Research Statement[1]

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Technological progress and innovation are the central determinants of economic growth. As a macroeconomist, the main focus of my research has been to understand the exact links between innovation and economic growth and to study the optimal policies to bolster them. The mapping between innovation and economic growth can be described broadly as

$$\text{Firms} \rightarrow \text{Inventors} \rightarrow \text{Ideas} \rightarrow \text{Aggregate Growth}$$

where firms hire inventors to produce new ideas/technologies which lead to economic growth. In line with this mapping, my research topics can be broadly grouped into three categories: (*i*) firm studies, (*ii*) inventor studies, and (*iii*) idea (patent) studies. Below, I describe the methodologies that I use and my research projects related to these categories.

Methodology. The methodology of my research agenda has been to combine (A) micro with macro perspectives, (B) theory with empirics, and (C) history with modern-time analysis.

(A) I have been a big proponent of the idea that our understanding of macroeconomic growth and technological progress can be significantly improved by combining *micro* and *macro* perspectives. A macroeconomy is made of micro *firms* that hire *inventors* to produce new innovative *ideas*. Therefore, my research - by focusing on the microeconomics of firms, inventors, and ideas - has aimed to shed light on economic growth by capturing the rich heterogeneity in innovation behavior at the firm level by using the wealth of information on firms and their innovations.

(B) Formal models allow us to make verbal notions operational and confront them with data. Therefore, my research focuses on combining general equilibrium growth theories with rich micro data on millions of U.S. patents, inventors, and firms. By also using structural estimation techniques, my research approach allows me not only to understand the underlying mechanisms, but also to do counterfactual policy exercises where I can study optimal industrial policy design.

(C) There is a 25-year-old theoretical endogenous growth literature that has produced many important theoretical frameworks for understanding long-run economic growth. However, there is less empirical evidence on the long-run patterns of innovation and inventors due to a lack of historical data. I strongly believe that past experiences of the U.S. economy can guide us in the current policy debates on innovation and industrial policy. Therefore, by digitizing the hard copies of the historical patent records between 1836-2012 and merging them with the historical census data between 1880-1940, I (together with Tom Nicholas) construct a brand new dataset to study innovation and growth from a long-run perspective. In addition, thanks to the data from the U.S. Census Bureau and various countries around the world, I analyze in depth the

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current landscape of innovation and firm dynamics in the U.S. and other countries using modern large-scale data.

I have adopted these methodologies in the following projects.

1 Firms

My first line of research consists of a series of papers that study various aspects of industry and firm dynamics. I have written a handbook chapter (Aghion, Akcigit, and Howitt [13]) that succinctly documents part of my research agenda on firms. My research on firms can be grouped into three subgroups: (*i*) firms in developed countries, (*ii*) firms in developing countries, and (*iii*) networks.

Firms in Developed Countries. At the national and state level, governments transfer money from taxpayers to firms to encourage more research and development (R&D). Why do we do this? Aren't there enough incentives already to develop new inventions and reap the corresponding rewards? On the one hand, competition among firms is encouraging firms to spend (potentially) too much in R&D. On the other hand, non-internalized positive spillovers from new technologies could mean that we do not invest enough into R&D. Which force is bigger? In addition, suppose that we did, in fact, have a shortfall in R&D spending. Does this mean every firm should receive the same amount of subsidy? How should we design the optimal innovation policies? These are some of the key questions that I have tried to answer in my research on firms. To this end, I have used general equilibrium models built on large databases of firms, to help determine whether, for example, enough R&D is already occurring in a given firm, industry, or region.

In Akcigit and Kerr [29], we study how external versus internal innovations promote economic growth through a tractable endogenous growth framework with heterogeneous innovation qualities, multi-product firms, and entry/exit. Firms invest in external R&D to acquire new product lines and in internal R&D to improve their existing product lines. After estimating this model using patent data and the U.S. Census of firms, we study how firm size interacts with innovation incentives. We show that small firms produce disproportionately more and higher quality innovations and have larger spillovers. In Acemoglu, Akcigit, Bloom, and Kerr [4], we build a model of firm-level innovation, productivity growth, and reallocation featuring endogenous entry and exit. A key feature is the selection between high- and low-type firms, which differ in terms of their innovative capacity. We find that industrial policy that subsidizes either the R&D or the continued operation of incumbents reduces growth and welfare. This illustrates the importance of firm heterogeneity in shaping policy. In Akcigit, Hanley, and Serrano-Velarde [27], we study French firms and their incentives to do basic versus applied research. We find that firms that have a broader technological base are more likely to invest in basic research due to cross-industry spillovers. In addition, we study the role of universities in the macroeconomic growth process. In Acemoglu, Akcigit, and Celik [5], we argue that openness to new, unconventional and disruptive ideas has a first-order impact on creative innovations. Using data on U.S. firms, their managers, and patents, we present robust evidence that openness to disruption is associated with more cre-

ative innovations. In Acemoglu, Akcigit, Hanley, and Kerr [6], we study the optimal industrial policy to preserve natural resources and encourage firms to switch from dirty to green (clean) technologies. In Acemoglu and Akcigit [3], we study the design of the optimal patent policy to bolster competition and innovation. In Aghion, Akcigit, Cagé, and Kerr [10], we analyze the relationships between taxation, corruption, and economic growth and in Aghion, Akcigit, and Fernandez-Villaverde [12], we study optimal capital taxation in an endogenous growth model.

While conducting this research, I noticed that informational frictions are among the biggest obstacles that prevent innovation. Therefore two of my projects are aimed at addressing this problem. First, innovation is typically a trial-and-error process. While some research paths lead to the innovation sought, others result in dead ends. Because firms benefit from their competitors working in the wrong direction, they do not reveal their dead-end findings. Time and resources are wasted on projects that other firms have already found to be fruitless. In Akcigit and Liu [31], we provide a model to study this prevalent problem. We characterize the significant efficiency losses due to wasteful dead-end replication and a "flight to safety" -an early abandonment of the risky project. We also study a centralized mechanism whereby firms are incentivized to disclose their actions and share their private information in a timely manner. In Akcigit, Hanley, and Stantcheva [28], we study the optimal design of R&D policies and corporate taxation to correct for technology spillovers across firms and the non-appropriability of innovations. Our key contribution is the consideration of asymmetric information: the government does not know which firms are the most productive. Simple, often used innovation policies, such as linear R&D subsidies and linear profit taxes, lead to large revenue losses relative to the optimal mechanism.

Firms in Developing Countries. An important part of my work has also focused on developing economies. Firm dynamics in developing countries show striking differences to those in developed countries. While some firms do grow as they age, most firms are simply stagnant and do not exit despite being small. In Akcigit, Alp, and Peters [17], we ask to what extent these patterns could be driven by cross-country differences in the rule of law and the efficiency of managerial delegation. Three results emerge from our analysis: (*i*) The Indian economy suffers from a lack of selection, whereby a low rate of creative destruction allows lower-quality producers to survive. (*ii*) The high delegation efficiency in the U.S. is an important determinant of why U.S. firms are large. (*iii*) While managerial delegation is inefficient in India, its effect on the lifecycle of Indian firms is limited due to important complementarities between the delegation efficiency and other factors affecting firm growth. In Akcigit, Alp, Eden, and Nguyen [16] we study the dynamics of technology adoption in Latin American countries. We present various empirical evidence to show the Latin America's technology adoption patterns from the U.S. and their implications on their income gap relative to the U.S. economy.

Networks. The propagation of macroeconomic shocks through input-output and geographic networks can be a powerful driver of macroeconomic fluctuations. Understanding the nature and direction of these propagations are crucial for designing the right policies to mitigate their potential costs on the aggregate economy. Therefore in Acemoglu, Akcigit, and Kerr [7], we show that in the presence of Cobb-Douglas production functions and consumer preferences, which are

the most commonly used functional forms in the literature, there is a specific pattern of economic transmission whereby demand-side shocks propagate upstream (to input supplying industries) and supply-side shocks propagate downstream (to customer industries) and that there is a tight relationship between the direct impact of a shock and the magnitudes of the downstream and the upstream indirect effects. We then provide supporting empirical evidence on these predictions from the U.S. economy.

Networks are also useful to understand economic growth. Technological progress builds upon itself, with the expansion of invention in one domain propelling future work in linked fields. In Acemoglu, Akcigit, and Kerr [8], we use 1.8 million U.S. patents and their citation properties to map the innovation network and its strength. The interaction of this pre-existing network with patent growth in upstream technology fields has strong predictive power on future innovation. This pattern is consistent with the idea that when there is more past upstream innovation for a particular technology class to build on, then that technology class innovates more.

Ongoing Work on Firms In my various ongoing projects, I continue to investigate the determinants of firm dynamics. What are the welfare impacts of international technological convergence? Relatedly, what are the impacts of policies that are used against this convergence, especially trade and innovation policies, on the U.S. economy and welfare? In Akcigit, Ates, and Impullitti [18], we investigate these questions. We provide new empirical evidence, propose an original dynamic general equilibrium theory of international technology competition and economic growth, with a focus on transitional dynamics, and quantify the welfare implications. We assess the role of import tariffs and R&D subsidies as policy responses to foreign technological competition.

The process of creative destruction, whereby resources are reallocated from less productive incumbents to more productive new entrants, is key for productivity growth. Does this process take place seamlessly or do some firms rely on various means to prevent this from happening? In another ongoing work (Akcigit, Baslandze, and Lotti [19]), we study the impact of political connections on creative destruction and reallocation in Italy. More specifically, incumbents might slow down new entry into their industries by relying on their political connections. On the other hand, new technologies might hit existing regulations (see the case of UBER in various countries, for instance) and political connections might help overcome such regulatory challenges. Our project sheds light on the quantitative importance of these different channels through which political connections shape firm dynamics and productivity growth in Italy.

Many policies and fiscal incentives target self-employed entrepreneurs in an attempt to improve productivity. Key questions for these policies are, first, what and how strong effects they have on entry into self-employment and on self-employed incomes. Second, are the effects mostly due to real economic reactions, or rather to changes in the reporting of income? Do financial incentives matter most or are simpler administrative requirements key? In an ongoing project (Aghion, Akcigit, Lequien, and Stantcheva [15]), we try to answer these questions, making use of individual tax returns data from the French internal revenue service over the period 1994-2012.

2 Inventors and Society

My second line of research has focused on understanding the incentives of inventors and the impact of innovations on individuals in the society. My papers on this topic can be grouped into three subgroups: (*i*) Modern-time inventors, (*ii*) historical inventors, and (*iii*) innovation and the society.

Modern-time Inventors. How does tax policy affect inventors? In Akcigit, Baslandze, and Stantcheva [20], we study this question by examining the effect of top tax rates on inventors' mobility across OECD countries since 1977. We put special emphasis on "superstar" inventors, those with the most and most valuable patents. We use data on inventors from the United States Patent Office to track inventors' locations over time and combine it with international effective top tax rate data. We find that superstar top 1% inventors are significantly affected by top taxes rates when deciding on where to locate. Inventors who have worked in multinational companies are more likely to take advantage of tax differentials.

Who becomes an inventor? Allocating the right individuals into those jobs with large spillovers enhances economic growth. In Aghion, Akcigit, Hyytinen, and Toivanen [14], using individual level data on a half million Finnish men, we study the relative importance of social origins, parental income, socioeconomic status, education, and own ability – as measured by IQ – on the probability of becoming an inventor. A first striking finding is that the relation between parental income and the probability to invent in our data mirrors that in both the contemporary and historical US even though Finland is one of the most equal and socially mobile societies. We find that the monetary resources of parents matter less than their education and that all parental characteristics are less important than a person's own ability. IQ is a key determinant of whether someone obtains higher education. Thus, IQ impacts the probability to become an inventor both directly and also indirectly through education. We further find that family structure matters: parental divorce reduces the probability to become an inventor, and father's income matters only if he lives with his son. Step-parents' resources do not seem to matter. Finally, we find that IQ and father's income are complements in the sense that having a high income father inreases the probability of inventing more for high IQ individuals, suggesting that high IQ individuals may fall victims to misallocation of talent.

In an ongoing project, Akcigit, Caicedo, Miguelez, Stantcheva, and Sterzi [21], we study the role of human interactions on human capital accumulation and individual innovativeness. We show both theoretically and empirically that high-skilled individuals (inventors) acquire human capital by interacting with others around them and that policies that hampers worker mobility across firms can hinder this process.

Historical Inventors. An important part of my research has been devoted on understanding innovations, inventors, and economic growth from a historical perspective. To this end, in Akcigit, Grigsby, and Nicholas [25], we examine the golden age of U.S. innovation by undertaking a major data collection exercise, digitizing the hard copies of the historical patent records since 1836 and linking inventors from those historical patents to Federal Censuses between 1880

and 1940, and to state and county-level aggregates. We identify a strong relationship between patented inventions and long-run economic growth. We find that patenting activity is positively related to commonly postulated drivers of regional performance including population density, financial development and geographic connectedness. We then profile the characteristics of inventors and their life cycle, and find that inventors were highly educated, and positively selected through exit early in their careers. They delayed marriage, and tended to migrate to places that were conducive to innovation. Father's income and education were positively correlated with becoming an inventor, though not when controlling for the child's education. There were strong financial returns to technological development. Finally, we document a U-shaped relationship between top income inequality and innovation. Innovative places also tended to be more socially mobile. Our new data help to address important questions related to innovation and long-run growth dynamics.

Using this new data, in Akcigit, Grigsby, and Nicholas [24] we provide new evidence of the impact of immigrants on US innovation and document labor market outcomes for migrant inventors. We show that technology areas where immigrant inventors were more prevalent between 1880 and 1940 experienced faster growth between 1940 and 2000. We also show that immigrant inventors were more productive during their life cycle than native born inventors, although they received significantly lower wage levels than their native born counterparts.

In an ongoing project, Akcigit, Grigsby, Nicholas, and Stantcheva [26], we take a historical perspective to study the effects of personal and corporate income taxation on innovation by firms and inventors in the United States since 1880. Despite the visceral debates about the negative impacts of taxation on growth, there has been a lack of empirical evidence on this issue. We fill this gap by making use of our new historical data on patents, inventors, firms, and state-level taxes in the United States. First, we specifically study the effects of taxation on the quantity and, importantly, quality of innovation, which we can directly measure using the long-run patent and inventor data since 1880. Second, we provide very long-run evidence on the effects of both personal income and corporate income taxation in the U.S.. Third, we assess the impacts of these taxes on individual inventors and on firms and their R&D labs.

Innovation and Society. Some of my research effort has been devoted to understanding the social implications of innovation. Does higher GDP per capita or GDP growth increase happiness? The existing empirical literature on happiness and income looks at how various measures of subjective wellbeing (SWB) relate to income or income growth, but without looking in further detail at what drives the growth process and at how the determinants of growth affect wellbeing. In Aghion, Akcigit, Deaton, and Roulet [11], we analyze the relationship between turnover-driven growth and subjective wellbeing. We show that: (*i*) the effect of creative destruction on expected individual welfare should be unambiguously positive if we control for unemployment, less so if we do not; (*ii*) job creation has a positive and job destruction has a negative impact on wellbeing; (*iii*) job destruction has a less negative impact in US Metropolitan Statistical Areas (MSA) within states with more generous unemployment insurance policies; (*iv*) job creation has a more positive effect on individuals that are more forward-looking.

The past decades have witnessed a sharp increase in top income inequality in many countries. However no consensus has been reached as to the main underlying factors behind this increase. In Aghion, Akcigit, Bergeaud, Blundell, and Hémous [9], we argue that in the U.S., innovation has certainly been one such factor. We use cross-state panel data to show that top income inequality is related to innovation. Second, we argue that this correlation reflects a causal effect of innovation-led growth on top income inequality. Third, we show that the effect of innovation is strongest after two years and disappears after five years. Finally, we show that innovation is positively correlated with social mobility, but less so in states with more intense lobbying activities.

3 Ideas

The third line of my research has focused on ideas. New ideas are the seeds for economic growth. The rise in living standards depends on the effectiveness of transforming new ideas into consumer products or production processes. Incarnating an idea into a product or a production process is by no means immediate. What happens to ideas and patents once they are produced? While a lot of the policy discussions center around increasing the number of ideas/patents/technologies produced, very little attempt is made at understanding how these new ideas are utilized after their invention. I have tried to fill this gap in a number of papers described next.

Ideas are not necessarily born to their best users and firms often develop patents that are not close to their primary business activity. This initial "mismatch" could potentially be mitigated in a secondary market where firms can buy and sell patents through patent agents (intermediaries). In Akcigit, Celik, and Greenwood [22], we study the secondary market for ideas (patents) in the U.S. We build an endogenous growth model where firms invest in R&D to produce new ideas. An idea increases a firm's productivity. By how much depends on the technological distance between an idea and the firm's line of business. Ideas can be bought and sold on a market for patents. A firm can sell an idea that is not relevant to its business or buy one if it fails to innovate. The developed model is matched up with stylized facts about the market for patents in the U.S. The analysis gauges how efficiency in the patent market affects growth.

What determines the value of a patent? How can we proxy for a patent's value? Prior work suggests that more valuable patents are cited more and this view has become standard in the empirical innovation literature. In Abrams, Akcigit, and Popadak [2], we make use of a completely new dataset that contains patent-specific revenues from various non-practicing entities (NPEs) and find that the relationship of citations to value in fact forms an inverted-U, with fewer citations at the high end of value than in the middle. We explain this relationship with a simple model of innovation, allowing for both productive and strategic patents, which are used to block entry. We find evidence of greater use of strategic patents where it would be most expected: among corporations, in fields of rapid development, and for more recent patents. These findings have important implications for our basic understanding of growth, innovation, and intellectual property policy.

The market for patents suffers from various frictions and so-called "patent trolls" or NPEs

have emerged due to these frictions. Despite the popularity of NPEs in the media and among policy circles, there is almost no systematic evidence on their business activities. How do non-practicing entities impact innovation and technological progress? The question has enormous importance for industrial policy, with virtually no direct empirical evidence to start answering it. In ongoing work (Abrams, Akcigit, and Oz [1]), we take a major step in this direction and make use of our NPE-derived patent and financial data to answer this question. We provide new evidence on the subject, theoretically, empirically, and quantitatively. In doing so we inform the debate that has portrayed NPEs alternatively as benign middlemen that help to reallocate intellectual property to where it is most productive or as stick-up artists that exploit the patent system to extract rents, thereby hurting innovation.

Patents and intellectual property are increasingly important forms of loan collateral, relaxing financial constraints that choke off innovative activities. This is particularly true among sectors where patents are more pledgeable due to a higher probability of resale by the lender in case of bankruptcy. In ongoing work, (Akcigit, Celik, Itenberg, and Ordonez [23]), we study the use of patents as collateral and its implications on new business formation in the U.S. economy. We build a new growth model and estimate it using the U.S. patent data, which records each case of a patent being pledged as collateral. We use the estimated model to quantify the welfare gains from relaxed credit constraints through the use of patents as collateral.

Where do ideas come from? How does technological progress occur? Is the nature of idea creation stable over time? In ongoing work (Akcigit, Kerr, and Nicholas [30]), we shed new light on these questions through a mixture of empirics and theory. We begin with an empirical analysis of all the U.S. patents granted since 1836. This analysis reveals several striking facts that emphasize the increasing importance of novel combinations of technologies for U.S. patents, compared to either new technology development or the reuse/refinement of older technology combinations, and the localized nature of these recombinations. We also build an endogenous growth model that can match these facts and illustrate the underlying mechanics of the technological development process.

Going forward, my research will continue to investigate the determinants of economic growth and innovation using historical and modern-time data, new theoretical frameworks and careful structural and quantitative analysis.

References

[1] Abrams, D. S., U. Akcigit, and G. Oz (2017): "Patent Trolls: Benign Middleman or Stick-Up Artist?," University of Chicago, Working Paper.

[2] Abrams, D. S., U. Akcigit, and J. Popadak (2013): "Patent Value and Citations: Creative Destruction or Strategic Disruption?," NBER Working Paper #19647.

[3] Acemoglu, D., and U. Akcigit (2012): "Intellectual Property Rights Policy, Competition and Innovation," *Journal of the European Economic Association*, 10(1), 1–42.

[4] Acemoglu, D., U. Akcigit, N. Bloom, and W. R. Kerr (2015): "Innovation, Reallocation, and Growth," NBER Working Paper #18993.

[5] Acemoglu, D., U. Akcigit, and M. A. Celik (2014): "Young, Restless and Creative: Openness to Disruption and Creative Innovations," NBER Working Paper #19894.

[6] Acemoglu, D., U. Akcigit, D. Hanley, and W. Kerr (2016): "Transition to Clean Technology," *Journal of Political Economy*, 124(1), 52–104.

[7] Acemoglu, D., U. Akcigit, and W. Kerr (2016a): "Networks and the Macroeconomy: An Empirical Exploration," *NBER Macroeconomics Annual*, 30(1), 273–335.

[8] Acemoglu, D., U. Akcigit, and W. R. Kerr (2016b): "Innovation Network," *Proceedings of the National Academy of Sciences*, 113(41), 11483–11488.

[9] Aghion, P., U. Akcigit, A. Bergeaud, R. Blundell, and D. Hémous (2015b): "Innovation and Top Income Inequality," NBER Working Paper # 21247.

[10] Aghion, P., U. Akcigit, J. Cagé, and W. R. Kerr (2016): "Taxation, Corruption, and Growth," *European Economic Review*, 86, 24–51.

[11] Aghion, P., U. Akcigit, A. Deaton, and A. Roulet (2016): "Creative Destruction and Subjective Wellbeing," *American Economic Review*, 106(12), 3869–3897.

[12] Aghion, P., U. Akcigit, and J. Fernandez-Villaverde (2013): "Optimal Capital versus Labor Taxation with Innovation-Led Growth," NBER Working Paper #19086.

[13] Aghion, P., U. Akcigit, and P. Howitt (2014): "What Do We Learn From Schumpeterian Growth Theory?," in *Handbook of Economic Growth*, vol. 2 of *Handbook of Economic Growth*, chap. 0, pp. 515–563. Elsevier.

[14] Aghion, P., U. Akcigit, A. Hyytinen, and O. Toivanen (2016): "Social Origins of Inventors," University of Chicago, work in progress.

[15] Aghion, P., U. Akcigit, M. Lequien, and S. Stantcheva (2017): "Does Self-Employment Respond to Simpler Fiscal Incentives? Evidence from France," University of Chicago, Working Paper.

[16] Akcigit, U., H. Alp, M. Eden, and H. Nguyen (2017): "Technology Adoption and the TFP Gap in Latin American Countries," University of Chicago, Working Paper.

[17] Akcigit, U., H. Alp, and M. Peters (2016): "Lack of Selection and Limits to Delegation: Firm Dynamics in Developing Countries," NBER Working Paper #21905.

[18] Akcigit, U., S. Ates, and G. Impullitti (2017): "Innovation and Trade Policy in a Globalized World," University of Chicago, Working Paper.

[19] Akcigit, U., S. Baslandze, and F. Lotti (2017): "Politicians and Creative Destruction," University of Chicago, work in progress.

[20] Akcigit, U., S. Baslandze, and S. Stantcheva (2016): "Taxation and the International Migration of Inventors," *American Economic Review*, 106(10), 2930–2981.

[21] Akcigit, U., S. Caicedo, E. Miguelez, S. Stantcheva, and V. Sterzi (2017): "Dancing with the Stars: Interactions and Human Capital Accumulation," University of Chicago, work in progress.

[22] Akcigit, U., M. A. Celik, and J. Greenwood (2016): "Buy, Keep or Sell: Economic Growth and the Market for Ideas," *Econometrica*, 84(3), 943–984.

[23] Akcigit, U., M. A. Celik, O. Itenberg, and G. Ordonez (2017): "Patents as Collateral and Directed Technical Change," University of Chicago, work in progress.

[24] Akcigit, U., J. Grigsby, and T. Nicholas (2017a): "Immigration and the Rise of American Ingenuity," *American Economic Review, Papers and Proceedings*, 107(5), 327–331.

[25] ——— (2017b): "The Rise of American Ingenuity: Innovation and Inventors of the Golden Age," NBER Working Paper #23047.

[26] Akcigit, U., J. Grigsby, T. Nicholas, and S. Stantcheva (2017): "The Long-run Effects of Corporate and Personal Income Taxes on Innovation in the U.S.: Evidence from Historical Patent Data," University of Chicago, work in progress.

[27] Akcigit, U., D. Hanley, and N. Serrano-Velarde (2016): "Back to Basics: Basic Research Spillovers, Innovation Policy and Growth," CEPR Discussion Paper #11707.

[28] Akcigit, U., D. Hanley, and S. Stantcheva (2016): "Optimal Taxation and R&D Policies," NBER Working Paper #22908.

[29] Akcigit, U., and W. R. Kerr (2017): "Growth through Heterogeneous Innovations," *Journal of Political Economy*, forthcoming.

[30] Akcigit, U., W. R. Kerr, and T. Nicholas (2017): "Mechanics of Innovation and Growth: Evidence from Historical Patents," University of Chicago, work in progress.

[31] Akcigit, U., and Q. Liu (2016): "The Role Of Information In Innovation And Competition," *Journal of the European Economic Association*, 14(4), 828–870.