-based capacity payment and a market-based energy payment. It balances considerations for both dynamic efficiency and static efficiency, where the capac-

ity payment subsidizes investments in renewable resources capacities, and the energy payment introduces competition in the generation of renewable energies.

2.2   Market Power in Mixed Markets

Market power issues can also arise in mixed markets such as healthcare, education, housing, transportation, and cultural and recreational facilities. In these markets, private firms coexist with public enterprises to provide goods and services.

In the paper **"Price-Quality Competition in a Mixed Duopoly"** (Klumpp and Su 2019), we consider two providers in a mixed market (e.g., higher education), where the private firm provides a high-price/high-quality variety of the good and serves richer individuals (e.g., an elite private university), and the public firm provides a low-price/low-quality variety and serves poorer individuals (e.g., a public university). When the government promotes market access by lowering the public firm's price, the public firm's budget can be balanced in three ways: through a reduction in its quality (cost saving); through an increase in its subsidy from outside the model (external funding); or through an increase in its subsidy via income taxation in the model (internal funding). We examine the private firm's response in each case. Our most striking result is that the cost saving approach leads the private firm to choose a lower quality and a higher price (i.e., it offers an inferior product compared to the benchmark), while the internal funding approach leads the private firm to choose a higher quality and a lower price (i.e., a superior product). The resulting welfare increases for the private firm's customers are sufficiently large that even they prefer to pay for the public firm's price reduction with a progressive income tax, rather than having the public firm lower its quality. Our results have important implications for the financing of publicly provided goods.

In a related paper **"When Social Assistance Meets Market Power: A Mixed Duopoly View of Health Insurance in the United States"** (Ranasinghe and Su 2021), Ashantha Ranasinghe and I develop a mixed duopoly model where the public firm is tasked to provide social assistance to low-income individuals. It does so by setting an income-based eligibility requirement instead of a price for its product. Unlike the model in Klumpp and Su (2019) where market participation is monotonically increasing in income, the social assistance setup examined here allows for non-monotone participation—that is, both ends of the income distribution participate in the market while some in the middle may opt out. We target the model to health insurance for the U.S. working-age population prior to the 2010 Affordable Care Act ("ACA"), with Medicaid acting as the public firm in our model. Using calibrated parameter values, we consider policy experiments that expand the public program to various degrees, from the actual Medicaid expansion under ACA, to a hypothetical universal public coverage ("Medicare for all"), and finally

to a universal public option with portable vouchers ("Medicare for all who want it"). We find that despite potentially significant inefficiency of the public firm, public program expansions are generally welfare improving. Central for these findings is the significant market power enjoyed by the private firm, which would result in high margins if left unchecked. However, as more individuals become eligible for the public program, the resulting increase in competitive pressure disciplines the private firm's ability to exercise market power.

3.   Other Research

While not directly related to my core research areas, I have also worked on the economics of networks. In the article **"Rational Terrorists and Optimal Network Structure"** (Enders and Su 2007), Walter Enders and I examine how different counterterrorism policies affect the optimal network structure adopted by terrorist organizations. We model the trade-off between security and intra-group communication faced by terrorist groups, assuming that a more densely connected network is less secure but more efficient for communication. We predict that terrorist groups reduce their network density in response to counterterrorism activities directed at group communications, thus moving away from logistically complicated attacks to simpler and less coordinated ones. This paper is later selected to be included as a chapter in the book titled **"The Economics of Terrorism"** (2016), edited by Walter Enders.

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