Three Essays on the Macroeconomic Impacts of Rent Seeking

Kurt von Seekamm
University of Massachusetts Amherst

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THREE ESSAYS ON THE MACROECONOMIC IMPACTS OF RENT SEEKING

A Dissertation Presented

By

KURT B. VON SEEKAMM JR.

Submitted to the Graduate School of the University of Massachusetts Amherst in partial fulfillment of the requirement for the degree of

DOCTOR OF PHILOSOPHY

September 2016

Department of Economics
THREE ESSAYS ON THE MACROECONOMIC IMPACTS OF RENT SEEKING

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Approved as to style and content by:

__________________________
Peter Skott, Chair

__________________________
Michael Ash, Member

__________________________
Donald Tomaskovic-Devey, Outside Member

__________________________
Michael Ash, Department Chair
Economics
ACKNOWLEDGEMENTS

There have been many people who contributed to the completion of this collection of essays. To begin, I would like to thank my dissertation committee for their excellent guidance, comments, and, above all, patience. In particular, my chair Peter Skott, has been an excellent mentor. His guidance, instruction, and research have been instrumental to my development as an economist. I would also like to thank my committee members Michael Ash and Donald Tomaskovic-Devey who have provided invaluable feedback on my work from its very early stages.

I am also indebted to the entire UMASS Economics Department. The faculty's relentless criticism of the field of economics and openness to alternative economic theories made for an intellectually stimulating, exciting, challenging, and unique graduate program. I would be remiss if I didn't specifically thank Arslan Razmi, Jim Crotty, Gerald Epstein, Roberto Veneziani, and Fidan Kurtulus for their expert instruction and their dedication to producing fascinating and critical research. In addition, it is safe to say that this collection of essays would have never been written if it were not for my undergraduate mentor, Mark Setterfield, who played a critical role in fostering my deep intellectual curiosity for the field of economics.

Finally, I would like to thank my family for their unconditional love and support. They have always given me the space and encouragement to pursue my personal and professional dreams. It goes without saying that I am most thankful to my partner, Katherine Fawcett, for not only her comments and feedback but also for standing beside me throughout the entire process.
ABSTRACT

THREE ESSAYS ON THE MACROECONOMIC IMPACTS OF RENT SEEKING

SEPTEMBER 2016

KURT VON SEEKAMM JR, B.S., TRINITY COLLEGE
M.A., UNIVERSITY OF MASSACHUSETTES AMHERST
Ph.D., UNIVERSITY OF MASSACHUSETTES AMHERST

Directed by: Professor Peter Skott

Chapter 1 of this dissertation focuses on the political economy of rent seeking. Using trading in financial markets, patent litigation and managerial privilege as descriptive examples from the modern economy, it identifies situations where rent seeking opportunities occur. The challenge of correctly distinguishing between productive activities and rent seeking activities demonstrate the empirical challenges of examining rent seeking. This chapter also suggests that in addition to the opportunity cost of physical capital, modern rent seeking has a significant opportunity cost in the form of the misallocation of human capital.

Chapter 2 explores the relationship between increased rent seeking, aggregate demand, and economic growth. A mature economy Post-Keynesian model is developed to include the existence of economic rents. Two cases are explored. The first assumes a fixed markup and a flexible rate of capacity utilization along the balanced growth path. The second allows for a flexible markup and a fixed rate of capacity utilization. In both cases, the existence of rent seeking has negative effects on the long-run rate of low-skill employment and negative level effects through the redistribution of high-skill workers.
Using IPEDS data on degree completions by field of study for the 48 contiguous states from 1990-2010, chapter 3 uses the composition of postsecondary degree completions by major field of study as an indicator of the degree of rent seeking. Increases in the level of rent seeking are shown to have negative effects on the growth rate of real personal income per capita. A stylized growth model shows how rent seeking regimes can explain the empirical results.
Rent seeking is an important concept in economics, but it is also one of the most poorly defined. Economics textbooks often mention rent seeking in the context of lobbying the government. However, with dramatically increasing income inequality, rents have begun to be referred to simply as “ill-gotten gains” (Bivens and Mishel, 2013). Unfortunately, the former definition is far too narrow and the latter definition is far too broad.

In writing this collection of essays, it was paramount to use a working definition of rent seeking that was clear, conclusive, and general enough to be relevant to macroeconomic modeling. Murphy et al (1991) develop such a definition. When individuals rent seek, they argue, “their private returns come from the redistribution of wealth from others and not from wealth creation.” The danger of this type of rent seeking is that if the returns to rent seeking are higher than the returns to creating wealth, individuals will be re-allocated away from activities that directly contribute to the production of output.

Using this definition, it is clear that rent seeking includes activities that lie outside of the public sector. Chapter 1 highlights some examples of rent seeking that occur in financial markets as a result of deregulation and increased competition, in patent creation and litigation as a result of regulation that is incomplete and poorly designed, and within firms as a result of bureaucracy and imperfect contracts. Although a far cry from a complete list of examples, these examples highlight the
shortcomings of the definition of rent seeking often found in textbooks that suggest government intervention is required for rent seeking to occur.

The working definition used for this manuscript points to the distribution of income between types of agents as the mechanism by which to examine rent seeking theoretically. However, standard economic models are often poorly suited to examine changes in the income distribution and the models that are well equipped to deal with these changes often have other serious shortcomings. In chapter 2 these problems are dealt with by augmenting a mature economy Post-Keynesian growth model to include rent seeking, a heterogeneous labor force, and the production and distribution of workers who are able to be involved in rent seeking activities.

In chapter 3, the empirical method employed by Murphy et al (1991) is used, and expanded, to empirically analyze the effects of rent seeking on growth in The United States. Using postsecondary degree completions by type as an indicator of rent seeking, the finding that increased rent seeking leads to slower growth is consistent with the findings of the theoretical model outlined in Chapter 2. Although this finding is consistent with the model, it should be stressed that it is far from conclusive as there is still more work to be done to properly measure the level of rent seeking.

When reading this manuscript it is likely that you will be looking for villains, and it is tempting to conclude that individuals who rent seek, or who are employed by firms that rent seek, violate some sort of moral code. While some forms of rent seeking are morally reprehensible, fraud and corruption for instance, other types of
rent seeking occur as a result of the institutional structure of the economy with which economic agents interact. So although this manuscript casts rent seeking as “social bad”, the individual economic agents are not to blame. The structure of the modern capitalist economy provides opportunities for introspectively well-intentioned economic agents to rent seek. It is paramount that the field of economics does a better job of analyzing and making policy recommendations to reduce the opportunities to and rewards of rent seeking.

As a final note, the essays contained within this manuscript are designed to be stand-alone essays. Although an effort was made to keep repetition to a minimum, some repetition was unavoidable.
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CHAPTER 1

“RENT SEEKING IN DEVELOPED ECONOMIES: FINANCE, PATENTS, AND MANAGERIAL PRIVILEGE”

A. Introduction

This chapter highlights different forms of rent seeking in modern economies. Contrary to what is taught in many economics textbooks, rent seeking does not necessarily require the manipulation of government regulations. Instead, rent seeking is prevalent throughout the economy and occurs between firms and governments, among competing firms, and within firms. In fact, rent seeking opportunities can develop as a result of government deregulation. Because rent seeking is so widespread, the goal of this chapter is exceedingly modest, aiming to provide some anecdotal evidence of rent seeking between different types of entities and the social costs associated with it. This chapter does not aim to provide an extensive list of all the different types of rent seeking.

Following Murphy et al. (1991), rent seeking is defined as any activity that has private returns from a redistribution, rather than creation, of wealth. Rent seeking activities have been observed throughout history, including in ancient Rome, Medieval China, and during the Middle ages (Baumol, 1990). The cost of rent seeking is its social waste. In some instances, it can simply be the amount of time an individual spends rent seeking as opposed to producing output. However, many rent seeking activities use additional resources beyond time, including both physical capital and human capital. The costs of the latter could be especially high if the most
attractive jobs available to the most talented individuals facilitate rent seeking instead of economically productive activities.

Under the definition of rent seeking in this chapter, rent seeking activities can be thought of as a contest of economic agents competing over an outcome that does not result in the production of output. Instead, the economic agents use resources to shift existing wealth or market power from one competitor to another. The outcome of the contest is the rent, and it has some value, monetary or otherwise, to the contest’s players. If a transfer of income takes place, the rent is theoretically observable and is constituted by the transfer to the victor. However, the size of the rent and the transfer of income are costly to society as a loss of efficiency and may also cause an undesirable change in the income distribution.

Unfortunately, the additional costs to society from rent seeking are largely unobservable to researchers. These unobserved costs are born in the form of payments made by economic agents, be they firms, governments, politicians, or individuals, in an attempt to secure available rents, in addition to opportunity costs of physical and human capital. Even when there is not a transfer of wealth or power, the total cost of rent seeking to society should include money spent by all individuals, even when none of them receive any rents. These social costs are in addition to the cost of the rent. If the rent were uncontested these additional costs of competitive rent seeking would not be realized (Krueger, 1974).

It should be noted here that the social costs of rent seeking include both the opportunity cost of capital, like building a fiber optic cable to carry trading information, and the opportunity cost of human capital, like hiring engineering PhDs
to design and trade financial derivatives. The costs of physical capital are fairly straightforward to calculate, those resources are no longer available to use in the production of another good. However, the opportunity cost of using human capital to rent seek is incalculable as it is not clear how that individual would have used his or her talents otherwise.

Often, opportunities to rent seek are considered a result of intervention by government. Regulations that create opportunities to procure rents include tariffs (Tullock, 1967) (Krueger, 1974), the regulation of monopolies (Baik, 1999), preferential tax treatment, the issuing and defense of questionable patents, and any other activity where the government is intervening in an otherwise efficient marketplace. In this context, the primary consequence of the existence of rent seeking is that it is an additional cost beyond the cost of the regulation.

The proposition that rent seeking exists inasmuch as the government provides opportunities for it requires the government to have both the ability and willingness to interfere in markets and redistribute income between parties (Hillman, 2013). Because rent seeking is generally viewed unfavorably, societies often look to implement further regulation as an attempt to curtail the amount of rent seeking. This can lead to a “vicious circle” where an attempt to reduce the amount of rent seeking may create more rent seeking opportunities (Krueger, 1974).

This chapter argues that, although governments do create opportunities to rent seek through their ability and willingness to redistribute income\(^1\), private

\(^1\) Illustrated by the discussion of patents in section 3.
agents are also capable of creating rents endogenously due to a lack of government regulation or through the hierarchical organization of firms. In fact, in any market where the conditions for perfect competition are not satisfied, firms and individuals have incentives to fight over the spoils of the production process. Furthermore, even when markets operate near the conditions of perfect competition, rent seeking can still occur through wasteful innovation and resource allocation, as is the case in modern financial markets.

When analyzing different types of rent seeking, it is important to keep in mind that many individuals who facilitate rent seeking, such as lawyers or those employed by financial institutions, are not necessarily the rent seekers themselves. Many of them are employees of rent seeking firms, or contracted by them. In order to not confuse the employee with the rent seekers (their employers), employees hired to facilitate rent seeking will be referred to as facilitating labor. Firms and individuals who organize and participate in rent seeking activities will be referred to as rent seekers or rent seeking labor.

The remainder of this chapter is organized as follows. Sections B-D use the existing literature on rent seeking to provide evidence that rent seeking takes place in financial markets, the secondary patent market and patent licensing, and within firms. Section E comments on the misallocation of human capital. The final section concludes.

**B. Finance: Trading on Speed**

Secondary financial markets provide an interesting example of rent seeking.
The activities of financial firms are functional in that they provide liquidity to “investors” and a constant re-evaluation of investment decisions that, without a well functioning financial market, would be non-existent. This constant re-evaluation of businesses can increase the level of investment by making investments revocable for the individual entrepreneur and decreasing risk.

On the other hand, the existence of well-functioning secondary financial markets may reduce the level of investment. If a pre-established company can be purchased at a lower price, it may diminish the incentives to create new companies. In addition, secondary financial markets may lure workers with business acumen away from starting their own business if they can instead buy and sell assets on financial markets for immediate profit (Keynes, 1936). Finally, and perhaps most importantly, even though secondary financial markets make an investment revocable for the individual, the investment is not socially revocable as the resources used to make it have already been used up.

The dual roles of secondary financial markets as incubators for new investment and shufflers of pre-existing wealth highlight the difficulties of distinguishing activities that play a functional role in the production process from those that are purely rent seeking. In the first case, traders of financial assets provide a service that is useful in the creation of new wealth. In the latter case, they act as speculators that do not contribute to the production of new wealth, but rather look to capitalize on the redistribution of wealth by transferring ownership of pre-existing assets.
In particular, professional speculators have transformed the role of financial markets. Instead of applying their efforts to correctly evaluate the long-term viability of investment projects, speculators look to foresee “changes in the conventional basis of valuation a short time ahead of the general public (Keynes, 1936).” This effort to outpace the market is pure rent seeking that proponents justify by citing improved pricing efficiency and increased liquidity. However, there is evidence that the pursuit of pricing efficiency and liquidity has yielded handsome profits to highly sophisticated speculators at the expense of functional market makers and less sophisticated investors who cannot compete on the basis of speed.

Using speed for the purpose of increasing liquidity draws to our attention the absurdity of the newfound role of professional speculators. Instead of facilitating the goals of clients to generate future returns, professional speculators look to exploit their comparative advantage by reducing their latency, or the amount of time it takes to execute an electronic operation. Latency occurs as a result of a computer needing time to process data and execute commands, and the amount of time it takes data or commands to travel between computers and data centers at different locations. When stocks are poised to fall, they use speed to ensure that they can dump assets before the general public. When stocks are poised to rise, they use their superior technology to purchase assets before the general public. This front running of the market does increase pricing efficiency as it causes assets to be priced faster, but it does so at the expense of ordinary investors whose actions would have led the market to same price, even in the absence of sophisticated institutional investors.
Arbitrage opportunities have increased with the number of cross-listed assets and with the advent of different exchanges. In response, regulators require that quotations be “harmonized” across different exchanges to ensure that market participants are trading their equities at the best price. To be compliant with Regulation National Market System (NMS), every exchange is required to feed information about the orders it’s receiving to an entity called the Security Information Processor (SIP), which then computes the publically displayed National Best Bid and Offer (NBBO). This process creates an opportunity for latency arbitrage, which uses faster execution speeds to complete trades faster than competitors. These opportunities arise when private companies have the ability to collect and compute the information going into the SIP faster than the SIP can, thereby “predicting” what the NBBO will be.

Intuitively, the consequences of such arbitrage could be ambiguous, but Wah and Wellman (2013) build a stylized model to analyze the impact latency arbitrage has on market performance. Their stylized model looks at only two exchanges that trade one security, one high-frequency trader (HFT) and multiple background (non high-frequency) traders. They find that the inclusion of latency arbitrageurs results in a reduction in total surplus, slightly improved execution times, and reduced liquidity represented by wider bid-ask spreads.

The aggregate costs of pursuing zero latency are largely unknown, but the

---

2 Regulation NMS requires that exchanges execute trades at the best price for all exchanges, harmonize prices across trading centers, make prices round to the nearest penny except for stocks trading below $1.00, and update market data rules. For a full explanation of Regulation NMS, see Securities and Exchange Commission (2005)
pursuit of zero latency has become big business for firms participating in financial markets. There are a large number of firms that provide financial companies with low latency services, including Spread Networks, Ciena, Lightower, and TNS. High frequency trading firms do indeed pay for the ability to compete on the basis of speed by co-locating their servers at different exchanges. Since light travels at a finite speed, co-location reduces the amount of distance the information needs to travel through fiber optic cables to reach the computers that automatically execute trades. The reason why firms are willing to pay a fee is that trading on speed is a winner take all competition. If a trader is second in line, they will not be able to take advantage of the arbitrage opportunities available (Baron et al, 2016).

Although all of these firms’ websites tout the benefits of their services, “Milliseconds can mean millions of dollars, (Ciena)” none of them provide any information as to what their services cost. Fortunately, the cost of building the infrastructure to provide some of these services is reasonably well documented. For example, in an effort to reduce latency, Spread Networks installed an 825-mile fiber optic cable between New York and Chicago. This cable reduces latency by approximately 3 milliseconds by utilizing a route that is approximately 100 miles shorter than their competitors (Steiner, 2010). Spread has not released the cost of installing the cable, but the estimated cost of the cable is approximately $300 million (Budish et al, 2013). It’s not entirely clear that this cable will serve no purpose if a faster technology, such as microwave towers or drones, are employed, but its usefulness outside of the financial markets seems close to nil.

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3 http://spreadnetworks.com/network-map
When considering trading on speed, increased market regulation does not explain the increased incentives to rent seek. The returns to trading on speed have been the result of technological innovation, innovation in financial assets, market fragmentation promoted by competition, and the high costs associated with high-speed algorithmic trading; not stricter regulation. In response to the increased sophistication of investors, firms that represent groups of unsophisticated investors have had to increase their investment in technology to reduce the likelihood of being taken advantage of by their faster counterparts.

A study done by Foucault et al (2016) provides just a small snapshot into a type of rent seeking activity in financial markets that they refer to as “toxic arbitrage”. By their definition, an arbitrage opportunity is considered toxic when the price of an asset pair differs across sellers, and one seller sells the asset at the “stale quote”. They argue that the number of stale quotes is increasing as a result of increased market fragmentation, including the creation of new “lit” exchanges, dark exchanges, electronic communications networks (ECNs) and off-exchange market makers\(^4\), and the proliferation of derivatives. Increased fragmentation, coupled with a decrease in latency, increases the likelihood that an arbitrageur can pick off a seller with a stale quote.

Using data from currency markets, Foucault et al (2016) find that a 1% increase in the likelihood that the arbitrageur wins is associated with a 4% increase in bid ask spreads. This reduction in liquidity for increased price efficiency increases the costs of other investors participating in currency markets, which they estimate

\(^4\) For a review of the market fragmentation literature see SEC (2013).
to be $161,000 per day. They show that there is a significant amount of daily variation in the number of arbitrage opportunities available, but provide no evidence that a reduction in the duration of arbitrage opportunities leads to a reduction in the number of arbitrage opportunities available. They also show that, the average arbitrage opportunity in this market lasts 0.89 seconds in their sample. Introducing technology that allows for computers to directly introduce trades\(^5\) reduced the average duration of arbitrage opportunities by 62 milliseconds.\(^6\)

The term toxic arbitrage is a bit surprising as economists often view arbitrage as something that increases market efficiency. When the same asset has different prices on two different trading platforms it is called cross-market arbitrage. This type of arbitrage occurs in markets where the prices of the same asset do not adjust at the same speed. In response to the difference in prices, an arbitrageur can step in and capitalize on the arbitrage opportunity or the market maker can update their quote. If the arbitrageur is faster than the market maker, the market maker suffers a loss at the expense of the arbitrageur. In this example, the arbitrageur has performed an important economic function of increasing pricing efficiency by reducing the amount of time that a stale price is listed in a market, but he also may have a negative impact on liquidity as market makers will increase their bid/ask spreads as a result of the increased risk.

Latency arbitrage is a winner takes all proposition. If a trader is an instant slower than another (measured in fractions of a millisecond) they lose the arbitrage

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\(^5\) In 2003 Reuters introduced the “AutoQuote API” which allows for the automated entry of trades by algorithms.

\(^6\) Or about half the duration of a blink of an eye.
opportunity to the faster trader. The consequences this type of rent seeking can be demonstrated by a simple arms race game. Assume that there is an arbitrage opportunity that exists with a value $a$ available to two firms. The firm that can execute the trade the fastest receives the entirety of the prize, $a$, while the slower firm receives nothing. An outside firm provides a subscription service to access the fastest trading technology at an average cost per trade, $c$, which firms can choose to pay or not to pay. If they do not pay for access, they incur no technology costs and use an inferior technology, which is the default technology for both firms. If both firms use the same technology, they have an equal chance to win the prize, $a$. This simple game can be represented as follows:

<table>
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<th>Don't</th>
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<tr>
<td>Buy</td>
<td>$\frac{1}{2}a - c$, $\frac{1}{2}a - c$</td>
<td>$a - c$, 0</td>
</tr>
<tr>
<td>Don't</td>
<td>$0, a - c$</td>
<td>$\frac{1}{2}a, \frac{1}{2}a$</td>
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It can be shown that (Buy, Buy) is the unique pure strategy Nash Equilibrium of the game if $c$ is less than $\frac{1}{2}a$. This outcome is Pareto inferior to the outcome where both players do not invest in the technology. In this stylized game, the total cost to the players of playing the Nash Equilibrium strategy is $2c$.

Pursuing trading speeds that are milliseconds faster than the competition is rent seeking. As a result of the transaction, no new wealth is created. Instead, the faster firm simply earns a rent from the slower trader and pays the technology service provider a fee. If both firms purchase the superior technology, there is no transfer of wealth between the two traders; the firm providing the technology
captures at least some of the available rent. However, the total cost to society is not known from this game and depends on the opportunity cost of the resources that are needed to use the technology.

Beyond showing that there can be social costs to rent seeking, this example also illustrates the complexities of identifying what agents engage in rent seeking. In this case, both financial firms may be thought of as rent seekers as they are looking to use technology to secure an edge over their opponent without creating any new wealth. Even though it captures part, if not most, of the rent, the technology firm is not rent seeking as it creates and provides the new technology to the traders. In addition, the employees\(^7\) of the firm are facilitating labor, as they are simply hired to perform a function for the rent seeking firm and its managers.

If it is the case that high-speed arbitrage increases the cost of executing trades without reducing the number of arbitrage opportunities it is hard to conclude that these types of high-speed arbitrage opportunities are anything but rent seeking. They simply represent a transfer of wealth from investors and market makers to arbitrageurs with the caveat that pricing efficiency is improved by fractions of a second. It is hard to see the benefit of this type of activity to the economy as a whole.

Latency arbitrage opportunities can come about as a result of things other than the market fragmentation example outlined above. High frequency trading firms can also use latency to process news and order flow (Baron et al, 2016). This type of competition through speed results in adverse selection as some market participants have information about an asset that others do not (Biais, et al, 2015).

\(^7\) At least those without decision making power
For instance, a financial firm may sell an asset to a less sophisticated market participant that they know for certain is about to decrease in value. The consequences of adverse selection in markets are well documented and the concept of “foreknowledge” is dealt with in Hirshleifer (1971) and Fama and Laffer (1971). In these papers, it is clearly shown that the production of information about future states for the purposes of trading before that information becomes public leads to incentives for private agents to speculate based on that information or to re-sell the information. Firms and individuals with private information about the future use that information to increase individual profits. However, the private returns from this foreknowledge do not increase social welfare. Instead, if there are costs associated with producing the private information, the result is a reduction in public welfare compared to when that information is disseminated publicly.

The speed advantage of the speculator corresponds to foreknowledge relative to the market maker. They know what happened to the true price of the asset before the rest of the market as a result of their superior technology. The speculator, keeping that information private, executes the arbitrage opportunity and earns a profit by redistributing wealth from the market maker to himself or herself. Imagine instead that both the market maker and the speculator receive the new information at the same time and process it at the same speed. In this case, the market maker updates its price and this price adjustment is precisely the same price adjustment that would have happened in the absence of the arbitrageur. Fortunately, there are laws in the United States that mandate markets distribute information simultaneously to all participants. Unfortunately, private firms spend a
large amount of money to ensure that they can process the information faster than other participants, making it indistinguishable from the case where they get the information first.

The existence of the possibility of obtaining and processing information before the rest of the market encourages rent seeking. If the speculator continues to use resources to try to produce private information, the outcome is not socially optimal as those resources used to rent seek are wasted, even if they obtain no rents. In sum, when information is private, the speculator captures private rewards and market participants lose as market makers may increase their bid/ask spreads to protect themselves from being taken advantage of by more sophisticated traders. The potential costs of such strategies include the costs of physical capital, the networks and computers used, and also the opportunity cost of human capital.

In the case of latency arbitrage, markets could indeed use speed to update market quality and reduce the likelihood of rent seeking firms to proliferate. Instead of selling access to speed to predatory firms, they could provide access to speed to market makers to obtain a socially superior outcome through increased market liquidity and price discovery. Ensuring that market makers are the fastest agents in financial markets, would remove the incentives for arbitrageurs to invest in technologies.

Alternatively, Budish et al. (2015) suggest that high frequency trading firms have the opportunity to rent seek based solely on market design. They argue that the use of continuous time trading leads to rent seeking opportunities and wasteful investment in technology that rewards market participants for executing trades
milliseconds faster than their competition. They propose that switching from continuous time trading to discrete time trading would remove the incentives for this type of rent seeking activities.

C. Patents: Rents as a Consequence of Regulation

Patents exist as a means of fostering innovation and economic growth through the creation of intellectual property rights. The primary benefit of a patent is that it entitles the owners to temporary monopoly rents based on their innovation and therefore high private returns. Patents provide innovators with monopoly rents with the hope that the long run benefits from innovation will outweigh the short run social costs of monopoly. From a social welfare perspective, the benefits of market power for the purpose of increasing economic innovation and growth date back to the works of Schumpeter (1947), Dasgupta and Stiglitz (1980) and Tandon (1984).

Secondary patent markets provide innovators the opportunity to sell or license their patents to firms that wish to buy them. This allows the innovators to realize immediate gains from their innovation and to facilitate the process from invention to production. However, it will be argued that given the lack of perfect enforceability of patents and a lack of transparency in secondary patent markets, opportunities to rent seek are created through costly litigation, questionable patent filings, and opportunistic patent arbitrage. In addition, the lack of enforceability of

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8 It is not universally agreed upon that patents foster innovation and growth. Boldrin and Levine (2013) provide an overview of why patents may not serve their designated purpose.
patents has created an industry where innovators sell questionable patents to firms in hopes of reducing their litigation risk.

The ability to create, sell, and license patents in secondary patent markets can provide a useful way to efficiently allocate ideas and resources. As was true with the rent seeking opportunity of trading on speed outlined above, the secondary market for patents is not a recent phenomenon. Dating back to the early 19th century, many prominent inventors used secondary markets for patents and patent licensing as a way to satisfy and finance their desire to invent, not to commercialize products (Mossoff, 2015). In principle, a secondary market for intellectual property rights plays an important role in an economy that uses market returns as a mechanism for fostering innovation.

Unfortunately, wherever there are rents present, there are opportunities to rent seek. In the case of intellectual property rights, the use of patent litigation, the contesting of valid patents or protection of questionable patents in the courts, is commonly used as a means of trying to capture some of the rents held by a patent owner. Of course, some of this litigation is deemed to be socially advantageous, as litigation can be used to protect ideas that were truly the unique contribution of an inventor. In addition, litigation can improve social welfare by revoking invalid patents that offer only trivial improvements or are not novel, as they would be achieved through the normal process of production (Merges, 2009). However, in some cases, the owners of these questionable patents file lawsuits against manufacturers who allegedly violate their patents in order to extract rents.
The creation of legally enforceable rents is only as good as their enforceability. If property rights are viewed as suspect, there are large incentives to litigate based on patent validity and infringement. This is especially true if the innovation has significant commercial value. This transforms what was intended to be guaranteed property rights into something akin to a lottery ticket, the value of which is determined by not only the commercial value of the innovation but also the probability that it can be defended in court (Lemley and Shapiro, 2005). From the other side of the argument, the risk involved with litigating an invalid patent may incentivize the production of patents that have questionable validity. Because patent litigation is costly, firms and individuals with fewer resources and higher levels of uncertainty about the commercial value of their invention will be far more likely to avoid litigation or settle outside of court.

This lottery approach to patents highlights the inefficiencies of new patent production in the United States. The total cost of obtaining a patent is no longer the fees paid to the United States Patent Office and legal fees paid to lawyers for reviewing and filing the necessary paperwork. Instead, the total cost of obtaining a patent includes the additional costs of defending the patents in federal court. Kesan and Ball (2006) use the number of documents filed per case to show that pre-trial costs associated with filing claims and settling cases before trial may not be “cheap” and can often exceed half a million dollars. A survey by the American Intellectual Property Law Association (2001) estimates the cost of patent litigation to be between $500,000 and $3,000,000 per case. The high costs of litigation can incentivize firms to settle the dispute outside of court. In the case where there are
many firms that may benefit from the repeal of the patent, the threat of litigation can be enough to lead firms to collude to preserve monopoly profits. In addition, they suggest that case settlement may actually indicate inefficiencies in the patent system that can lead to a collective action problem.

The uncertainty of property rights granted by patents, coupled with the high costs of litigation, incentivize firms and individuals to create and file questionable patents. This can lead to the creation of a “patent thicket” where firms must navigate a large number of patents, including patents that are in the process of being evaluated, to ensure that they are not infringing on someone else’s intellectual property rights (Shapiro, 2001). The risks for firms can be significant, as they may result in financial liability or an injunction to cease production.

There are a number of barriers that may prevent a patent from being challenged. First, patents that have been awarded are assumed to be valid by the courts. This places the burden on the challenger to provide “clear and convincing” evidence that the patent should be revoked. Second, the costs of litigation are significant. This can often lead to a large number of questionable patents that go unchallenged. While litigation can sometimes be thought of as rent seeking, it may actually be an undersupplied social good in the case of invalidating questionable patents. (Hall et al. 2003)

To illustrate this, consider a firm that has been awarded a questionable patent with significant commercial value. With the patent in hand, the firm has exclusive rights to produce the product and can issue a cease and desist order to
firms that do not license the patent from them. Further, there are two other firms who would benefit from having the patent revoked. An individual firm may file a lawsuit against the patent holder in hopes of having the patent overturned through a trial with cost, $T$, or both firms can coordinate and split the cost of the trial. Both potential challengers to the patent know that it is questionable and can either go to trial in hopes of winning it with probability $p$ or lose the trial with probability $(1-p)$. If the trial is successful and the patent is revoked, both firms split the benefit, $w$, from winning the trial. If the trial is lost and the patent is upheld, both firms receive the same benefit as if the patent were overturned, but they must pay the licensing fee, $l$. At the beginning of the game, firms must decide whether or not to fight the patent in court or pay a non-refundable licensing fee to the patent holder. If the firm goes to trial and loses, it must pay the licensing fee in addition to the cost of the trial.

The following payoff matrix can represent this example:

<table>
<thead>
<tr>
<th></th>
<th>License</th>
<th>Trial</th>
</tr>
</thead>
<tbody>
<tr>
<td>License</td>
<td>$0.5w - l$,</td>
<td>$0.5w - l$</td>
</tr>
<tr>
<td></td>
<td>$0.5w - l$</td>
<td>$0.5w - l + pl - T$</td>
</tr>
<tr>
<td>Trial</td>
<td>$0.5w - l + pl - T$,</td>
<td>$0.5w - l + pl - 0.5T$</td>
</tr>
<tr>
<td></td>
<td>$0.5w - l$</td>
<td>$0.5w - l + pl - 0.5T$</td>
</tr>
</tbody>
</table>

The above game is an assurance game, or stag hunt, for a range of probabilities of winning the trial. To see this, note that player 1 pays the licensing fee to the owner of the patent when player 2 decides to pay the licensing fee if:

$0.5w - l + pl - T < 0.5w - l$

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9 It is assumed that licensing the patent is preferable to not producing at all.
10 For the purposes of this example assume that $0.5w - l \geq 0$ and it is profit maximizing for the patent owner to issue the license.
Which is true if:

\[ p < \frac{T}{l} \]

So if the probability of winning is sufficiently low, player 1 will always choose to pay the licensing fee when player 2 decides to pay the licensing fee. If \( T > l \), then both firms decide to license, even if the probability of winning the trial is unity.

If player 2 decides to go to trial, player 1 will go to trial if:

\[ .5w - l + pl - .5T > .5w - l \]

Which is true if:

\[ p > \frac{.5T}{l} \]

If both of the above inequalities hold, due to the symmetry of the game, there are two pure strategy Nash Equilibria; (License, License) and (Trial, Trial). These Nash Equilibria can be Pareto ranked, with the (License, License) equilibrium being Pareto inferior to the (Trial, Trial) equilibrium.

Beyond the uncertainty of winning the trial, another reason for this type of collective action problem is that patent settlements, including licensing agreements, are often made privately through a bilateral agreement without making the settlement public (Gans and Stern, 2010). This places the onus on each firm to individually negotiate settlements or collectively negotiate settlements through patent pools. The problem with this type of transaction is that it does not promote a transparent or liquid secondary market. Instead, it leads to further uncertainty about the true market value of intellectual property. In some cases, firms may make
reverse payments to competing firms to keep them from entering the market (Shapiro, 2001).

The uncertainty around a patent’s validity has led to a rise in “Non Practicing Entities”, affectionately referred to as “patent trolls”. These firms are distinguished from inventors and producers in that they acquire patents for the sole purpose of selling or obtaining licensing fees for the patents, do not conduct R&D, and wait until firms are most vulnerable before claiming infringement (Hagiu and Yoffie, 2013). This definition of patent trolls falls perfectly in line with this paper’s definition of rent seeking in that they produce no output (including R&D) and their private income is derived from the sale of a pre-existing asset that has value.

Opponents to this interpretation are likely to note that Non Practicing Entities (NPEs) are not new and that they provide greater liquidity to secondary patent markets by exploiting arbitrage opportunities. Both points may be true, but they do not diminish their classification as rent seekers. From the seller’s side, the existence of NPEs certainly increases the likelihood of selling a patent of uncertain value, particularly among small firms and inventors. The lack of a well functioning transparent marketplace makes finding willing buyers for patents difficult. However, from the buyer’s side, it is not clear that privately licensing patents increases market efficiency. Rather, NPEs are able to exert their power through asymmetric information and opportunistic timing to extract rents from firms who wish to use the protected technology for production. In addition, this has the added social costs of allowing firms to continue to develop technologies, even when that technology presumably already exists.
The rise of patent trolls has led to the development of “defensive aggregators” (Hagiu and Yoffie, 2013). These firms act as group insurance against NPEs in that they purchase large numbers of problematic patents and license the rights to use them in the aggregators’ portfolio for a fee. In return, the former patent holder receives protection against patent trolls by reducing litigation risk and litigation costs for problematic patents. The defensive aggregators also assure members that the patents held within the defensive aggregators’ portfolio would never be used against them. This type of activity is defensive rent seeking, as it provides protection for patents that would otherwise run a reasonable risk of being invalidated.

The social cost of the issuance of weak patents exceeds the social cost of the patent through the granting of monopoly rents. By fostering innovation and presumably growth, these monopoly rents have been deemed to be socially acceptable, based on the externalities generated from guaranteeing property rights. However, the additional cost of rent seeking reduces the value of the patent system and the likelihood that the benefits from innovation exceed the social costs of the monopoly rents.

**D. Rent Seeking Within Firms: Managers and Executives**

Up to this point, this paper has demonstrated that rent seeking can happen as a result of both technological innovation in competitive markets and government regulation originally designed to foster innovation and growth. However, rent seeking also takes place within the firm, as a result of hierarchical organizations.
When decision-making power is concentrated among a small number of individuals, workers, managers, and executives may spend time trying to influence these decision makers, as opposed to producing output.

Milgrom (1988) refers to this type of rent seeking behavior as “influence costs”. These costs are borne by firms with hierarchies that are highly centralized. Under this firm structure, an employee can receive large benefits by spending time trying to influence one, or just a few, of a firm’s primary decision makers. In addition, decisions that make little difference to the firm, but have large impacts on distribution within the firm, are likely to attract workers’ time.

In some instances, the costs of this type of activity are small. For example, a firm may be trying to decide which employees to move to a newly acquired building across the street. Some workers may have strong preferences towards staying in the old building or moving to the new building. In this case, they may invest time trying to influence managers based on their preferences. Although not directly related to monetary compensation, this is a form of rent seeking.

Influence costs, however, can be far greater to firms than those simply incurred when workers try to improve or maintain their working conditions. In the face of uncertainty, firms may have to choose between different technologies, allocating funds between departments, setting managerial pay, and determining employee promotions. All of these decisions, when under the control of a small group of decision makers, incentivize workers to split their time between producing output and campaigning for managers and executives to act in a way that is in the worker’s best interest.
Scharfstein and Stein (2000) divide managerial rent seeking into two different types of activities, “resume polishing” and “scorched earth”. The first causes managers to spend time on making themselves more appealing to other potential employers by participating in activities that only increase their external visibility. The second involves managers adopting specialized practices that their replacements would have a hard time understanding. These could include specialized software, accounting practices, etc.

Edlin and Stiglitz (1995) suggest that managers may entrench themselves by investing in uncertain investment projects that they will be able to observe the outcome of before outsiders. These risky investments give the manager the ability to use their private information to rent seek and negotiate better compensation contracts than they would have received if they had made investments with more certain returns. Alternatively, Shleifer and Vishny (1989) suggest that managers have incentives to invest in projects that most closely align with their individual skills, even when other projects may be value maximizing, in order to increase their value to shareholders.

The effects of influence costs are sometimes realized through an inefficient allocation of resources among divisions within a firm. Given that there is a scarce amount of funds to be distributed, managers have incentives to lobby executives to procure funds for their department. Knowing this, firms are left to weigh the private, potentially distorted, recommendations of division managers against a potentially noisy public signal (Wulf, 2009). In response, firms may implement mechanisms to reduce the benefits of distorted signals from managers, which could
be costly. In addition, differing power structures within hierarchical firms can result in an inefficient allocation of funds in firms that are highly diversified (Rajan et al, 2000). This is especially true when the most influential managers head larger divisions.

More recently, the importance of rent seeking through influence costs for executives have come under some scrutiny. The primary source of these rents stem from an agency problem between firms and shareholders. To try to alleviate this agency problem, firms have increased the proportion of performance pay to executives in hopes of more closely aligning the objectives of shareholders and management. However, it is not clear that executive performance compensation necessarily aligns the interests of the executive and firm, because the firm’s objective is not perfectly contractible and a perfect performance measure does not exist (Oosterbeek et al, 2011).

In the absence of a perfect performance measure, executives have incentives to design compensation contracts that appear to align with shareholder’s objectives, but also take advantage of the imperfect contractibility of performance. For instance, executive pay has increasingly included stock options tied solely to the market performance of the firm’s stock and not their performance relative to peer firms (Bebchuk and Fried, 2005). Occasionally, this allows the executive to take advantage of a strong stock market, even if their individual performance did not have much effect on the stock price. Similarly, it allows for executives to take advantage of above average industry performance, even if their firm underperforms relative to its peers.
With the existence of the imperfect contractibility of performance, executives have incentives to rent seek to increase their guaranteed pay, in addition to their performance pay. However, as the growth of executive pay outpaces the growth of average worker pay, firms must justify or conceal the level of executive pay once it reaches an “outrage constraint”. Firms can do this by hiring outside consultants to examine whether or not the level of executive pay is appropriate (Wade et al, 1997) or by hiding it in non-traditional pay such as below market rate loans and debt forgiveness from the firm (Bebchuck and Fried, 2005).

In the study by Wade et al (1997), they examine how firms’ compensation committees and executives justify executive pay practices. Broadly speaking, firms can justify pay in three ways; through external compensation consultants, alignment with shareholder interests, and firm performance. Using COMPUSTAT data from 255 companies that list their stock on the S&P 500 index, Wade et al (1997) find that the type of pay justification used depends most strongly on the performance of the firm, stock ownership concentration, and whether or not the CEO received a bonus. Market-based justification is most likely to be used when the firm is doing well, while external validation is used most often when the CEO receives a bonus and/or a large proportion of shares is owned by an external shareholder.

Executive pay justification that responds to the state or organization of the firm can be interpreted as rent seeking. In particular, the use of external compensation consultants is costly for firms and tends to result in higher pay for executives than their peer average (Gillan, 2001) and (Bizjak et al, 2008). In addition, compensation consultants tend not to be fully external as they have other
professional relationships with the firm (Bebchuck and Fried, 2005). This increase in pay without a corresponding increase in performance, transfers income from shareholders, who may have a large equity stake in a company, to executives, who have incentives to rent seek as their performance is not perfectly contractible.

Intra-firm rent seeking shines light on the fact that wherever there are agency problems, there is incentive to rent seek. The incentives to rent seek can be reduced by a redesign of compensation contracts, managerial monitoring done by the board of directors, the threat of hostile takeovers, and a fluid market for managers. However, as was outlined above, managers and executives have incentives to rent seek by undermining these discipline mechanisms. They do this by maintaining personal and professional relationships with the board of directors, camouflaging their compensation, and undertaking uncertain and manager specific investments. In all of these cases, the end result is a transfer of income from shareholders to managers in the form of rents.

**E. Discussion: The Allocation of Human Capital**

The urgency in which policy makers should deal with regulating instances of rent seeking depends on the social costs of the rent seeking activity. For instance, if the amount of physical capital used is large, such as in the case with latency arbitrage, policy makers should act swiftly so that capital can be re-directed to more productive activities. However, rent seeking activities may become particularly damaging in terms of the misallocation of human capital. In particular, if rent seeking or facilitating labor earns high salaries, then the opportunity cost of rent
seeking may be extremely high as rent seeking activities may draw workers away from socially productive endeavors.

The syphoning of highly educated workers away from socially productive endeavors is apparent in the financial markets. Long gone are the days of a large trading floors packed with thousands of traders. In 1980 there were 5,500 people executing trades on the floor of the NYSE. In 2013, that number had dropped to 700. Now, the raucous floor of the NYSE has become quiet enough to host permanent sets for television networks like CNBC and Bloomberg. Because trades can be executed directly through computer programs, highly educated computer programmers, physicists and scientists have replaced boisterous, gruff, and often uneducated traders. (Levine, 2013)

The change in the average skill level of finance workers is well documented by Philippon and Reshef (2012). In their study, they track human capital intensity and wage premiums in finance between 1909 and 2006. They find that high wages, skill intensity and complexity are not permanent features and that finance has not always been a high-skill intensive industry. Since 1970, the relative skill of workers in finance with more than a high-school education compared to the US economy as a whole has increased from approximately 0.5 to 0.1. This means that the share of high-skill workers employed in finance has increased from 5% higher to 10% higher than in the average sector (Philippon and Reshef, 2013). More striking, however, is the dramatic increase of the most skilled workers employed at financial firms.

For example, in 1982 Jim Simons founded Renaissance Technologies LLC, an investment management company that handles over $15 billion in assets. He was
not a savvy “businessman” or experienced trader, but a former code breaker for the Department of Defense and a former Mathematics professor at MIT and Harvard. According to their website, the company hires much in the same vein with “roughly half” of their 150 Long Island employees possessing a PhD in scientific disciplines.

And Renaissance Technologies is not alone, the Prediction Company, founded by James Farmer and Norman Packard, who left their jobs at Los Alamos National Laboratory and a tenured position as a professor of physics at the University of Illinois respectively, requires their employees to have their masters or equivalent in fields like mathematics, statistics, physics, financial engineering, etc. to be considered for a job as a quantitative research analyst. Want to write code for the Prediction Company? A degree in computer science is compulsory (Prediction Company). Want to work as a quantitative researcher at Citadel? You better pack your PhD, be ABD, or a junior faculty member in economics, engineering, finance, mathematics, or physics (Citadel).

The opportunity cost of losing these workers to become facilitating labor or rent seekers should not be understated. As Simon Jones, a former quantitative trader at Citi puts it,

“I was working with the best of the best. My bank employed the brightest engineers, chemists and scientists – and we were all working together to get richer. The chemical and physics and health industries are worse off because of what we do because I tell you this: if there was a pay bonus structure similar to what we had in the City for curing cancer, we’d have found a cure for cancer.” (Manzoor, 2013)

Although this quote has lofty expectations for facilitating labor, policy makers need to take seriously the potential consequences of rent seeking when it comes to the reallocation of human capital from socially productive activities to rent seeking.
activities.

**F. Conclusions**

What is true about all the aforementioned forms of rent seeking is that none of them are new. In the financial markets, trading on speed was not done automatically by computers, but by traders who purchased floor seats on the New York Stock Exchange. From their very implementation, patents have been filed and contested. Hierarchical firms have provided managers with incentives to rent seek for all of modern history.

Just because rents have been around for a long time does not mean that the problems of rent seeking have been solved or that they have become insignificant. In fact, the importance of rent seeking is likely to ebb and flow throughout all stages of economic development. On the one hand, weak institutional structures can lead to high levels of rent seeking through the socially wasteful acts of theft and bribery. On the other hand, highly developed and robust institutions can provide opportunities to rent seek through poorly designed legislature, the enforcement of intellectual property rights, technological innovation, and hierarchical firm organization.

Of particular concern is that, in general, the roles within the economy that afford workers the opportunity to participate as facilitating or rent seeking labor are classified at “high-skill”. This does not mean to suggest that positions without the opportunity to rent seek are low-skill. In fact, many “low-skill” jobs require very technical skills in order to be performed correctly. Instead, they are high-skill in the sense that people in these roles possess some sort of post-secondary education. In
the case of algorithmic traders, this may include both STEM and finance degree recipients. In the case of patents it is likely to include individuals who possess business and law degrees. For managers, it may include people who hold degrees in business, the social sciences, and finance, among others.

The perverse incentives to rent seek raise concerns about the allocation of talent within an economy that provides opportunities to rent seek primarily to those with postsecondary degrees. This may be of significant importance to policy makers as an increase in the number of highly educated workers, resulting from increased opportunities to or incentives for rent seeking, may lead to worsening economic outcomes.
CHAPTER 2

“A POST-KEYNESIAN MODEL OF RENT SEEKING”

A. Introduction

This chapter focuses on how changes in rent seeking, defined as any activity that has private returns that come from a redistribution of wealth and not from wealth creation (Murphy et al. 1996), impact the income distribution, low-skill employment, and the level of output along the balanced growth path. As was outlined in the previous chapter, examples of rent seeking activities include, but are not limited to, trading in financial markets, patent litigation, and intra-firm rent seeking.

Much of the discussion around income distribution and growth has been focused on income and wealth inequality amongst individuals. The discussion almost always excludes an examination of the allocation of workers between different types of economic activities. This is not to say that analyzing the income distribution between individuals is unimportant. In fact, it has motivated some of the rent seeking taking place in today’s economy. The model presented here includes both an analysis of changes in the income distribution along with an examination of worker allocation. However, some of the negative economic consequences attributed to increasing income and wealth inequality may still occur in the absence of increasing income and wealth inequality. Therefore, even when rent seeking does not lead to increased income and wealth inequality, it is still socially wasteful and has meaningful impacts on the macroeconomy.
Previous attempts at modeling rent seeking focus on the allocation of workers and the effect it has on innovation and therefore accumulation. Murphy et al (1991) assume that workers can choose between becoming “entrepreneurs”, in the sense that they can improve the production process through technological innovation, or rent seekers. Other models focus on the explicit role that government plays in the creation rent seeking opportunities or assumes that rent seekers are drawn from a homogenous pool of workers (Acemoglu, 1995).

This model differs from previous models of rent seeking on three fronts. First, instead of focusing on growth effects of rent seeking, it analyzes the impacts of rent seeking on the employment rate of low-skill workers along the balanced growth path. Second, it brings the distribution of income and aggregate demand to the center of the analysis through the inclusion of three different types of agents; capitalists, high-skill workers, and low-skill workers who all have different saving behavior. Finally, it makes the assumption that obtaining a postsecondary degree is necessary to participate as an employee facilitating rent seeking. This leads to changes in rent seeking having an impact on not only the distribution of high-skill, credentialed, workers but also on the production of individuals with a postsecondary degree.

One of the key assumptions of the model is that rent seeking takes place at the firm level and that workers are hired as cost to firms that engage in rent seeking. Therefore, high-skill workers are hired as facilitating labor and that they are not playing the role of the rent seeker. What is important for this discussion is that an
increase in rent seeking opportunities causes firms to increase their demand for facilitating labor.

Fluctuations in the facilitating labor share of income can come about as a part of the development process, a product of technological innovation, changes in attitudes towards rent-seeking activities, or a function of the state of the political system. However, this paper does not set out to answer the question of the endogenous evolution of the share of income paid to facilitating labor. Instead, it has a much more modest goal of analyzing the potential impacts of a shift from an economy where rent seeking opportunities are scarce and the demand for facilitating labor is low to economies where rent seeking opportunities are more prevalent and the demand for facilitating labor is high.

The remainder of this paper is organized as follows. Section B provides some motivation for the existence of rent seekers. Sections C-F outline the assumptions of the model in regards to the production of output, the production of high-skill workers, and mature economies. Sections G-H outline a Post-Keynesian growth model with rent seeking and analyze the impact of rent seeking on low-skill employment and the model’s stability conditions. Section I concludes.

B. The Determination of Rents

The primary innovation of this paper is the inclusion of rent seeking within a Post-Keynesian framework. For the purposes of this paper, an activity is considered to be rent seeking if its “private returns come from the redistribution of wealth from others and not from wealth creation (Murphy et. al., 1991).” However, it should be
noted that the firms responsible for hiring people to procure rents are not necessarily the ones that receive the entirety of the rents. Instead, firms must pay facilitating labor a share of their income for their services.

The definition of rent seeking used in this paper is likely too strong. In practice, some activities contain both rent seeking and wealth creating elements. However, the majority of rent seeking activities share the characteristic that their returns are primarily a result of the transfer of income and wealth between parties and not the creation of output and new wealth. In this sense, rent seeking activities have a zero-sum component where the effort exerted by workers is unproductive as no output is created, but functional in the sense that they defend or increase the profit share of the firm. Put differently, rent seeking activities have a private return while producing social waste.

With this in mind, workers can spend their time participating in rent seeking activities as facilitating labor instead of activities that directly contribute to the production of output. In the United States, rent seeking activities include things like lobbying, trading in financial markets, tax compliance, and patent creation and defense amongst others.

Given that rent seeking activities only serve to redistribute wealth and income, the type of rent seeking being examined can be represented by a zero sum game where two parties are fighting over a fixed income. In this context, firms can be fighting over market share through certain types of advertising campaigns or lawyers to defend intellectual property rights. Similarly, financial firms may hire
workers to compete over fixed returns to arbitrage opportunities through latency (Budish et al, 2015).

In the two-firm case, the structure of a generic rent seeking game is as follows. Rent seeking firms can either hire facilitating labor to rent seek at a cost measured as a percentage of total industry output, $\eta y$, or it can choose not to rent seek and does not hire facilitating labor. If neither firm chooses to hire facilitating labor, the two firms produce their equilibrium share of output, $\alpha$. If one firm chooses to hire facilitating labor and the other firm does not, the firm pays their facilitating labor a percentage of the industry’s total output, $\eta y$, and receives income in the form of rents, $r$, from the other firm. If the firm chooses not to hire facilitating labor when the other firm chooses to hire rent seekers, the firm loses income equal to the rents, $r$.

<table>
<thead>
<tr>
<th></th>
<th>Hire</th>
<th>Don’t</th>
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<tbody>
<tr>
<td>Hire</td>
<td>$\alpha (1-\eta)y, (1-\alpha)(1-\eta)y$</td>
<td>$\alpha (1-\eta)y + r, (1-\alpha)y - r$</td>
</tr>
<tr>
<td>Don’t</td>
<td>$\alpha y - r, (1-\alpha)(1-\eta)y + r$</td>
<td>$\alpha y, (1-\alpha)y$</td>
</tr>
</tbody>
</table>

Hiring facilitating labor is the strictly dominant strategy for all values of $r \geq \alpha \eta y$ and $r \geq (1-\alpha)\eta y$. If these inequalities hold, the unique pure strategy Nash Equilibrium of the game is reached when both firms hire facilitating labor. At the Nash Equilibrium, the net change in the firms’ market share is zero but profit-maximizing firms still choose to hire facilitating labor at a cost. This reduces the industry’s total surplus by $\eta y$.

There are three important findings from this game. The first is that profit maximizing firms will not hire facilitating labor if there are not rent seeking
opportunities available to them or if the return from rent seeking is less than the cost of hiring facilitating labor. Second, no rents need to be earned by any firm for facilitating labor to be hired. All that is required is that there are rents available to be captured. Together these two findings suggest that increases in the size of the available rents increases the share of output being paid to facilitating labor. Finally, rent seeking can be entirely eliminated through a tax on either rents or the hiring of facilitating labor. Unfortunately, in practice taxing rents is difficult as they are sometimes hard to distinguish from productive activities and rent seeking activities may also have a wealth-generating component.

The existence of rents can affect the economy through two different channels. The first channel is through a change in the distribution of income. Rent seeking represents a redistribution of income between capitalists through the distribution of rents and from capitalists to facilitating labor through the costs associated with rent seeking. If facilitating labor has a different marginal propensity to save, the hiring of facilitating labor will change aggregate saving behavior. The second channel, the hiring of facilitating labor, impacts the labor market. If facilitating labor is scarce, changes in employment caused by an increase in the amount of rent seeking could impact the level of output by reallocating workers away from output related activities toward rent seeking activities and by increasing the number of people obtaining a postsecondary education.

It is impossible to pin down the value of \( \eta \), but it is assumed that the percentage of total output paid to facilitating labor is a fixed proportion of the amount of output produced. This means that total amount of income being paid to
facilitating labor is $\eta Y$ where $\eta$ is the facilitating labor share of income. The percentage of total output paid to facilitating labor can change over time, but for the purposes of this paper these changes are assumed to be determined exogenously.

**C. Assumptions**

1. Overview of the Model

This model assumes a heterogeneous labor force. In the production process, firms employ three factors of production to produce a single good, capital, high-skill labor, and low-skill labor. High-skill labor is differentiated from low-skill labor in that high-skill workers have obtained a post-secondary degree. As a result of their higher productivity, high-skill workers are paid a premium over low-skill workers. The stock of high-skill workers is not fixed and low-skill workers can transform themselves into high-skill workers through a postsecondary education system. Capitalists receive a profit share and sell a single good at a markup over average total costs. In addition to the traditional production process, firms can rent seek in an attempt to increase the individual firm's profit share. To do this, they hire high-skill workers to facilitate the firm's rent seeking. In return, facilitating labor is paid a percentage of total output.

Capitalists are assumed to save out of profits, high-skill workers involved in productive activities save out of wage income, facilitating labor saves out of their share of income, and low-skilled workers do not save. It is assumed that capitalists have a higher saving rate than high-skill workers employed in output activities and facilitating labor. This means that an increase in the share of income being paid to
high-skilled workers or facilitating labor reduces aggregate saving. Along the balanced growth path, saving must be equal to investment and the economy grows at the natural rate of growth defined as the growth rate of the labor force.

2. The Production Process

As a simplifying assumption in many Post-Keynesian models, it is assumed that the production function has fixed coefficients and that the production of output depends on two inputs, capital and labor. However, by relaxing the two input assumption and including a heterogeneous labor force additional insights can be gained. Therefore, the model in this paper assumes three types of agents; capitalists, high-skill workers, and low-skill workers.

Following Dutt and Veneziani (2015), high-skill workers and low-skill workers are qualitatively different in that they possess different roles in the production process. They are distinguished from one another in that high-skill workers have obtained a postsecondary degree while low-skill workers have not. By obtaining a degree, Dutt and Veneziani argue that high-skill workers are qualitatively different than low-skill workers in that they are inputs into the production of a single good but that they can also induce technological progress and “education as family members, educators and mentors.”

This paper follows their paper by asserting that high-skill workers and low-skill workers both contribute to the production of a single good and that high-skill workers and low-skill workers are qualitatively different. However, instead of assuming that high-skill workers contribute to technological progress as innovators,
this paper assumes that they are distinguished from low-skill workers in that they can be employed as facilitating labor. Finally, as a simplifying assumption it is assumed that high-skill workers are fully employed. Therefore, the total labor force of the economy is given by:

\[ N = L + \phi H + (1 - \phi) H + U \]  

(1)

Where \( N \) is the size of the total labor force, \( L \) is the number of low-skill workers employed, \( H \) is the number of high-skill workers, \( \phi \) is the proportion of high-skill workers employed in output related activities, \( (1 - \phi) \) is the proportion of high-skill workers employed as facilitating labor, and \( U \) is the number of unemployed low-skill workers. The employment rate of low-skill workers is therefore defined as:

\[ e = \frac{L}{L + U} \]  

(2)

Where \( e \) is the low-skill employment rate.

A three input fixed coefficient production function includes low-skill labor, high-skill labor, and capital. Algebraically,

\[ Y = \min[L, \phi H, K] \]  

(3)

Where \( L \) is the number of low-skill workers employed, \( \phi \) is the proportion of high-skill workers participating in output related activities\(^1\), \( H \) is the number of high-skill workers employed, and \( K \) is the size of the capital stock. Given the production function in equation 3, and assuming full utilization of \( L \) and \( H \), the level of output can be written as:

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\(^1\) Alternatively, \( \phi \) can be interpreted as the average proportion of time spent on productive activities as opposed to rent-seeking activities by high-skill workers over the course of a workday.
\[ Y = uK = \phi H = L \]  

Where the rate of capacity utilization is given by \( u = Y / K \).

Assuming that only high-skill workers are hired as facilitating labor it is possible to write the total wage bill being paid to facilitating labor as:

\[ \eta Y = w_R (1 - \phi) H \]  

Where \( w_R \) is the average wage paid to facilitating labor.²

Payment to facilitating labor can be interpreted as a labor cost to firms. However, rent-seeking labor costs are distinguished from production labor costs in that they are fixed and no wealth or output is produced as a result. Therefore, gross profits can be written as:

\[ \prod = (1 - \eta) Y - W \]  

Where \( \prod \) is gross profits and \( W \) is the total wage bill due to employment used in the production of output. For future use, the total wage bill can be divided into the wage bill being paid to high-skill workers and the wage bill being paid to low-skill workers such that:

\[ W = W_H + W_L \]  

Where:

\[ \frac{W_H}{W_L} = \frac{\phi H}{w_R} = \frac{\tau}{1} > 1 \]  

\( W_H \) is the total wage bill paid to high-skill workers employed in output related activities.

\[ w_R = \frac{\eta Y}{(1 - \phi) H} \]
activities, $\phi$ is the proportion of high-skill workers employed in output related activities, $W_L$ is the total wage bill paid to low-skill workers, $w_0$ is the average wage paid to high-skill workers employed in output related activities, $w_L$ is the average wage paid to low-skill workers, and $\tau$ describes the average wage premium paid to high-skill workers over low-skill workers employed in productive activities.

Dividing both sides of equation 7 by output and rearranging yields:

$$\sigma_\pi + \sigma_w + \eta = 1$$

(9)

Where $\sigma_\pi$ is the profit share, $\sigma_w$ is the wage share, which can be divided into income going to high-skill and low-skill workers, and $\eta$ is the facilitating labor share. Equation 10 differs from a two input income share equation in that the labor share of income can be divided into three components. These components include the share of income going to high-skill workers employed in output related activities, the share of income going to low-skill workers, and the share of income going to facilitating labor.

D. The Production of High-Skill Workers

High-skill workers may be employed as facilitating labor based on their professional qualifications. In the case of legal proceedings, there is the requirement that lawyers obtain law degrees before practicing law. However, when it comes to other industries that rent seek, like finance, there is no written rule that facilitating labor must possess a postsecondary degree. However, Philippon and Reshef (2012) find that skill intensity and wages in finance increases with de-regulation. This finding is consistent with the idea that increases in the opportunities to rent seek
cause firms to increase their demand for facilitating labor. In turn, this causes an increase in relative wages between facilitating labor and high-skill workers employed in productive activities.

In the long-run, an increase in relative wages, $w_o / w_r$, should not be durable as high skill workers will reallocate themselves between employment as facilitating labor and employment in productive activities until the average wage earned by both is equal. However, this process will likely take time and it is not clear that the stock of high-skill workers participating in productive activities is well suited to transition quickly to employment as facilitating labor. Instead, it is more likely that the distribution of high-skill workers will be altered by the flow of new high-skill workers into the labor force.

The flow of high-skill workers into the labor force depends on a broad set of personal, social, intellectual, and financial considerations. Students face a very complex problem and have imperfect information when deciding whether or not to pursue a postsecondary degree. The influence of their intellectual interests, the decisions made by their peers, and the advice of mentors surely plays an important role. However, except for the most intellectually curious or very wealthy, the decision to obtain a postsecondary degree depends on whether or not it will pay off economically. In particular, given the significant upfront costs and foregone wages, students need to decide whether or not the degree “pays off” and in many instances whether or not they can come up with the money to attend at all.

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3 This of course assumes that there are not any barriers to being hired as facilitating labor beyond obtaining a postsecondary degree.
In making the decision of whether or not to pursue a postsecondary degree, and with the personal, social, intellectual, and financial considerations in mind, low-skill workers must compare the flow of the wage premium versus the cost of obtaining the degree. Algebraically, a low-skill worker will obtain a degree if,

$$\int (w_R - E[w_L]) e^{-rt} dt \geq C$$

(10)

Where $C$ is the total cost of obtaining a postsecondary degree and $E[w_L]$ is the expected low-skill wage after accounting for the low-skill employment rate. The key feature of equation 10 is that the decision of whether or not to obtain a degree depends on the return to a postsecondary degree. As the purpose of this paper is to look at the long-run impacts of rent-seeking, it is assumed that in the long-run the growth rate of high-skill workers is equal to the growth rate of the labor force. In addition, since newly minted high-skill workers are free to engage in output related or rent-seeking activities, the average wages paid to each of these activities must equal one another along the balanced growth path. In addition, the ratio of the average high-skill wage to the low-skill wage is pinned down to the constant premium paid to high-skill workers. Consistent with equation 10, the human capital accumulation equation can be written as:

$$\dot{H} = \gamma_0 + \gamma_1 \frac{(\tau - 1)w_L}{C} - \delta = n$$

(11)

Where $\dot{H}$ is the growth rate of the stock of human capital, $\gamma_0$ is a shift parameter representing social norms, $\gamma_1$ represents the sensitivity of students to future earnings above the cost of attending a post-secondary institution, $C$ is the total cost
of obtaining a post-secondary degree, $\delta$ is the rate at which high-skill workers leave the labor force, and $n$ is the growth rate of the labor force.

**E. Mature Economy**

Most Post-Keynesian growth models omit the explicit treatment of the labor market and the labor force in their analysis. This “dual economy” approach to growth models excludes the examination of labor constraints and the treatment of the rate of employment as an important consideration in firm’s investment decisions. When analyzing the impacts of increased rent-seeking in developed economies, excluding the impact of the employment rate on firms pricing and output decisions is a serious omission.

This is not to say that rent seeking does not take place at every stage along the development process. In developing countries that are politically unstable and lack effective legal and judicial institutions the presence of rent seeking can reduce growth through fear that investment opportunities will be upended by political uprising or theft. In addition, rent seeking can take the form of payments to more organized and powerful groups, especially the military (Kimenyi and Mbaku, 1993) and by workers seeking high paying employment within the government (Gelb et al, 1991). When property rights are viewed as weak, incentives to rent seek are strong particularly for rich agents (Sonin, 2003). In the dual economy framework, analyzing the effect of rent seeking is an important task but one that is left for future research.
The approach taken in this paper is to examine the impact of rent seeking in a developed economy like the modern United States economy, which lacks a large amount of hidden unemployment. In this context, it seems unreasonable to maintain the assumption that the employment rate has no influence on the growth rate as is made in much of the Post-Keynesian literature.\(^4\)

The primary consequence of moving toward a mature economy analysis is that within a mature economy the equilibrium growth rate is pinned down to the growth rate of the labor force, absent technological innovation. In the Harrodian tradition this growth rate is referred to as the natural rate of growth. However, within this tradition there is not a mechanism in place to assure that the warranted, or actual, rate of growth will be equal to the natural rate of growth. Instead, the Harrod-Domar model exhibits “knife-edge” stability where any change in a key parameter will cause the economy’s growth rate, or warranted rate of growth, to deviate permanently from the natural rate of growth.

This poses a problem for long-run growth analysis, as the existence of a stable equilibrium long run rate of growth is doubtful and the economy grows at the natural rate of growth only by chance. On the one hand, the economy may find itself growing far faster than the growth rate of the population, plus technological innovation, which is unsustainable as the economy will come up against labor constraints. On the other hand, if the economy grows more slowly than the natural rate of growth, the stock of unemployed workers is forever increasing and the

\(^4\) For an overview of mature economy Post Keynesian growth models see Skott and Zipperer (2010).
economy collapses to a dual economy where the labor market conditions have no bearing on the growth rate.

**F. Baseline Model**

Following the Post-Keynesian tradition including Rowthorn (1981), Dutt (1984), Marglin and Bhaduri (1990), and Robinson (1962) investment is a function of the rate of capacity utilization and the profit share. Following Flaschel and Skott (2006), Ryoo and Skott (2008), and Skott and Zipperer (2012) the mature economy investment function is extended to include the employment rate as an additional parameter. The extension of the investment function that is unique to this paper is that investment also depends on the share of income paid to facilitating labor. The baseline investment function is given by,

\[
\frac{I}{K} = f(u, \sigma_n, e) \quad f_u > 0, \ f_{\sigma_n} > 0, \ f_e \leq 0
\]  

(12)

Where \( u \) is the rate of capacity utilization (output to capital ratio), \( \sigma_n \) is the profit share and \( e \) is the employment rate of low-skill workers. Using equation 9, equation 12 can be rewritten as:

\[
\frac{I}{K} = f(u, \eta, \sigma_w, e) \quad f_u > 0, \ f_{\sigma_w} < 0, \ f_\eta \leq 0, \ f_e \leq 0
\]  

(13)

Where \( \sigma_w \) is the wage share of production workers and \( \eta \) is the facilitating labor share of income. Increases in the rate of capacity utilization leads to an increase in investment. Increases in the share of income going to facilitating labor, the labor share of income, and the employment rate reduce investment.
An increase in the share of income going to facilitating labor reduces accumulation in this framework because facilitating labor is a cost to firms, so an increase in the share of income going to facilitating labor reduces the aggregate profit share. Therefore, firms require a higher rate of capacity utilization or a higher profit share in order to entice the same level of accumulation. Similarly, high employment rates reduce accumulation as high levels of employment increase the bargaining power of low-skill workers and reduce animal spirits.

In this model there are two classes, capitalists and high-skill workers, both of whom save. Low-skill workers consume the entirety of their income, capitalists save out of profits, and high-skill workers save out of wage and rent income. Therefore, the saving rate can be given by:

\[
\frac{S}{K} = s(u, \eta, \sigma_w, \tau), \quad s_u > 0, \ s_\eta < 0, \ s_{\sigma_w} < 0, \ s_\tau > 0
\]  

(14)

The important assumption made in the saving function is that capitalists have a higher saving rate than high-skill workers and high-skill workers have a higher saving rate than low-skill workers. Therefore, increases in the facilitating labor share and the labor share have a negative effect on the saving rate. Finally, an increase in the markup paid to low-skill workers has a positive effect on the saving rate because it represents a transfer of income from low-skill workers to high-skill workers given a constant labor share.\(^5\)

To close the model, the equilibrium condition that the saving rate is equal to

\(^5\) It would be possible to include \(C\) as a determinant of the saving rate. However, low-skill workers do not save so presumably they are paying for their education by shifting consumption from non-educational goods and services toward education while they are obtaining their degree.
the rate of investment and the maturity condition that accumulation is equal to the growth rate of the labor force is imposed.

\[ \frac{S}{K} = s(u, \eta, \sigma_w, \tau) = g = \frac{I}{K} \]  \hspace{1cm} (15)

\[ g = n \]  \hspace{1cm} (16)

Where \( S \) and \( I \) are net saving and investment, \( g \) is the accumulation rate, and \( n \) is the growth rate of the labor force. The maturity condition is required for steady growth. A growth rate above the growth rate of the labor force is ruled out as the economy would eventually come up against a constraint in terms of the rate of capacity utilization and/or the employment rate. A growth rate that falls below the growth rate of the labor force would lead to a rate of employment that would decrease secularly and the economy would turn into a non-labor constrained, dual economy.

In the remaining sections of this paper the effects of changes in the share of income going to facilitating labor is examined in two different specifications. The first specification allows for the rate of capacity utilization to vary freely with a fixed profit share. The second specification requires that the desired rate of capacity utilization be equal to the actual rate of capacity utilization in the long run. The former specification is consistent with most versions of the Kaleckian model while the later is most consistent with the Harrodian and Robinsonian traditions.

**G. Fixed Markup**

The first version of the Post-Keynesian model of rent seeking to be explored
includes the explicit assumption that the rate of capacity utilization is free to vary in the long-run and that the profit share is fixed. Since the profit share is determined by a pricing markup equation in the production process, this also pins down the wage share of income. However, changes in the profit share are allowed through exogenous changes in the facilitating labor’s share of profits.

\[ \sigma_w = \bar{\sigma}_w \]  \hspace{1cm} (17)

\[ \sigma_\pi = 1 - \eta - \bar{\sigma}_w \]  \hspace{1cm} (18)

Using equations 15, 16 and 17 the saving rate can be re-written as:

\[ \frac{S}{K} = s(u, \eta, \bar{\sigma}_w, \tau) = n \]  \hspace{1cm} (19)

Since \( n, \eta, \bar{\sigma}_w \), and \( \tau \) are all exogenous variables, equation 19 determines a unique equilibrium value of the utilization rate:

\[ u^* = u(\eta, \bar{\sigma}_w, \tau) \hspace{1cm} u_\eta > 0 \text{, } u_{\bar{\sigma}_w} > 0 \text{, } u_\tau < 0 \]  \hspace{1cm} (20)

The equilibrium rate of capacity utilization is decreasing in the profit share as increases in the profit share result in a reduction of aggregate demand as capitalists are assumed to save a higher percentage of their income than high-skill or low-skill workers. This means that increases in the wage share and increases in the share of income paid to facilitating labor both increase the equilibrium rate of capacity utilization. An increase in the markup paid to high-skill workers reduces the equilibrium rate of capacity utilization as high-skill workers are assumed to save a portion of their income and low-skill workers do not save. This leads to a reduction in aggregate demand and capacity utilization.
Using the equilibrium rate of capacity utilization and equations 13 and 16 it is possible to write the rate of investment as:

\[
\frac{I}{K} = f\left(u(1-\eta - \sigma_w, \tau), 1-\eta - \sigma_w, e\right) = n
\]  

(21)

Again, since \( n, \eta, \sigma_w, \) and \( \tau \) are all exogenous variables, equation 21 determines a unique equilibrium low-skill employment rate:

\[
e^* = e\left(u(1-\eta - \sigma_w, \tau), 1-\eta - \sigma_w\right)
\]  

(22)

The equilibrium low-skill employment rate is increasing in the rate of capacity utilization and the profit share. Therefore, increases in \( \eta \) and \( \sigma_w \) will cause an increase in the equilibrium employment rate through a capacity utilization effect but a decrease in the rate of employment through a profit share effect. The overall effect on the employment rate due to an increase in the facilitating labor share of income is:

\[
\frac{\partial e}{\partial \eta} = e_u u_\eta + e_{\sigma_s} (-1)
\]

Since \( e_u > 0, u_\eta > 0 \), and \( e_{\sigma_s} > 0 \) the effect of an increase in the facilitating labor share of income on the rate of employment is negative if:

\[
e_{\sigma_s} > e_u u_\eta
\]

The sign of which depends on the relative sensitivity of the investment function to changes in the rate of capacity utilization and the profit share. However, something can be said about the likelihood of this inequality holding. Consider the case where high-skill workers and capitalists have a similar saving rate. This implies that the effect of a change in the share of income paid to facilitating labor would have a
relatively small aggregate demand effect and the change in the rate of capacity
utilization would also be small. This would lead to a small derived effect on the rate
of employment. Therefore, the more similar the saving rates are between capitalists
and high-skill workers, the more likely an increase in the facilitating labor share of
income is to lead to a reduction in employment.

In addition to the employment effect there is also a high-skill worker
allocation effect due to the change in the level of rent seeking. To see this, note that
the total wage bill can be written as:

\[ w_o \phi H + w_r L = \sigma_w Y \]  \hspace{1cm} (23)

Using equations 4, 8, and 23 the wage paid to high-skill workers participating in
output activities can be written as:

\[ w_o = \frac{\tau}{1 + \tau} \sigma_w \]  \hspace{1cm} (24)

Using equations 5, 17, and 24 it can be shown that the equilibrium proportion of
high-skill workers employed in output related activities is:

\[ \phi^* = \frac{\frac{\tau}{1 + \tau} \sigma_w}{\eta + \frac{\tau}{1 + \tau} \sigma_w} \]  \hspace{1cm} (25)

Since the high-skill to low-skill wage ratio and the wage share paid to workers in
output related activities are constant in the Kaleckian framework, an increase in the
share of income going to facilitating labor must lead to a reduction in the proportion
of high-skill workers participating in output related activities in order to keep the
average wage paid to high-skill workers in output related activities equal to the
average wage paid to facilitating labor.
Additionally, an increase in the share of income going to facilitating labor increases the high-skill to low-skill labor ratio. However, unlike in neoclassical growth models there is not necessarily an increase in growth due to the increase in human capital. Instead, because the increase in high-skill workers is caused by an increase in rent seeking the effect on long-run employment is ambiguous.

H. Flexible Markup and Fixed Rate of Capacity Utilization

It is not clear that in the long-run firms will be willing to allow the rate of capacity utilization to permanently deviate away from their desired rate of capacity utilization. Instead, equilibrium in the goods market can be achieved by allowing prices and the rate of employment to adjust. In this setup, changes in aggregate demand caused by a change in the distribution of income can cause both changes in output, through changes in the rate of employment, and derived changes in the distribution of income. In the face of a positive demand shock, the price of goods and services are bid up causing the profit share of firms to increase.

With the assumption that changes in prices and employment, not changes in the rate of capacity utilization, accommodate changes in the goods market, it is assumed the rate of capacity utilization is equal to the desired rate of capacity utilization. For simplicity, the rate of capacity utilization will be normalized to one.

\[ u = u^d = 1 \]  \hspace{1cm} (26)

Therefore, the rate of investment can now be written as:

\[ \frac{I}{K} = f(\sigma, \epsilon, \eta) \quad f_\eta < 0, \quad f_{\sigma \eta} < 0, \quad f_\epsilon < 0 \]  \hspace{1cm} (27)
Equation 27 is decreasing in the share of income going to facilitating labor, the labor share, and the rate of low-skill employment.

Increases in the employment rate can reduce the accumulation rate by increasing worker turnover, by worsening the business climate, and by increasing monitoring costs (efficiency wage). At high levels of employment it becomes more difficult for firms to replace employees from the existing pool of unemployed workers. This may cause firms to go out and recruit workers from other firms, increasing the costs associated with their training and retaining of employees. Additionally, as the employment rate increases, effort exerted by workers may decrease requiring an increase in monitoring costs to maintain the desired level of effort.

As in the baseline model, the saving rate is given by equation 14 and is equal to the growth rate of the labor force along the balanced growth path:

\[
\frac{S}{K} = s(\eta, \sigma_w, \tau) = n
\]  

(28)

Using equations 9 and 28 and setting \(u=1\), the wage share can be written as a function of the markup paid to high-skill workers and rent share of income:

\[
\sigma_w = \psi(\eta, \tau) \quad \psi_\eta < 0, \psi_\tau > 0
\]  

(29)

To maintain a growth rate equal to the growth rate of the labor force, the saving rate must be constant. Therefore, changes in any of the parameters that affect the saving rate must be offset by changes in another parameter. In equation 28, changes in the share of income going to facilitating labor results in a decrease in the saving rate as it represents a transfer of income from capitalists to facilitating labor who are
assumed to save less of their income. In order to maintain the same saving rate, the profit share must increase resulting in a decrease in the wage share.

The fall in the wage share is a derived consequence of the increase in aggregate demand caused by the transfer of income from capitalists to facilitating labor. In this framework increases in aggregate demand are met by increases in the profit share, which must be accompanied by a decrease in the wage share. Similarly, an increase in the premium paid to high-skill workers results in a reduction of aggregate demand as income is transferred from low-skill workers, who do not save, to high-skill workers who do save. Since the rate of capacity utilization is fixed, the wage share increases to equilibrate the goods market.

Using equation 29 it is possible to re-write equation 13 as:

$$\frac{I}{K} = f(\eta, \psi(\eta, \tau), e) = n$$

(30)

Which can be written as:

$$e = e(1 - \eta - \psi(\eta, \tau)) \quad e_\eta < 0, \ e_\tau > 0$$

(31)

To see that the employment rate is unambiguously decreasing in the share of income going to facilitating labor, notice that the derivative of the equilibrium level of employment with respect to $\eta$ is given by:

$$\frac{de}{d\eta} = -1 - \psi_\eta$$

Which is negative if $\psi_\eta > -1$. This occurs because an increase in the facilitating labor share of income must imply a reduction in the profit share to maintain a constant saving rate.
In this version of the model there will also be a change in the equilibrium proportion of high-skill workers participating in output related activities. However, in this case, the wage share is no longer constant. Using equations 25 and 36 the equilibrium proportion of high-skill workers participating in output related activities is given by:

\[
\phi^* = \frac{\frac{\tau}{1+\tau} \psi(\eta, \tau)}{\eta + \frac{\tau}{1+\tau} \psi(\eta, \tau)}
\]

The effect of an increase in the share of income going to facilitating labor is negative if:

\[
\psi_{\eta} < \psi(\eta, \tau)
\]

Which it is because \( \psi_{\eta} < 0 \).

This model suggests that increases in the level of rent seeking affect the economy by reducing the long-run profit share and the wage share paid to workers employed in production activities. Along the balanced growth path, a decrease in the profit share causes a reduction in the equilibrium rate of low-skill employment. In addition, increases in the facilitating labor share of income lead to a reduction in the proportion of high-skill workers in the productive sector. This directly causes a reduction in average productivity, as more high-skill workers are required to produce the same amount of output.

I. Conclusions

This paper has demonstrated that changes in the level of rent seeking can
have negative effects on the low-skill employment rate, effects on the allocation of high-skill workers, and impact the average level of human capital in the economy. The negative employment effects are possible when the rate of capacity utilization or the profit share is flexible. However, it is possible in the flexible capacity utilization model that increased rent seeking may increase low-skill employment.

In both versions of the model, increased rent seeking results in an increase in the proportion of high-skill workers employed as facilitating labor. By definition, this results in a reduction in average productivity, as a higher number of high-skill workers employed in the economy are needed to produce the same level of output. Since workers are transformed into high-skill workers by obtaining a postsecondary degree, which is costly, increased rent seeking is wasteful as money used to train facilitating labor could be allocated to more productive activities.

In the context of neoclassical growth models, increased rent seeking results in an increase in the average level of human capital as measured by the ratio of high-skill workers to low skill workers. However, when increases in human capital are the result of increases in rent seeking there is no guarantee that higher levels of human capital result in higher growth. In fact, the model examined above is consistent with the possibility that higher levels of human capital accumulation may accompany a reduction in average productivity.

Second, no rents need to be earned by any firm for rent seekers to be hired. Rather, rent seeking must be motivated by private returns to rent seeking activities. The cost to rent seeking is the social waste of hiring facilitating labor to pursue these private returns that have little social benefit. Since rents do not need to be
earned by any firm for facilitating labor to be hired, the only way to eliminate rent seeking is to eliminate the availability of rents.
CHAPTER 3

“RENT SEEKING AND THE ALLOCATION OF COLLEGE GRADUATES: AN ANALYSIS OF THE UNITED STATES”

A. Introduction

Rent seeking is the pursuit of income that does not directly contribute to the production of output. An activity is considered rent seeking when the private return earned from that activity is the result of a transfer of income between two parties and no output is produced (Murphy et al., 1991). As the opportunities to earn these types of private gains increase, individuals may be drawn away from activities with high social benefits, causing the average productivity in the economy to decrease. In addition, rent seeking may cause a redistribution of income, which has an impact on saving and investment behavior. This redistribution can have negative long-run, low-skill, employment effects.

There are many examples of economic activities that redistribute income without directly contributing to the level of output. A fairly straightforward example of such an activity would be trading in the financial markets. Although certain traders may contribute to improved efficiency in the marketplace, others simply redistribute income from one group of traders to another. Recent technological advances in the form of high frequency trading, black box trading, and other forms of algorithmic trading have led to further increases in the ability of sophisticated
traders to earn larger shares of total trading income, while only marginally increasing market efficiency, if at all (Jarrow and Protter, 2011) (Zhang, 2010).

The financial markets are not the only place where rent seeking occurs. The rising complexity of the tax code increases the cost of firms’ compliance with corporate income tax law as they rely on a larger number of accountants to ensure that they are taking full advantage of the ever-changing list of deductions (Schoonjans et al., 2011) (Slemrod and Blumenthal, 1996). Firms also hire a large number of lawyers to defend their intellectual property, to protect themselves from lawsuits, and to confirm that their activities do not violate pre-existing laws (Merges, 2010). Within companies, managers and executives compete for income in the form of bonuses and promotions. Contrary to the shareholder value movement, heavily performance driven compensation contracts influence companies’ “rainmakers” to increase the short-run profitability of firms, sometimes at the expense of long-run profitability and stability (Crotty, 2009). These profits are an intertemporal transfer of income from individuals with future stakes in the company to current executives. Some marketing activities may also be considered rent seeking as firms redirect money to protect their market share instead of using that money to create output (Cowling and Mueller, 1978).

Even though rent seeking may be prevalent in an economy, the level of rent seeking occurring is hard, if not impossible, to measure empirically. One approach, originally proposed by Murphy et al. (1991), is to use the number of postsecondary students enrolled in law programs as a percentage of total enrollment as an
indicator of the level of rent seeking. However, law students are an indicator of only one type of rent seeking that may be taking place in an economy. In addition to lawyers, accountants, executives, and financial traders also partake in rent seeking activities and would go unobserved if only lawyers were used as an indicator of rent seeking. This paper expands upon this indicator of rent seeking by including business degree recipients, communications degree recipients, consumer science degree recipients, and social science degree recipients\(^1\) as a broader indicator of rent seeking.

One could argue that the composition of college graduates by field of study is not as strong of an indicator of the degree of rent seeking as the composition of employment across industries or occupations. However, industry composition or even occupation composition may be a misleading indicator of the level of rent seeking taking place. Industry and occupation data tend to be slow moving and path dependent variables, and therefore are not a good measure of current opportunities. Graduation data better reflects current employment opportunities.

In this paper, the use of college graduates by field of study as a measure of the degree of rent seeking is not meant to suggest that the graduates themselves will go on to become rent seekers. Instead, many of them obtain a degree in pursuit of a job that facilitates rent seeking. Therefore, much of what is being captured by the

\(^1\) Social Science degree recipients are included in rent-seeking because they are disproportionately likely to obtain management and finance jobs upon graduation. See Appendix A.
use of college graduates is the availability of jobs that facilitate rent seeking. As such, the interpretation of the role of high-skill, or credentialed, workers in this paper is facilitating labor that is hired by firms pursuing rents.

Related papers by Johnson et al. (2011) and Glaser and Saks (2006) analyze the effect of the number of corruption convictions by the U.S. Department of Justice between 1975 and 2000 has on state level growth. Johnson et al. (2011) find that corruption has a negative effect on growth in the United States, while Glaser and Saks find that corruption does not have a statistically significant effect on the growth rate once controls are added. The use of corruption convictions in a state is an innovative, but very specific measure, as it only captures illegal rent seeking activities. Although a high number of convictions may lead to lower growth, this measure omits a large category of legal forms of rent seeking that take place across a wide variety of industries.

Using the composition of degree completions as an indicator of rent seeking, this chapter provides both theoretical and empirical evidence that is consistent with the claim that increased rent seeking has negative impacts on the economy. Using state level graduation data constructed from the Integrated Postsecondary Education System (IPEDS), it is shown through a series of cross-sectional and panel regressions that increased rent seeking, indicated by the distribution of degrees awarded by field of study, affects state level growth in real personal income per capita.
It should be stressed that, in this case, the distribution of college students is not being interpreted as an input to the production function. Instead, a high proportion of postsecondary students in rent related fields of study is an indicator that the structure of the existing economy favors rent seeking, and that firms hire a large proportion of the highly educated as facilitating labor. In addition, the distribution of degree recipients is not necessarily a measure of wage differentials across prospective employment opportunities upon graduation, but rather a measure of the overall composition and availability of jobs for credentialed workers.

Beyond its methodological similarity to the paper by Murphy et al. (1991), this paper is related to a vast literature of country level and state level growth regressions. In the 1990s, there was a proliferation of cross-sectional growth regressions with studies by Barro (1991), Mankiw, Romer and Weil (1992), Barro et al (1991), Barro and Xavier Sala-i-Martin (1992), amongst many others. More recently, cross-country panel growth regressions have become very popular, including studies by Durlauf and Quah (1999), Bassinini and Scarpetta (2001), and Barro and Xavier Sala-i-Martin (2004). However, state level growth regressions are far less popular, in part due to a lack of annual data. That being said, there are a number of cross state growth analyses, such as those done by Frank (2009a and 2009b).

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2 In the empirical exercises that follow, the number of all college graduates as a percentage of the population aged 18-24 is used as a measure of the flow of human capital into the production function.

3 It should be noted that an alternative interpretation, where student composition leads to growth in output, cannot be ruled out.
2009b) and Johnson et al. (2011). Nevertheless, none of these papers include a measure of rent seeking.

The remainder of this paper proceeds as follows. Section B provides some motivation. Section C develops a stylized model of rent seeking. Section D outlines the data set and empirical approach. Section E presents the results and Section F concludes the analysis.

**B. Motivation**

“Many of the best students are not going to research cancer, teach and inspire the next generation, or embark on careers in public service. Instead, large numbers are becoming traders, brokers and bankers. At Harvard in 2014, nearly one in five students who took a job went to finance. For economics majors, the number was closer to one in two. I can’t help wondering: Is this the best use of talent?” (Mullainathan, 2015)

Standard human capital theory suggests that some of the variation in growth rates across countries can be explained by differences in levels of human capital. The simplest and perhaps most commonly cited model in support of this theory is the augmented Solow-Swan model developed by Mankiw, Romer, and Weil (1992). In this model, human capital is treated as an input into a stylized, Cobb-Douglas, production function represented by:
\[ Y = K^\alpha H^\beta (AL)^{1-\alpha-\beta} \]

Where \( Y \) is the level of output, \( K \) is the size of the capital stock, \( H \) is the level of human capital, \( A \) is a measure of labor augmenting technology, and \( L \) is the size of the labor force. The growth rate of output can be obtained by taking logs of both sides of the production function and differentiating with respect to time to obtain:

\[ \dot{Y} = \alpha \dot{K} + \beta \dot{H} + (1-\alpha-\beta)(\dot{A} + \dot{L}) \]

One of the main findings of this model is that increases in the growth rate of the human capital stock lead to endogenous increases in the growth rate of output, ceterus paribus. This finding has led researchers to estimate the effect differences in human capital have on differences in cross-country growth rates. Caselli (2005) goes through a careful empirical analysis to examine the effect different measures of human capital have on growth rates. In the human capital literature, the number of years of schooling, the teacher-pupil ratio, the amount of teaching materials per student, the number of structures per student, and the human capital of teachers are shown to partially explain differences in growth rates across countries as they are assumed to affect average productivity. The obvious policy recommendation that comes out of this type model is that countries should implement policies to increase the level of human capital.

In the United States these types of policy recommendations are prevalent. Politicians from the right and the left have consistently argued that the way to increase growth in America is to increase the level of human capital by increasing
investment in primary, secondary, and post-secondary education. However, these types of human capital policies ignore underlying institutional factors that influence a country’s growth rate. In particular, economies that have a high proportion of highly educated individuals participating in activities that do not directly produce output could have a rapidly increasing stock of human capital to fulfill the increased demand for credentialed workers and slow output growth.

This is not to say that increases in human capital cannot positively impact an economy. High-skill labor forces surely produce more output than those that are relatively low-skill assuming that they are employed in activities directly tied to the production of output. Instead, this paper argues that economies that dedicate their highly educated workers to facilitate rent seeking activities will tend to grow more slowly than those that have highly educated workers that produce output. Put differently, the effectiveness of human capital policies depends on what career options are available to an economy’s highly skilled workers.

C. Model

The primary purpose of the model is to examine possible mechanisms by which increased rent seeking negatively affects low-skill employment, redistributes high skill workers from the production of output to the facilitating of rent seeking, reduces average wages, and reduces average productivity as more workers are required to produce the same amount of output. In the model, output is divided between capitalists, high-skill workers and low-skill workers in the form of profits.
and wages, respectively. Following Dutt and Veniziani (2015), high-skill and low-skill workers are qualitatively different inputs in the production function and have qualitatively different roles in the economy. High-skill workers and low-skill workers both contribute to the production of output, but high-skill workers may choose to be facilitating labor, which do not produce output.

It is assumed that the production function is a Leontief production function, given by:

\[ Y = \min(L, \phi H, K) \]  

(1)

Where \( Y \) is the level of output, \( \phi \) is the proportion of high-skilled workers employed in the output related activities, \( H \) is the number of high-skill workers in the economy, and \( L \) is the number of low-skill workers employed. There is no substitutability between high-skill and low-skill workers. Assuming that there is no labor hoarding, output is given by:

\[ Y = uK = \phi H = L \]  

(2)

Where \( u \) is the rate of capacity utilization \( Y/K \) and is assumed to be constant. Along the balanced growth path, equilibrium requires that the growth rates of the high-skill labor force, the low-skill labor force, and the population be equal:

\[ \dot{H} = \dot{L} = n \]  

(3)

Where \( n \) is the growth rate of the population. For simplicity, it is assumed that high-skill workers in the productive sector are paid a constant premium over low-skill workers and is denoted by:
\[
\frac{w_o}{w_L} = \tau
\]  
(4)

Where \( w_o \) and \( w_L \) are the average wages paid to high-skill workers employed in output related activities and low-skill worker respectively. High-skill workers are paid a percentage of total output by firms for their services as facilitating labor. Since high-skill workers are assumed to be the only ones that can be employed as facilitating labor, the total amount of income paid to facilitating labor is equal to the total wage bill going to high-skill workers employed by rent seeking firms:

\[
\eta Y = w_R (1 - \phi) H
\]  
(5)

Where \( \eta \) is the facilitating labor share of output and \( w_R \) is the average wage paid to high-skill workers employed as facilitating labor. Changes in the facilitating labor’s share of income can be brought about through regulatory changes, such as changes in the tax code, changes in the enforcement of intellectual property rights laws, and changes financial regulation. However, changes in the facilitating labor’s share of income may also happen organically within an economy through technological change, financial innovation, changes in the structure of compensation contracts, and changes in social norms.

In this model, rents can be interpreted as a tax on total output. Firms are assumed to be profit maximizing and profits are given by the amount of output left over after paying the wage bill and forfeiting a portion of total output to facilitating labor. Gross profits are given by:
\[ \Pi = (1 - \eta)Y - W \quad (6) \]

Where the first term represents total post-rent revenue and the second term is the total wage bill paid to workers employed in output related activities. Dividing both sides of equation 6 by the level of output yields the profit share:

\[ \sigma_{\pi} = 1 - \eta - \sigma_w \quad (7) \]

Where \( \sigma_w \) is the wage share \( W/Y \).

Capitalists save out of profits, high-skilled workers save out of both wage and facilitating labor income, and low-skill workers consume the entirety of their income. It is assumed that capitalists have a higher marginal propensity to save than high-skill workers. This suggests that the saving rate is a function of the facilitating labor share and the wage share.\(^4\)

\[ \frac{S}{K} = s(\eta, \sigma_{\pi}) \quad s_\eta < 0, \ s_{\sigma_{\pi}} > 0 \quad (8) \]

An increase in the profit share has a positive effect on the saving rate, as it represents a redistribution of income from workers to capitalists who have a higher saving rate. Holding the profit share constant, an increase in the facilitating labor share reduces the post-rent profit share. This is because an increase in the level of rent seeking results in a transfer of income from capitalists to high-skill workers, reducing the saving rate.

\(^4\) Increases in the premium paid to high-skill workers will have a positive impact on the saving rate. However, in this version of the model the wage premium is assumed to be constant.
Since this is a long-run model, it is assumed that the utilization rate is equal to firms’ desired rate of capacity utilization and can be normalized to 1. Following Skott (1989), the post-rent profit share and the employment rate determine the rate of growth of output:

\[ \hat{Y} = h(\sigma, e) \quad h(\sigma, e) > 0, \quad h(e) < 0 \]  

(9)

An increase in the profit share makes increasing output more appealing to firms, so the effect of a change in the profit share on the \( h \) function is positive. Increases in the level of employment reduce the overall business climate as high levels of employment increase workers’ bargaining power. Put differently, at high levels of employment, firms require a higher profit share in order to increase the rate of output growth. Using equations 7 and 9:

\[ \hat{Y} = h(1 - \eta - \sigma, e) \]  

(10)

Along the balanced growth path, the growth rate of output and the saving rate (the growth rate of the capital stock) must be equal to the growth rate of the labor force:

\[ n = s(\eta, \sigma) = h(1 - \eta - \sigma, e) \]  

(11)

Using equation 11, it is possible to write the wage share as a function of the facilitating labor’s share:

\[ \sigma_w = \psi(\eta) \quad \psi(\eta) < 0 \]  

(12)

Increases in the facilitating labor share unambiguously reduce the wage share, as a lower wage share is required to keep the saving rate constant. Using equations 10 and 11, it is possible to write the output expansion function as:
\[ h(1-\eta-\psi(\eta), e) = n \]  \hspace{1cm} (13)

This requires that:

\[ e = e(1-\eta-\psi(\eta)) = e(\eta) \]  \hspace{1cm} (14)

An increase in \( \eta \) has an unambiguously negative effect on the employment rate if:

\[ \psi_\eta > -1 \]  \hspace{1cm} (15)

This occurs because an increase in the facilitating labor share of income must imply a reduction in the profit share to maintain a constant saving rate.

In addition to having employment effects, an increase in facilitating labor’s share of income also has an impact on average productivity. To see this, use equations 4, 5, and 12 to rewrite the high-skill wage as:

\[ w_o = \frac{\tau}{l+\tau} \psi(\eta) \]  \hspace{1cm} (16)

An increase in the level of rent seeking therefore has a negative effect on the high-skill wage. Using equations 2, 5, and 16 it is possible to write the equilibrium proportion of high-skilled workers employed in the productive sector as:

\[ \phi^* = \frac{\tau}{\eta + \frac{\tau}{1+\tau} \psi(\eta)} \]  \hspace{1cm} (17)

An increase in \( \eta \) reduces \( \phi^* \) if:

\[ \eta \psi_\eta < \psi(\eta) \]

Which it is, since:
\[ \psi_{\eta} < 0 \]

Therefore, a reduction in the proportion of high-skill workers employed in output related activities unambiguously reduces the average level of productivity, as a larger stock of high-skill workers is required to produce the same amount of output.

This model suggests that increases in the facilitating labor share affect the economy by reducing the long-run profit share and the wage share paid to workers employed in output related activities. Along the balanced growth path, a decrease in the profit share causes a reduction in the equilibrium rate of low-skill employment. In addition, increases in the facilitating labor share of income leads to a reduction in the proportion of high-skill workers involved in the production of output. This directly causes a reduction in average productivity.

The model is consistent with the idea that increases in the level of rent seeking cause a redistribution of high-skill workers towards facilitating rent seeking activities. If students respond strongly to post graduation employment opportunities, one should expect to see a response in the composition of undergraduate degree completions by major and in the number of students pursuing degrees. Looking at the composition of degree completions may be a reasonable indicator of the level of rent seeking in an economy.

**D. Empirical Approach**

The empirical approach is similar to that used by Murphy et al. (1991). In
their paper, they run two cross-sectional regressions, one for a set of 91 countries, and the other for a set of 55 countries that have more than 10,000 students enrolled. However, using a cross-country sample can be problematic. The main objection to using cross-country data is that the countries in the sample are heterogeneous in terms of their culture, laws, currency, and more, making unobserved variables a potentially large source of error (Crain and Lee, 1999). When it comes to postsecondary majors and enrollment, these differences may be exacerbated by poor data collection and differing standards of postsecondary education. For these reasons, this paper uses a sample of the 48 contiguous states to run both a cross-sectional regression and panel regressions.

1. Cross Sectional Regression

To test the "long-run" impacts of the allocation of talent, a cross-sectional analysis is performed on the 48 contiguous states, using the average growth rate of real personal income per capita over the time period 1990-2010 as the dependent variable. This type of regression follows Barro (1991), Murphy et al. (1991), Glaeser, Sheinkeman and Shleifer (1995), along with many others. This type of regression takes the form:

$$\text{avg} \hat{Y} = \beta_0 + \beta_1 \ln Y_i + \beta_2 S_i + \beta_3 R_i + \beta_4 X_i + \text{avg} G_i + \epsilon_i$$

Where $\text{avg} \hat{Y}$ is the average growth rate of real personal income per capita, $\beta_0$ is the constant term, $\ln Y_i$ is the initial level of real personal income per capita, $R_i$ is the
initial composition of postsecondary degree completions in rent seeking related majors, $S_i$ is the initial composition of postsecondary degree completions in STEM related majors, $X_i$ is a measure of the initial level of educational attainment in state $i$, and $avgG_i$ is a measure of the average level of government expenditures over the entire time period.

2. Panel Regression

Cross-sectional analyses fail to properly account for variables that change over time and to control for country or state level variation. Moving to panel analysis allows for the control of time invariant differences between states. Between 1990 and 2010, annual data exists for the United States but it is not clear that contemporaneous values of state level controls should have contemporaneous growth effects in this case. Instead, levels of the explanatory variables likely have long-run effects. This tension between variables’ short-run and long-run effects on growth means that there is still information to be gleaned from a cross-sectional analysis, especially when the sample of the 48 states is relatively homogenous when compared to a large sample of countries.

To control for time invariant unobserved state characteristics and cyclical fluctuations, a panel regression using five-year averages of the growth rate and

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5 Panel regressions that use annual data yield similar results.
initial values of the explanatory variables between 1990 and 2010 is used. This type of regression takes the form:

$$avgY_i = \beta_0 + \beta_1 \ln Y_{it} + \beta_2 S_{it} + \beta_3 R_{it} + \beta_4 X_{it} + \beta_5 \text{avgG}_{it} + c_i + \epsilon_i$$

Where $avgY_i$ is the five year average of the growth rate of real personal income per capita in state $i$ for five year period $t$, $\ln Y_{it}$ is the initial value of the natural log of real personal income per capita in state $i$ at the beginning of period $t$, $S_{it}$ is the value of the proportion of bachelor’s degrees awarded in STEM related fields of study in state $i$ at the beginning of period $t$, $R_{it}$ is the value of the proportion of bachelor’s degrees awarded in rent related fields of study in state $i$ at the beginning of period $t$, $X_{it}$ is a measure of educational attainment in state $i$ at the beginning of period $t$, $\text{avgG}_i$ is a measure of the average level of government consumption over each five-year period and $c_i$ is a vector of time invariant unobservable factors.

3. Labor Mobility

One potentially significant problem with using postsecondary degree completions as a measure of rent seeking is the relatively high level of labor mobility and the free flow of capital and ideas across state lines in the United States. This raises concerns that postsecondary degree recipients may be making education decisions based on economic conditions in other states. However, if students tend to

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6 Initial values are used to more closely estimate the long-run findings of the theoretical model. Using the five-year average of the percentage of STEM related and Rent related degrees yield similar results.
go to college in a different state than where they intend to seek employment upon graduation, there would not be much to say about why the number of students completing degrees in a state would impact economic growth.

Fortunately, students do tend to reside and work in the state in which they get their undergraduate degree. One year after graduation, 85% of college graduates continue to reside in the state where they received their undergraduate degree. By year five, 70% of students remain in the state in which they graduate (Kodrzycki, 2001). To help further ease concerns that outmigration is a problem; regressions for only public postsecondary institutions are run. This reduces the problem of outmigration, as public colleges tend to have higher instate enrollment than private colleges, due to their proximity and reduced instate tuition.

To further quell concerns of outmigration, a difference in differences regression popularized by Card and Krueger (1994) is run. In this case, there is no policy change that is analyzed. Instead, the employment shock during the dot-com bubble is used as a quasi-natural experiment to analyze the impact of an employment bubble tied to an industry on the composition of degree completions.

The difference in difference estimation technique takes the form of:

7 College graduate retention rates vary by state.
8 Additionally, this paper does not make the claim that students need to employed in the state upon graduation or in a field related to their major to have the composition of degree completions be a valid indicator of the degree of rent seeking in that state. Instead, all that is required is that students choose their major based on possible employment opportunities within the state in which they attend a postsecondary institution.
\[ CS = \beta_0 + \beta_1 dB + \delta_0 d2 + \delta_1 d2 dB + \beta_2 X_{it} + u_{it} \]

Where \( CS \) is the proportion of computer science degrees awarded as a percentage of all bachelor's degrees awarded, \( \beta_0 \) is a constant, \( dB \) is a dummy variable that is equal to one if the individual/state receives the treatment of an employment boom in computer science related industries, \( d2 \) is a dummy variable for the time period after the treatment is administered, \( d2 dB \) is an interaction term identifying the group that receives the treatment after the treatment date, and \( X_{it} \) is a vector of controls. \( \delta_1 \) is the difference in differences estimator. This estimator measures the difference in the difference of the composition of computer science majors between the treatment and control groups before and after the treatment date (Wooldridge, 2007).

4. Data

The primary data source for this paper comes from the Integrated Postsecondary Education Data System (IPEDS) surveys of Institutional Characteristics and Degree Completions. This is a very rich and complete source of data, as all institutions of higher education classified as Title IV institutions are required to participate in the IPEDS program. The Institutional Characteristics Survey and the Completions survey from the IPEDS database are used to construct the data.
The Institutional Characteristics Survey contains a vast array of information regarding all postsecondary institutions. The components gathered include a unique ID code and name of all reporting institutions, the affiliation of the institution (whether or not it is public, private nonprofit, or private for-profit), the sector of the institution (whether it is less than 2 year, 2-4 year, or 4 year or higher), the state or US territory the institution is located in, the highest level of degree offered, the institution level, and the region of the institution. All institutions that are less than two-year institutions are removed from this dataset. This leaves a list of all degree granting institutions in the United States with programs of two years or more.

The completions survey includes a list of degrees conferred by field of study at the 6-digit Classification of Instructional Programs (CIP) code level, the level of the degree (associate's, bachelor's, master's, Ph.D.), and the gender of the recipient at every reporting institution. There are approximately 1,000 unique majors identified at the 6-digit CIP level that fit into 42 different major categories. The complete list of major categories is available in appendix B. CIP codes were updated in 2000 and 2010, requiring the recoding of certain degree completions at the 6-digit level to ensure a consistent dataset over time. All degree completions are reported according to their 2010 CIP code.

In the IPEDS system, each degree granting institution is given a unique identification code. Using the Survey of Institutional Characteristics, each institution is sorted by state. The two surveys are then merged by the unique institution ID number, retaining the state where the institution is located, whether or not the
institution is public or private, the number of degree completions by 2-digit CIP code, and the level of the degree completion.

The resulting data set includes the 42 different major categories listed in appendix B by degree level for each individual state. To keep the analysis tractable, the 42 different major categories are segmented into two degree classifications of interest, STEM related degrees and rent related degrees. Making such a distinction between degrees required making some assumptions about which degrees should be included in which categories. There is some guidance as to what majors should be included as STEM majors, even though there is no firm consensus. In this paper, a broad classification of STEM degrees is applied and includes degrees awarded in agriculture, natural resources, computer science, engineering, engineering technologies, biology, mathematics, physical sciences, and science technology. Rent related degrees include communications, legal studies, business, and social sciences. The remaining majors are classified as other. Using these classifications, the ratio of degree completions to total degree completions at the bachelor’s level for STEM degrees (STEM), rent related degrees (Rent), and other degrees (Other) are calculated.

Ideally, in a state level growth regression the growth rate of real state product per capita would be the dependent variable. In the case of the United States, however, time consistent state domestic product data is not available between 1990 and 2010. During that time period, the industry classification system switched from the Standard Industrial Classification System to the North American Industry
Classification System. Therefore, personal income per capita collected from the U.S. Bureau of Economic Analysis (BEA) is used instead. Since the personal income per capita data is given in current dollars, the Bureau of Labor Statistic’s Consumer Price Index for All Urban Consumers (CPI) is used to calculate the real personal income per capita (RPI) for all 48 contiguous states in 2012 dollars. The growth rate of RPI is calculated to generate the dependent variable, the growth rate of real personal income per capita (Growth).

Researchers have run thousands of cross-sectional and panel growth regressions using a number of different control variables. Many variables have been found to be statistically significant in some regressions and not significant in others. This causes a great deal of uneasiness when it comes to picking the relevant and correct control variables. Sala-i-Martin, Doppelhofer, and Miller (2004) have run statistical analysis to determine what control variables tend to be significant using Bayesian Averaging of Classical Estimates. In their study, they identify 67 explanatory variables used across studies and find that only 18 are significantly and robustly partially correlated with the growth rate. This model uncertainty makes correctly specifying the regression equation difficult, if not impossible. For this reason, simplicity is favored over complexity and the control variable list is left relatively short as the primary takeaway from the Sala-i-Martin et al. paper is that initial levels of income per capita, a measure of primary schooling and government
expenditure as a percentage of GDP, should be included in the analysis. Beyond these variables, the justification of the inclusion of other controls is weak.

The most prevalent control in cross-country growth regressions is the inclusion of the log of the initial level of GDP per capita. Nearly every long-run growth regression includes this variable and it is found to be significant across a vast array of studies (Barro and Sala-i-Martin, 1992). This finding that the log of the initial level of GDP per capita is significant has sometimes been referred to as the "iron law of convergence" (Barro, 2012). For this reason, the log of real personal income per capita is included as a control.

As has been suggested in the cross-country growth literature, starting with Barro (1992), measures of human capital have been shown to contribute significantly to the growth rate of the country. This has led researchers to include a number of different measures of human capital in their growth regressions. In the Sala-i-Martin et al. study of the robustness of control variables, it is found that the enrollment rate of individuals of primary school age should be included in long-run growth regressions. In the United States, however, it should not be expected to be an important a measure of differences in human capital across states due to the prevalence of compulsory education requirements. Because primary school enrollment rates do not vary much across states, a measure of postsecondary schooling (Ba’s/Population) is more sufficient. To construct this parameter, the total

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9 For a discussion on the effects of government consumption on growth, see Bergh and Henrekson (2011).
number of undergraduates obtaining a bachelor’s degree in the state in a given year and dividing it by the state’s population of 18-24 year olds.

To construct a measure of government consumption, data is obtained on the level of state government expenditure from the U.S. Census Bureau’s Census of Government Finances, starting in 1990. The data is transformed into 2012 dollars using the consumer price index. The difference in real state expenditure and real state education expenditure is used to calculate real state non-education expenditure as a percentage of real personal income (Gov. Spending) as a measure of state level government expenditures. Summary statistics for the full sample for the entire time period 1990-2013 are presented in table 1.

Table 1: Summary Statistics

<table>
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<tr>
<th>Variable</th>
<th>Obs.</th>
<th>Mean</th>
<th>S.D.</th>
<th>Min</th>
<th>Max</th>
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</thead>
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<td>0.012</td>
<td>0.023</td>
<td>-0.115</td>
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<td>0.044</td>
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</tr>
<tr>
<td>lnRPI</td>
<td>1008</td>
<td>10.519</td>
<td>0.170</td>
<td>10.058</td>
<td>11.048</td>
</tr>
<tr>
<td>Gov. Spending</td>
<td>1008</td>
<td>0.120</td>
<td>0.025</td>
<td>0.073</td>
<td>0.207</td>
</tr>
<tr>
<td>Ba's/Population</td>
<td>1008</td>
<td>0.052</td>
<td>0.014</td>
<td>0.019</td>
<td>0.108</td>
</tr>
</tbody>
</table>

5. Trends in Postsecondary Degree Completions

The data set employed in this paper tracks bachelors degree completions in the 48 contiguous states between 1990 and 2010. Over this time period, there has been fairly robust growth in the total number of bachelor’s degrees awarded by all title IV postsecondary institutions with the exception being between 1994 and 1997 when the level of bachelor’s degree completions was flat (figure 1). Decomposing the total number of degree completions by type reveals that this slow down in the
Figure 1: Total BA Degree Completions for the 48 Contiguous States

Figure 2: Total BA Degree Completions for the 48 Contiguous States by Type

Source: IPEDS Survey of Institutional Characteristics and Survey of Degree Completions

Source: IPEDS Survey of Degree Completions and Survey of Institutional Characteristics
rate of growth of degree completions was a result of a decrease in the number of rent seeking related degrees awarded between 1993 and 1997 while the overall trend in other degrees was relatively constant over the same time period (figure 2).

The overall trend in degree completions is similar for the sample of only public postsecondary institutions. However, the reduction in public bachelors degree completions is more pronounced than the reduction in the sample as a whole (figure 3). As was true for the public school sample, the reduction in growth of the total number of degree completions was caused by a significant reduction in rent related degree completions while non-rent related degree completions continued to grow at the same rate (figure 4).

The composition of degree completions shows similar trends when all schools are included and when only private schools are included in the national dataset (figures 5 and 6). In both cases, the composition of rent related degree completions fluctuates between 30% and 40% with STEM related degree completions comprising only 10% to 20% of total degree completions.

Even though the national trend follows a pattern, there is a significant amount of variation in the composition of degree completions at the state level. Figure 7 shows the composition of public degree completions for the states of California, Colorado, Massachusetts and Vermont. The composition of degree completions in California and Massachusetts are similar but the composition of degree completions in Colorado and Vermont are noticeably different. Colorado is the only state in the subsample that has the proportion of rent related degrees
Figure 3: Public School BA Degree Completions for the 48 Contiguous States

Figure 4: Public School BA Degree Completions for the 48 Contiguous States by Type
Figure 5: Composition of Total Degree Completions for the 48 Contiguous States

Figure 6: Composition of Public School Degree Completions for the 48 Contiguous States
above the proportion of “other” degrees while Vermont graduates a very large number of “other” degrees relative to the other states in the subsample.

**E. Results**

The Rent variable is an indicator of the level of rent seeking and does not necessarily suggest that increasing the proportion of college graduates in rent related fields causes a change in the growth rate. Instead, the interpretation of the Rent variable is that changes in the level of rent seeking cause changes in both the proportion of degree completions, and the growth rate. This does not exclude the possibility that more traditional human capital channels of growth may be playing
an important role in determining the growth rate, especially when longer run
regressions are considered.

1. Cross Sectional Regression Results

The cross-sectional regression considers how the initial levels of all of the
explanatory variables influence the average growth rate over the entire period from
1990-2010. Table 2 shows the regression results of the cross-sectional regression
for the sample of public schools and shows the long-run effects of changes in the
explanatory variables. For a preliminary glimpse at the results, a scatter plot
showing the relationship between the percentage of rent related degree
completions at public schools and the average growth rate between 1990 and 2010
is shown in figure 8.

As can be seen in the figure, states that graduate a higher proportion of
students with rent related degrees tended to grow more slowly between 1990 and
2010. When regressions are run including controls, the sign on the initial proportion
of rent related degree completions is negative and significant in regressions 2-4.
This is consistent with the hypothesis that states that initially have an environment
conducive to rent seeking see real personal income per capita grow more slowly
than states that have an environment that is less conducive to rent seeking.
The sign on the coefficient for the number of bachelor’s degrees awarded as a
percentage of the population aged 18-24 is positive and significant at the 5% level in
regressions 3 and 4. The initial level of the log of real personal income per capita is

---

10 See appendix C for the regression results for the full sample of title IV schools.
significant and negative at the 1% level in regression 1. However, it is only
significant at the 5% level in regression 2, the 10% level in regression 3 and is
insignificant in regression 4. The initial level of STEM graduates and the initial level
of government consumption expenditures are not significant at the 10% level.

Figure 8: Relationship Between Rent Related Degree Completions and Average
Growth 1990-2010

Due to the long time period examined it is not possible to separate the effect
changes in rent seeking have on average growth from more traditional human
capital channels as this specification is consistent with either interpretation. Over
the very long run, higher proportions of rent related degree completions may
reduce growth by reducing the composition of skills that foster innovation and
therefore growth. This reduction in the composition of skills may be the result of the increased returns to rent seeking. However, it should be noted that, over the long run, simply increasing the proportion of degree completions to the size of the college aged population has a positive effect on the long run average growth rate consistent with traditional human capital theories.

Table 2: Cross-Sectional Regressions for Public Schools

<table>
<thead>
<tr>
<th>Dependent variable: average growth rate of real personal income per capita 1990-2010</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>lnRPI</td>
<td>-0.010***</td>
<td>-0.007**</td>
<td>-0.006*</td>
<td>-0.006</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.003)</td>
<td>(0.003)</td>
<td>(0.004)</td>
</tr>
<tr>
<td>STEM</td>
<td>0.002</td>
<td>-0.018</td>
<td>-0.019</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.023)</td>
<td>(0.024)</td>
<td>(0.024)</td>
<td></td>
</tr>
<tr>
<td>Rent</td>
<td>-0.046***</td>
<td>-0.039***</td>
<td>-0.040***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.013)</td>
<td>(0.011)</td>
<td>(0.013)</td>
<td></td>
</tr>
<tr>
<td>Ba’s/Population</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.156**</td>
<td>0.156**</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.067)</td>
<td>(0.067)</td>
</tr>
<tr>
<td>Gov. Spending</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-0.003</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.022)</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>0.118***</td>
<td>0.098***</td>
<td>0.086**</td>
<td>0.088**</td>
</tr>
<tr>
<td></td>
<td>(0.032)</td>
<td>(0.034)</td>
<td>(0.035)</td>
<td>(0.040)</td>
</tr>
<tr>
<td>Obs</td>
<td>48</td>
<td>48</td>
<td>48</td>
<td>48</td>
</tr>
</tbody>
</table>

Robust standard errors are reported in parenthesis. ***p<.001 **p<0.05 *p<0.10

2. Five Year Average Panel Regression Results

Table 3 shows the results of the panel regressions using the five-year average of the growth rate as the dependent variable between 1990 and 2010. The initial values of the log of real personal income per capita, the proportion of STEM degree completions, the proportion of rent seeking related degree completions, and the number of bachelor’s degrees awarded as a percentage of the population 18-24
years old are included as controls, along with the five-year average level of
government expenditures.

Table 3: Five-Year Average Panel Regressions for Public Schools Without Fixed
Effects

<table>
<thead>
<tr>
<th>Dependent variable: five-year average growth rate of real personal income per capita</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
<th>(8)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>lnRPI</strong></td>
<td>-0.015***</td>
<td>-0.012***</td>
<td>-0.012***</td>
<td>-0.015***</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.004)</td>
</tr>
<tr>
<td><strong>STEM</strong></td>
<td>-0.002</td>
<td>-0.004</td>
<td>-0.017</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.028)</td>
<td>(0.029)</td>
<td>(0.033)</td>
<td></td>
</tr>
<tr>
<td><strong>Rent</strong></td>
<td>-0.086***</td>
<td>-0.085***</td>
<td>-0.105***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.016)</td>
<td>(0.016)</td>
<td>(0.017)</td>
<td></td>
</tr>
<tr>
<td><strong>Ba's/Population</strong></td>
<td>0.012</td>
<td></td>
<td>0.024</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.084)</td>
<td></td>
<td>(0.094)</td>
<td></td>
</tr>
<tr>
<td><strong>Gov. Spending</strong></td>
<td></td>
<td>-0.078***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.029)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Constant</strong></td>
<td>0.166***</td>
<td>0.169***</td>
<td>0.169***</td>
<td>0.215***</td>
</tr>
<tr>
<td></td>
<td>(0.031)</td>
<td>(0.041)</td>
<td>(0.041)</td>
<td>(0.048)</td>
</tr>
<tr>
<td><strong>Obs</strong></td>
<td>192</td>
<td>192</td>
<td>192</td>
<td>192</td>
</tr>
<tr>
<td><strong>FE?</strong></td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
</tr>
</tbody>
</table>

Robust standard errors are reported in parenthesis. ***p<.001 **p<0.05 *p<0.10

Consistent with the cross-sectional regressions, the Rent variable is negative
and significant at the 1% level in random effects regressions 6-8. The coefficient on
the initial level of the log of real personal income per capita is negative and
significant at the 1% level in the random effects model. As in the cross-sectional
regression, the STEM variable does not have a significant effect on the average
growth rate of real personal income per capita. The sign on the coefficient of
Ba's/Population is positive but not significant at the 5% level when included. The
effect of an increase in Gov. Spending on the average growth rate of real personal
income per capita is negative and significant at the 1% level.
As was mentioned previously, the inclusion of state level fixed effects controls for time invariant unobserved differences between states. The results of regressions 9-12 in table 4 indicate much stronger, statistically significant effects of the initial level of STEM and Rent related degree completions on growth than in regressions 5-8. The magnitude of the lnRPI and degree completions as a percentage of the college age population estimates are also significantly larger than in the random effects regression, while the coefficient on the government spending variable remains negative but becomes insignificant.

| Dependent variable: five-year average growth rate of real personal income per capita |
|---------------------------------|----------|----------|----------|
| lnRPI                           | -0.034*** | -0.049*** | -0.056*** | -0.052*** |
|                                  | (0.005)   | (0.008)   | (0.009)   | (0.011)   |
| STEM                            | 0.133**   | 0.172**   | 0.181***  |
|                                  | (0.064)   | (0.067)   | (0.061)   |
| Rent                            | -0.207*** | -0.177*** | -0.179*** |
|                                  | (0.026)   | (0.027)   | (0.030)   |
| Ba’s/Population                 | 0.609**   | 0.604**   |
|                                  | (0.235)   | (0.240)   |
| Gov. Spending                   |           |           | -0.173    |
|                                  |           |           | (0.126)   |
| Constant                        | 0.368***  | 0.577***  | 0.604***  | 0.581***  |
|                                  | (0.057)   | (0.091)   | (0.098)   | (0.101)   |
| Obs                             | 192       | 192       | 192       | 192       |
| FE?                             | YES       | YES       | YES       | YES       |

Robust standard errors are reported in parenthesis. *** p<.001 **p<0.05 *p<0.10

The point estimates of the effect of an increase in rent seeking represented by the percent of college graduates in rent related majors suggest that an increase in rent seeking that results in a one percentage point increase in the percentage of
college graduates with a rent related major reduces the growth rate of real personal income per capita by between 0.04 percentage points and 0.207 percentage points. These results are consistent with what one would expect from the rent-seeking argument, but other factors may have played a role in these results. Therefore, these results should be viewed as suggestive rather than conclusive.

Although the proportion of degree completions by major are used here as an indicator of rent seeking, the analysis does not exclude the possibility that more standard human capital channels are impacting the rate of growth. This is particularly true in the cross-sectional analysis when initial levels of distributions of degree completions are used. It could be that over the twenty years examined, the addition of a large proportion of individuals trained in rent related fields has had a negative impact on the growth rate, in addition to the increased levels of rent seeking. However, this human capital channel is less plausible in the panel regression, as human capital channels may take a substantial period of time to have growth effects.

3. State Spillovers

To be clear, the employment shock that occurs in certain states and not in others is not the result of an explicit policy change, but rather a change in the expansion of industries related to the five computer information and computer systems design industries identified by Hecker (2005). These industries include software publishers, internet publishing and broadcasting, internet service
providers and web search portals, data processing, hosting, and related services, and computer systems design and related services.

Table 5: Difference in Difference Estimates for Public Schools

<table>
<thead>
<tr>
<th></th>
<th>(13)</th>
<th>(14)</th>
<th>(15)</th>
<th>(16)</th>
<th>(17)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diff in Diff</td>
<td>0.004*</td>
<td>0.004*</td>
<td>0.005***</td>
<td>0.005***</td>
<td>0.005***</td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
<td>(0.002)</td>
<td>(0.002)</td>
<td>(0.002)</td>
<td>(0.002)</td>
</tr>
<tr>
<td>Treatment</td>
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<td>0.002</td>
<td>0.001</td>
<td>0.001</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.001)</td>
</tr>
<tr>
<td>Post 1994</td>
<td>0.002***</td>
<td>0.003***</td>
<td>0.004***</td>
<td>0.004***</td>
<td>0.005***</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.001)</td>
</tr>
<tr>
<td>lnRPI</td>
<td>-0.008**</td>
<td>-0.008**</td>
<td>-0.008**</td>
<td>-0.011***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.003)</td>
<td>(0.003)</td>
<td></td>
</tr>
<tr>
<td>Growth</td>
<td>-0.077***</td>
<td>-0.073***</td>
<td>-0.078***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.023)</td>
<td>(0.022)</td>
<td>(0.022)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ba's/Population</td>
<td>-0.115**</td>
<td>-0.101*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.057)</td>
<td>(0.055)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gov. Spending</td>
<td>-0.066***</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>(0.015)</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>0.020***</td>
<td>0.100***</td>
<td>0.104***</td>
<td>0.106***</td>
<td>0.148***</td>
</tr>
<tr>
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<td>(0.037)</td>
<td>(0.037)</td>
<td>(0.036)</td>
<td>(0.035)</td>
</tr>
<tr>
<td>Obs</td>
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<td>420</td>
<td>420</td>
<td>420</td>
<td>420</td>
</tr>
</tbody>
</table>

Robust standard errors are reported in parenthesis. *** p<0.01, ** p<0.05, * p<0.10

What is interesting about these industries is that the magnitude of the change in employment varied dramatically across the 48 contiguous states. In fact, the majority of the increase in employment in these industries as a percent of total state employment occurred in just 9 states: California, Colorado, Delaware, Georgia, Massachusetts, New Hampshire, Utah, Virginia, and Washington. There was very little to negative growth in these five computer related industries over the entire sample period in nineteen other states: Alabama, Arkansas, Idaho, Indiana, Kentucky, Louisiana, Maine, Michigan, Mississippi, Nevada, New Mexico, Oregon,
Pennsylvania, South Carolina, South Dakota, Tennessee, West Virginia, Wisconsin, and Wyoming.

To examine the effect of an employment shock in computer science related industries identified by Hecker (2005), the sample of 48 states is separated into a control group, a treatment group, and an omitted group. States that experience a 1 percentage point increase in the composition of computer science related employment are put into the treatment group. States that experience less than a 0.5 percentage point increase in the composition of computer science related employment are placed into the control group. The treatment and control groups are listed in appendix D.

As can be seen from figure 9, on average, the treatment group experiences a very strong expansion in the composition of computer science related employment. In addition, although the treatment group shows an increase in the average composition of computer science employment, the trends in employment prior to the shock in 1994 are broadly similar in both the treatment and the control groups. After 1994, the trends in the composition of employment diverge significantly.

The results of this divergence can be seen in figure 10 for the entire sample of Title IV schools, and in figure 11 for just public schools. In the sample as a whole, there is a significant increase in the composition of computer science degree completions in both the treatment and the control groups. However, the difference in the composition of computer science degree completions between the treatment group and the control group is increasing over time. Between 1994 and 2004, the
Figure 9: Average Percent Computer Science Employment

Figure 10: Average Percent Computer Science BA's for All Schools
difference between the treatment and control group increases by almost a full percentage point. In the public school sample, this increase is more than twice as large and suggests that the problem of employment spillovers is reduced, but not entirely eliminated by looking at a sample that includes only public schools. The difference in the trends of the private and public school sample’s composition of computer science degree completions over time is shown in figure 12.

A set of difference in difference regressions with controls are run to test the statistical significance of the difference in the trends prior to and after the employment shock. Regressions 13-17 show that the difference in differences estimator is positive and significant at the 5% level in the public schools sample. The point estimate suggests that after the employment shock, the treatment group experienced an increase in the composition of computer science majors that was 0.4-0.5 percentage points greater than the increase in the control group. Although relatively small, it represents approximately 16.7 to 20.9 percent of the 2.39 percentage point increase in the composition of computer science degree completions over the control group.

**F. Conclusions**

This paper has presented theoretical and empirical evidence consistent with the argument that increases in the level of rent seeking may result in the reduction of state level growth in real personal income per capita. Using the composition of degree completions as an indicator of the level of rent seeking, it was found that
Figure 11: Average Percent Computer Science BA's for Public Schools

Figure 12: Difference in Percent Computer Science BA Degrees
increased levels of rent seeking correspond with lower state level growth. This result is robust to different econometric specifications.

There are two theoretical mechanisms that are consistent with the empirical findings. First, increases in rent seeking can slow growth through a redistribution of income, as an increase in rent seeking is a cost to firms. The derived effect of this redistribution on income distribution is an increase in the facilitating labor share, a decrease in the profit share, and a corresponding decrease in the wage share.

Since capitalists have higher saving rates than high-skill workers, as income is redistributed to facilitating labor, the saving rate falls, causing a reduction in the long-run rate of low-skill employment. Second, increased rent seeking increases the proportion of the population involved in rent seeking activities as facilitating labor. This lowers average productivity.

It should be stressed that although the empirical results in this paper are consistent with the theoretical model, they are far from conclusive. Future research in this area should focus on constructing a measure of rent seeking that more closely proxies for rent seeking conditions in a given state or country. Such a measure might include instances of corruption litigation, instances of intellectual property litigation, political donations and lobbying efforts, government subsidy outlays, the complexity of the tax code, and measures of monopoly power. This paper should be seen as a contribution that is consistent with the findings of the corruption literature and not conclusive evidence that increased rent seeking reduces growth.
With this in mind, the findings of this paper suggest that economic policy makers should be increasingly concerned with changes in social norms and efforts by economic agents to redistribute income towards activities that do little to contribute to social welfare as they may lead to slower growth and influence the acquisition of skills in an economy. Furthermore, measures aimed at decreasing the level of rent seeking in the economy can be beneficial. Such measures could include taxing income earned in financial markets at a higher rate, increasing taxes on incentive based pay, and simplifying the tax code.

Beyond increasing output and low-skill employment, policies that reduce the level of rent seeking may also alter the major selection of college undergraduates. This finding may be relevant to policy makers that are concerned with the skills acquired in postsecondary schools, especially as a higher proportion of undergraduate degrees are at least partially funded through grants and subsidized loans. In addition, it suggests that standard human capital theory may fall short in fully explaining differences in growth rates across states, and perhaps countries, as increases the level of human capital may be accompanied by lower than expected growth if the composition of majors is not considered.

Although this paper makes no claims as to how the distribution of college graduates may affect technological innovation, the ability to influence the distribution of college graduates may be an important factor in the rate of innovation. This is of particularly relevant to policies designed to increase the number of STEM related college graduates. If students see post-graduation
employment opportunities as influential in major selection, policies designed to increase interest in STEM related fields of study may not be the best way to influence student’s choice of major. Instead, policy makers may be able to more effectively influence major selection by influencing post graduation employment opportunities.
# APPENDIX A
## OCCUPATION BY MAJOR

Where Majors End Up By Occupation from “What’s it Worth”

<table>
<thead>
<tr>
<th>Degree</th>
<th>Occ. 1 (%)</th>
<th>Occ. 2 (%)</th>
<th>Occ. 3 (%)</th>
<th>Occ. 4 (%)</th>
<th>Occ. 5 (%)</th>
<th>Total %</th>
<th>% STEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural and Natural Resources</td>
<td>MGMT (24)</td>
<td>SALES (15)</td>
<td>LS (8)</td>
<td>OFF (7)</td>
<td>BLDG (4)</td>
<td>58%</td>
<td>8%</td>
</tr>
<tr>
<td>Arts</td>
<td>ARTS (25)</td>
<td>MGMT (14)</td>
<td>OFF (12)</td>
<td>SALES (12)</td>
<td>EDU (8)</td>
<td>71%</td>
<td>0%</td>
</tr>
<tr>
<td>Biology and Life Science</td>
<td>MGMT (16)</td>
<td>HLTH PROF (15)</td>
<td>LS (12)</td>
<td>SALES (11)</td>
<td>OFF (8)</td>
<td>62%</td>
<td>12%</td>
</tr>
<tr>
<td>Business</td>
<td>MGMT (25)</td>
<td>SALES (18)</td>
<td>FIN (18)</td>
<td>OFF (12)</td>
<td>BUS (6)</td>
<td>79%</td>
<td>0%</td>
</tr>
<tr>
<td>Communications and Journalism</td>
<td>MGMT (21)</td>
<td>SALES (17)</td>
<td>ARTS (14)</td>
<td>OFF (14)</td>
<td>EDU (7)</td>
<td>73%</td>
<td>0%</td>
</tr>
<tr>
<td>Computers and Mathematics</td>
<td>COMP (46)</td>
<td>MGMT (16)</td>
<td>OFF (7)</td>
<td>SALES (6)</td>
<td>BUS (4)</td>
<td>79%</td>
<td>46%</td>
</tr>
<tr>
<td>Education</td>
<td>EDU (54)</td>
<td>MGMT (9)</td>
<td>OFF (9)</td>
<td>SALES (6)</td>
<td>BUS (3)</td>
<td>81%</td>
<td>0%</td>
</tr>
<tr>
<td>Engineering</td>
<td>ENGR (32)</td>
<td>MGMT (22)</td>
<td>COMP (9)</td>
<td>SALES (7)</td>
<td>ARCH (4)</td>
<td>74%</td>
<td>45%</td>
</tr>
<tr>
<td>Health</td>
<td>HLTH PROF (69)</td>
<td>MGMT (8)</td>
<td>OFF (4)</td>
<td>SALES (3)</td>
<td>HLTH SUP (3)</td>
<td>87%</td>
<td>0%</td>
</tr>
<tr>
<td>Humanities and Liberal Arts</td>
<td>MGMT (18)</td>
<td>OFF (15)</td>
<td>SALES (14)</td>
<td>EDU (11)</td>
<td>ARTS (6)</td>
<td>64%</td>
<td>0%</td>
</tr>
<tr>
<td>Industrial Arts and Consumer Services</td>
<td>MGMT (22)</td>
<td>SALES (12)</td>
<td>EDU (9)</td>
<td>TRAN (8)</td>
<td>OFF (7)</td>
<td>58%</td>
<td>0%</td>
</tr>
<tr>
<td>Law and Public Policy</td>
<td>PROT (32)</td>
<td>MGMT (11)</td>
<td>OFF (11)</td>
<td>COMM (9)</td>
<td>SALES (8)</td>
<td>71%</td>
<td>0%</td>
</tr>
<tr>
<td>Physical Sciences</td>
<td>MGMT (18)</td>
<td>SALES (11)</td>
<td>LS (10)</td>
<td>HLTH PROF (10)</td>
<td>OFF (8)</td>
<td>57%</td>
<td>10%</td>
</tr>
<tr>
<td>Psychology and Social Work</td>
<td>COMM (18)</td>
<td>MGMT (16)</td>
<td>OFF (15)</td>
<td>SALES (11)</td>
<td>EDU (8)</td>
<td>68%</td>
<td>0%</td>
</tr>
<tr>
<td>Social Science</td>
<td>MGMT (22)</td>
<td>SALES (16)</td>
<td>OFF (13)</td>
<td>FIN (7)</td>
<td>BUS (6)</td>
<td>64%</td>
<td>0%</td>
</tr>
</tbody>
</table>
APPENDIX B
COMPLETE LIST OF MAJOR CATEGORIES

Agriculture, Agriculture Operations, and Related Sciences
Natural Resources and Conservation
Architecture and Related Services
Area, Ethnic, Cultural, Gender, and Group Studies
Communication, Journalism, and Related Programs
Communications Technologies/Technicians and Support Services
Computer and Information Sciences and Support Services
Personal and Culinary Services
Education
Engineering
Engineering Technologies and Engineering-Related Fields
Foreign Languages, Literatures, and Linguistics
Family and Consumer Sciences/Human Sciences
Legal Professions and Studies
English Language and Literature/Letters
Liberal Arts and Sciences, General Studies, and Humanities
Library Science
Biological and Biomedical Sciences
Mathematics and Statistics
Military Science, Leadership and Operational Art
Military Technologies and Applied Sciences
Multi/Interdisciplinary Studies
Parks, Recreation, Leisure, and Fitness Studies
Philosophy and Religious Studies
Theology and Religious Studies
Physical Sciences
Science Technologies/Technicians
Psychology
Homeland Security, Law Enforcement, Firefighting and Related Protective Services
Public Administration and Social Service Professions
Social Sciences
Construction Trades
Mechanic and Repair Technologies/Technicians
Precision Production
Transportation and Materials Moving
Visual and Performing Arts
Health Professions and Related Programs
Business, Management, Marketing, and Related Support Services
High School/Secondary Diplomas and Certificates
History
Residency Programs
## APPENDIX C
### FULL SAMPLE REGRESSION RESULTS

### Table 6: Cross Sectional Regressions for All Schools

<table>
<thead>
<tr>
<th></th>
<th>(18)</th>
<th>(19)</th>
<th>(20)</th>
<th>(21)</th>
</tr>
</thead>
<tbody>
<tr>
<td>lnRPI</td>
<td>-0.011***</td>
<td>-0.005*</td>
<td>-0.007**</td>
<td>-0.008**</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.003)</td>
<td>(0.003)</td>
<td>(0.004)</td>
</tr>
<tr>
<td>STEM</td>
<td>0.005</td>
<td>0.008</td>
<td>0.007</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.026)</td>
<td>(0.024)</td>
<td>(0.024)</td>
<td></td>
</tr>
<tr>
<td>Rent</td>
<td>-0.048***</td>
<td>-0.041**</td>
<td>-0.043***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.018)</td>
<td>(0.016)</td>
<td>(0.016)</td>
<td></td>
</tr>
<tr>
<td>Ba's/Population</td>
<td>0.127**</td>
<td>0.128**</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.051)</td>
<td>(0.053)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gov. Spending</td>
<td></td>
<td></td>
<td></td>
<td>-0.007</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.026)</td>
</tr>
<tr>
<td>Constant</td>
<td>0.128***</td>
<td>0.086***</td>
<td>0.097***</td>
<td>0.102**</td>
</tr>
<tr>
<td></td>
<td>(0.036)</td>
<td>(0.027)</td>
<td>(0.031)</td>
<td>(0.038)</td>
</tr>
<tr>
<td>Obs</td>
<td>48</td>
<td>48</td>
<td>48</td>
<td>48</td>
</tr>
</tbody>
</table>

Robust standard errors are reported in parenthesis. *** p<.001 ** p<0.05 * p<0.10

### Table 7: Five-Year Average Panel Regression For All Schools Without Fixed Effects

<table>
<thead>
<tr>
<th></th>
<th>(22)</th>
<th>(23)</th>
<th>(24)</th>
<th>(25)</th>
</tr>
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<tbody>
<tr>
<td>lnRPI</td>
<td>-0.015***</td>
<td>-0.010***</td>
<td>-0.012***</td>
<td>-0.015***</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.003)</td>
<td>(0.004)</td>
<td>(0.004)</td>
</tr>
<tr>
<td>STEM</td>
<td>0.022</td>
<td>0.027</td>
<td>0.017</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.032)</td>
<td>(0.033)</td>
<td>(0.035)</td>
<td></td>
</tr>
<tr>
<td>Rent</td>
<td>-0.073***</td>
<td>-0.069***</td>
<td>-0.087***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.016)</td>
<td>(0.016)</td>
<td>(0.018)</td>
<td></td>
</tr>
<tr>
<td>Ba's/Population</td>
<td>0.070</td>
<td>0.081</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.049)</td>
<td>(0.055)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gov. Spending</td>
<td></td>
<td></td>
<td></td>
<td>-0.076***</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.028)</td>
</tr>
<tr>
<td>Constant</td>
<td>0.166***</td>
<td>0.144***</td>
<td>0.157***</td>
<td>0.199***</td>
</tr>
<tr>
<td></td>
<td>(0.031)</td>
<td>(0.035)</td>
<td>(0.036)</td>
<td>(0.043)</td>
</tr>
<tr>
<td>Obs</td>
<td>192</td>
<td>192</td>
<td>192</td>
<td>192</td>
</tr>
<tr>
<td>FE?</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
</tr>
</tbody>
</table>

Robust standard errors are reported in parenthesis. *** p<.001 ** p<0.05 * p<0.10
**Table 8: Five-Year Average Panel Regressions for All Schools With Fixed Effects**

Dependent variable: five-year average growth rate of real personal income per capita

<table>
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<th>(26)</th>
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<th>(28)</th>
<th>(29)</th>
</tr>
</thead>
<tbody>
<tr>
<td>lnRPI</td>
<td>-0.034***</td>
<td>-0.047***</td>
<td>-0.059***</td>
<td>-0.055***</td>
</tr>
<tr>
<td></td>
<td>(0.005)</td>
<td>(0.008)</td>
<td>(0.011)</td>
<td>(0.013)</td>
</tr>
<tr>
<td>STEM</td>
<td>0.091</td>
<td>0.139*</td>
<td>0.139*</td>
<td>0.139*</td>
</tr>
<tr>
<td></td>
<td>(0.073)</td>
<td>(0.080)</td>
<td>(0.077)</td>
<td></td>
</tr>
<tr>
<td>Rent</td>
<td>-0.236***</td>
<td>-0.201***</td>
<td>-0.205***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.031)</td>
<td>(0.033)</td>
<td>(0.036)</td>
<td></td>
</tr>
<tr>
<td>Ba’s/Population</td>
<td>0.413**</td>
<td>0.395**</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.162)</td>
<td>(0.169)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gov. Spending</td>
<td></td>
<td>-0.146</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.131)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>0.368***</td>
<td>0.575***</td>
<td>0.654***</td>
<td>0.634***</td>
</tr>
<tr>
<td></td>
<td>(0.057)</td>
<td>(0.089)</td>
<td>(0.108)</td>
<td>(0.113)</td>
</tr>
<tr>
<td>Obs</td>
<td>192</td>
<td>192</td>
<td>192</td>
<td>192</td>
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<tr>
<td>FE?</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
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</tbody>
</table>

Robust standard errors are reported in parenthesis. *** p<0.001 ** p<0.05 *p<0.10
## APPENDIX D
### TREATMENT AND CONTROL STATES

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<td>California</td>
<td>Alabama</td>
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<td>Colorado</td>
<td>Arkansas</td>
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<tr>
<td>Delaware</td>
<td>Idaho</td>
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<tr>
<td>Georgia</td>
<td>Indiana</td>
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<td>New Hampshire</td>
<td>Louisiana</td>
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<td>Michigan</td>
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<td>Washington</td>
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<td>New Mexico</td>
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<td>Wisconsin</td>
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<tr>
<td></td>
<td>Wyoming</td>
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