THESIS

ENTREPRENEURSHIP, INFORMATION, AND ECONOMIC GROWTH

Submitted by

Devin Bunten

Department of Economics

In partial fulfillment of the requirements

For the Degree of Master of the Arts

Colorado State University

Fort Collins, Colorado

Fall 2010

Master's Committee:

Department Chair: Steven Shulman

Advisor: Stephan Weiler

Ronnie Phillips
Sammie Zahran

ABSTRACT OF THESIS

ENTREPRENEURSHIP, INFORMATION, AND ECONOMIC GROWTH

This thesis analyzes the impact of entrepreneurship on economic growth across US cities within a formal production function approach. Like previous analyses of economic growth—but unlike many studies of entrepreneurship—economic growth is measured in personal income per worker. The production function features three traditional inputs with a novel fourth: entrepreneurial capital. Entrepreneurship is a process of information revelation which produces a dynamic externality providing marketplace information to potential future market entrants, outside firms, lenders and others. Entrepreneurial capital measures the contribution of this information to economic growth. Multiple measurements of entrepreneurial capital are used, each emphasizing different aspects of the entrepreneurial environment. The statistical results support the views that entrepreneurship is a causal input to local economic growth, that the effects of entrepreneurship are geographically localized, and that the thicker markets of large cities.

Devin Bunten
Department of Economics
Colorado State University
Fort Collins, CO 80523
Fall 2010

Table of Contents

Abstract	iii
Chapter One: Introduction	1
Chapter Two: Literature Review	5
Chapter Three: Theoretical Motivation	30
Chapter Four: A Model of Entrepreneurship and Information	34
Chapter Five: The Data	45
Chapter Six: Summary of Predictions	51
Chapter Seven: Empirical Results	55
Chapter Eight: Conclusions	84
References	90

Chapter One

Introduction

Large and persistent differences in income between and within countries are an empirical fact. Economists have explained these differences by invoking the increasing division of labor, physical capital accumulation, educational advances, increased technical knowledge, and institutional differences. However, richer countries can afford more capital, better education, more research and development, and better institutions. This endogeneity complicates analysis and requires a framework that can reckon with these complicating factors.

Robert Solow's 1957 model of growth utilized a theoretical framework that showed that capital stock differences explain a good deal of income deviation. However, this model left a great deal of deviation unaccounted for; this "Solow Residual" was broadly interpreted as exogenous technology. Solow revolutionized understanding with this quantitative approach, but left for others the work of incorporating other factors into this basic model.

Later economists took up this mantle, and incorporated the stunning increases in education and technical knowledge that occurred during the twentieth century. These economists—starting with Arrow and Uzawa—formulated models of human capital accumulation and learning-by-doing. Endogenous growth theory further reduced the residual by integrating technical progress into these human capital approaches. While these endogenous models were more sophisticated than Solow's exogeneity, this sophistication did not translate into substantially improved empirical precision.

Daron Acemoglu refocused study on the role of institutions in development. Acemoglu, Johnson, and Robinson (2001) found that accounting for differences in historical institutions explained a significant portion of income levels between countries. However, institutional deviations provide an incomplete answer: despite largely similar institutions, there remain large regional differences in income across the US. Additional factors need to be invoked to explain such deviations.

Solow's growth model was expanded in a different direction by the incorporation of endogenous saving. These growth models are built around optimizing agents making saving and consumption decisions which are ideal privately, if not socially. While these models can include uncertain outcomes, the risk faced by households and firms follows some probability distribution--of which the agents are aware. Of course, this assumption departs from reality: agents do not have an accurate picture of the payoffs to all possible investment decisions, nor the probability distribution across the outcomes of these decisions. If information is limited enough, this assumption may not be warranted: inaccurate perceptions of probability distributions may lead to allocative inefficiencies. How, then, do market participants form their expectations?

Transactional marketplace information can provide an answer to the question of expectation formation, and can perhaps shed light on regional deviations in economic activity. Marketplace information is created by collective trial and error: outside actors emulate successful firms and avoid improve upon the actions of the less successful. Past entrepreneurial activity provides information that guides the actions of other potential market entrants, banks and other lenders, and public officials. The formation of probability distributions does not occur in a vacuum; these distributions are the outcome of agents' acquisition of information about the viability of various projects by observing the actions and transactions of others. Market information about the likelihood of different outcomes, the viability of projects, and the limits of markets helps firms make better investment decisions, helps entrepreneurs pursue more viable opportunities, and helps banks identify more promising projects—and thus increases economic activity.

Better marketplace information reduces the uncertainty of investment and encourages entrepreneurship—leading to still more marketplace information. Conversely, uncertainty sidelines entrepreneurs in places bereft of information—perpetuating the uncertainty. Both cases produce self-reinforcing but divergent outcomes: a high-information, high-entrepreneurship equilibrium and a low-information, low-entrepreneurship equilibrium. Because marketplace information is based on the observation of and interaction with established firms, it is non-rival and largely non-excludable, and thus a public good. To the extent that this information can lead to sustained improvement in income levels, a theoretical role exists for government intervention to provide this public good and push economies from the low-information to the high-information equilibrium.

If this marketplace information is geographically localized, geographically asymmetric outcomes will result. With these potential geographic deviations in mind, this paper hypothesizes the existence of "entrepreneurial capital", an informational public good. Entrepreneurial capital is an input to the aggregate production functions, alongside physical and human capital. Entrepreneurs, banks, firms, and public officials in locales with high levels of marketplace information are better equipped to effectively identify and pursue viable investment projects—much like workers in locales with high levels of human capital produce more output per period. With an equal amount of other inputs, locales with high levels of entrepreneurial capital produce more output.

This paper proceeds with an extended literature review that carefully relates the previous literature to the motivation for this paper. The literature review covers early views on economic growth and entrepreneurship, neoclassical growth and variants, later attempts to bridge innovation and growth theory, empirical growth accounting, the modern entrepreneurship literature, and the economics of information. The paper continues with a theoretical section, the development of both a theoretical model and a testable empirical model and an explanation of the data. The various predictions generated by the models are synthesized before the results are presented.

The empirical results support four key findings: (1) Entrepreneurial capital has a positive and significant effect on income levels. (2) Entrepreneurial capital has positive externalities that are geographically localized. (3) Employment-weighted measures of entrepreneurial capital are larger—and explain more income deviation—than firm-weighted measures. (4) Entrepreneurial capital is most effective in populous, dense cities. Discussions of the implications of these findings, shortcomings of this study, and avenues for future research conclude the analysis.

Chapter Two

Literature Review

This paper weaves together the disparate threads of economic growth, entrepreneurship, and marketplace information—a broad approach that hearkens back to earlier literature and shall therefore begin with Adam Smith. Smith argued that the division of labor increased labor productivity, and he illustrated this with his pin factory: splitting the process of pin creation into finer and more easily repeatable tasks increased the productive capacity of a factory. Only the extent of the market limits the productive gains of division: the relatively large market of a town allows for a baker, a butcher, and a brewer, whereas a small farm requires the farmer to perform all three roles. The town provides the opportunity to divide and specialize, implying not only gains from trade but increasing returns to scale. Extending Smith's example, a large modern city has not just a brewer, but many brewers specializing in a various types of beer—not to mention importers selling beers from other cities and countries.

Smith's account explains some portion of economic progress over time, and some deviation of output levels between places. But no matter how well this process explains the economy's increased ability to produce, say, carriages, it explains none of its ability to move beyond carriages to cars. Such a leap requires more than a division of labor and specialization; it requires fundamentally new technologies and products. The invisible hand will tend to lead individuals to pursue potentially profitable enterprises—but how do they identify these enterprises? If the people of a town already supply the bread, meat, and beer required by the town, then what process drives the baker to put away his apron and start a car company?

Josef Schumpeter explored these questions in *The Theory of Economic Development* (1911, trans. 1934) and other works. Schumpeter posited that entrepreneurs lead the economy from one product or process to the next. In Schumpeter's view, an entrepreneur is an individual who takes an idea and turns it into economic knowledge. For example, the requisite pieces to produce a modern automobile were known prior to their mass production: carriages provided the basic form, gear-turning engines already drove trains, and internal-combustion engines were patented before Henry Ford built an assembly line. Cars themselves did not emerge until entrepreneurs like Benz and Daimler in Germany and then Ford in America transformed the underlying technical knowledge into economically viable products. Technical knowledge can be a prerequisite, but the transformative entrepreneurial innovations are the partner of Smith's division of labor. Schumpeter emphasized market-expanding entrepreneurial innovation, while Smith focused on the refinement of these new markets with further productivity-enhancing divisions of labor.

Schumpeter defined development explicitly as "the carrying out of new combinations." With that in mind, he highlighted five types of entrepreneurship, all conforming to the general principle of transformation.

> This concept covers the following five cases: (1) The introduction of a new good—that is one with which consumers are not yet familiar—or of a new quality of a good. (2) The introduction of a new method of production, that is one not yet tested by experience in the branch of manufacture concerned, which need by no means be founded upon a discovery scientifically new, and can also exist in a new way of handling a commodity commercially. (3) The opening of a new market, that is a market into which the particular branch of manufacture of the country in question has not previously entered, whether or not this market has existed before.

> (4) The conquest of a new source of supply of raw materials or half-manufactured goods, again irrespective of whether this source already exists or whether it first has to be created. (5) The carrying out of a new organisation of any industry, like the creation of a monopoly position (for example through trustification) or the breaking up of a monopoly position.

Again, this overlaps Smith's view of development—the greater division of labor is a new method of production. Schumpeter's understanding expands from Smith's focus to a broader understanding of development.

It is worth reiterating that entrepreneurial innovation is distinct from technical innovation. Schumpeter does not distinguish between an entrepreneur in Silicon Valley on the cutting edge of technology and another in Iowa opening the first coffee shop in a small town. Both are transforming general knowledge into economic knowledge. Conversely, a scientist may produce innovative technological changes, but their invention is not entrepreneurial innovation. Invention—a clear necessity for sustained development—instead produces the grist for entrepreneurs. Entrepreneurs, in turn, drive the widespread adaptation of new technologies that increases living standards.

In addition to new ideas, entrepreneurs require funding. Almost by definition, the new firms that entrepreneurs create have no profits from which to fund expansion, nor do they have a credit history to justify lending. Schumpeter viewed banks as crucial to entrepreneurial innovation and thus foundational to economic development. The willingness of lenders to extend credit depends on their assessment of credit risk—an early foreshadowing of the links between entrepreneurship, information, and economic growth expounded upon herein.

Schumpeter also promulgated the idea of "Creative Destruction", an implication of two insights into the nature of entrepreneurship: first, "new combinations are embodied in new firms which do not arise out of the old," and second, "we must never assume that the carrying out of new combinations takes place by employing means of production which happen to be unused." New firms use resources that were previously employed elsewhere in the economy at the expense of established firms. Carriage companies did not invent automobiles, and automobile companies did not displace carriage companies by employing idle resources, but by bidding for and employing workers and obtaining capital that would otherwise have been available to other firms. This theoretical foundation eases the difficulty of quantifying a concept as slippery as entrepreneurship: measuring new firm growth is a relatively straightforward prospect.

In *The Economy of Cities* (1969), Jane Jacobs promotes an entrepreneurial view of growth focused on cities, which have two means of economic development. First, import replacement creates growth: cities produce goods they previously imported and thereby free resources to import new and different goods. From the outside world, the only change is that a city imports a different mix of goods. From inside the city, however, the economy has grown: residents are consuming all the same goods and some new imports. This process relies on local entrepreneurs producing goods that were previously imported.

Jacobs identifies another process of growth that does not rely on import replacement: the "adding of new work to old." By this, she doesn't mean the research and development of established firms, but rather the organic process by which entrepreneurs solve in-company problems and sell their solutions—potentially in vastly different industries. Jacobs highlights 3M, which began as Minnesota Mining and Manufacturing. 3M shortened its name after it began selling glues it developed to keep its shipments secure during transit. It developed the glue for internal purposes, but soon began selling glue alongside its other products. 3M—a failure in the mining industry and an upstart in the adhesives industry—pursued an entrepreneurial innovation by adding new work to old.

Jacobs's two cases—import replacement and new work—represent the two paths of economic development: producing the same products for less, or producing new products. The first echoes Adam Smith's division of labor while the second extends Schumpeter's entrepreneurial innovation. However, both require entrepreneurs willing to gamble on unproven processes or products.

The two aspects are also self-reinforcing. A firm that invents a new product may not simultaneously develop the ideal production and distribution processes; process innovations can follow from product ones. The division of production amongst many firms—rather than a single vertically integrated firm—leads to a greater number of potential innovators seeking opportunities to add new work to old. While Jacobs emphasized cities—rather than the entrepreneurs that inhabit them—their actions form the basis of her analysis. This paper extends Jacobs's views by examining the conditions under which entrepreneurs assess the viability of projects at the city level, and how variations in these conditions create divergent outcomes between cities.

Modern Growth Theory

While Smith, Schumpeter, and Jacobs all shed light on the functioning of the economy and the entrepreneurial process, none provided a testable model incorporating growth and entrepreneurship. The modern growth literature provides a framework for developing such a model.

Solow (1957) developed a growth model capable of distinguishing between shifts in the aggregate production function due to technical change and movements along the curve due to increases in capital stock. Solow calculated that one eighth of US income growth was attributable to increases in capital, with the remainder—the vast majority—"attributable to technical change." However, this Solow residual contains more than technical change: changes in human capital, institutions, lending, and entrepreneurship, are contained within the residual. Later papers remedied these deficiencies by building on Solow's framework, which has remained a workhorse for generations.

Arrow (1962) incorporated human capital via a learning-by-doing process. His model embedded the stock of knowledge within a heterogeneous, time-indexed capital stock, so that a unit of capital created in a given time period produces more output than capital produced in previous periods. Because increases in knowledge are manifested in more productive capital, capital investment in the current period also increases the stock of knowledge. This increase in knowledge makes capital produced in later periods more productive than it would otherwise be. Because of this external effect, the benefits of investment are not fully captured by investors—leading to an inefficiently low level of investment. While the model assumes homogenous labor, Arrow comments that "the [exogenous] growth rate of the labor force incorporates qualitative as well as quantitative increase." Left untouched is the potential for endogenous "qualitative increases" based on agents' choice of non-productive human capital investment in place of labor or leisure.

Uzawa (1965) endogenized technological change using an education sector with non-increasing returns. His production function is identical to Solow's, but workers divide their time between productive and non-productive sectors. The non-productive sector determines the amount of labor-augmenting technical change. Robert Lucas extended the model to explicitly include a human capital term; their intertemporal collaboration became known as the "Lucas-Uzawa Model". Unsurprisingly, externalities result in under-investment: because workers do not capture the entirety of gains from education, workers will under-invest in education. The result is inefficiently slow technical progress.

In a 1985 article on international trade, Paul Krugman grafted learning-by-doing production onto traditional comparative advantage. In a world with multiple tradable goods sectors the increasing returns endemic to learning-by-doing allow two economies to specialize in different sectors, gain comparative advantages in their respective specialties, and trade. That is, increasing returns lead to geographically asymmetric technical knowledge. In Krugman's formulation, this knowledge is localized and limited by industry, which can lead to economic divergence. When consumers are indifferent between two goods, the gains from specializing and trading will improve welfare universally. Shifting preferences leading consumers to prefer one good over the other will result in divergent growth as the favored country reaps still further scale benefits and the other stagnates. Lucas's seminal 1988 paper—the second half of the alphabetically named Lucas-Uzawa model—used Krugman's model to further examine the human capital externality.

Paul Romer (1986) incorporated "knowledge" into an Uzawa-like model that allowed for the possibility of globally increasing returns to technical "knowledge". Agents invest a fraction of output into knowledge, and the overall level of knowledge is the average individual knowledge. Any individual agent faces diminishing returns to investment in knowledge, but, because of external effects of knowledge, a doubling of all inputs—labor, capital, and knowledge—more than doubles output. That same externality, however, means that any given agent has an incentive to free ride, leading to the traditional under-investment in knowledge.

Romer (1990) modeled knowledge as non-rival yet partially excludable—precluding perfect competition, which Romer replaced with monopolistic competition. Firms use their partially excludable knowledge to exact monopoly profits. Romer's "knowledge" deviates from a pure human capital, which he describes as rival: while more than one person can have the same level of human capital, the cost of teaching a second person is equal to teaching the first and thus non-trivial. His example of knowledge is a new product design: endlessly reproducible at trivial cost and thus fully non-rival, although partially excludable. This distinction incents profit-maximizing firms to invest in knowledge, the result of which is endogenous technical progress. The partial excludability of knowledge leads to under-investment in research. Romer concludes, again, that firms under-invest in research and suboptimal growth in the competitive equilibrium.

In his 1988 paper, Lucas analyzed the various strains of this literature by comparing three models: a traditional Solow model, the Lucas-Uzawa model, and a learning-by-doing model a la Krugman. He aimed to develop a theoretical framework able to account for the persistence of cross-country differences. He found the traditional model—in which differences result from initial level of technology and differential saving rates—unable to explain the divergence between the contemporary situations in technically advanced Japan, rapidly progressing South Korea, and relatively technology-starved China. Lucas hypothesized that internationally variable human capital stocks better explain the divergence.

In his human capital models, agents improve their productivity by increasing their knowledge of the productive process through either an education sector or learning-by-doing. In Lucas's expansion of the closed models to an open world economy, the only explanation for the large and persistent immigration flows from poor to rich countries is a human capital externality. Empirically, the Lucas-Uzawa and Solow models have "exactly the same ability to fit US data." While Lucas's extension does not result in a better fit, it does provide a useful exploration of knowledge well beyond the Solow model's completely exogenous technical change.

Lucas then digresses from his main subject to discuss the role of cities in economic growth. While he uses nationally aggregated data in his model, he acknowledges the rather heroic assumption that the human capital externality is national in scope. He states that there is reason to think that the externalities may be largely local, and cites Jacobs's *The Economy of Cities* as a convincing demonstration of the localized impacts of human capital externalities. Puerto Rico gave Lucas a ready example: productivity on the island would not be much changed if it achieved statehood, and is instead dependent on local factors. Between his inclusion of human capital and discussion of cities, Lucas pushed the frontiers of growth theory towards greater realism and promoted a discussion of the relevant economic units—cities, with their localized knowledge, rather than nations.

None of the models considered so far model Schumpeter's entrepreneurial innovation. Instead, they assume a perfect ability to create knowledge or human capital—Arrow even models technical progress as linear in time invested. Creative destruction is largely absent as well. Arrow incorporates the obsolescence of capital separate from depreciation, but again with strict determinism. Romer's 1990 paper provided for short-term monopoly profits—and the implicit destruction of previous-period monopoly previous—but once again in a deterministic setting: any time spent on knowledge-creation resulted in monopoly profits at the expense of previous monopolists. Schumpeter believed that entrepreneurship is risky, that innovation can be chancy, and that successful implementation of investments in new firms and new knowledge is inherently uncertain. With that in mind, do these models' assumptions approximate reality well enough, or is the uncertainty of research, investment, and entrepreneurship crucial to understanding growth processes and income levels?

Romer's firms research technological advances and thus fuel economic growth, but researchers discover many more innovations than firms implement. How do firms and entrepreneurs choose which ideas to pursue? Are some agents better at identifying and pursuing viable innovations, and what causes these variations? This paper holds that publically available but geographically limited information about the viability of projects leads to uncertainty in low-information economies, limiting their ability to produce new goods. The geographic variability of this information results in economic divergence.

Creative Destruction and Economic Growth

Aghion and Howitt (1992) include uncertainty of innovation in an endogenous growth model, extending previous models which assumed that innovations deterministically followed research. In their model, firms research innovations which yield monopoly profits until another firm innovates. Upon each new innovation, the previous innovation becomes "common knowledge." Periods are defined as the time between innovations, and so the fewer resources invested in research by other firms, the greater the profit for the current monopolist. The model results in creative destruction: innovating firms create monopoly profits while destroying the profits of a previous firm. Following the patent-race literature, firms in this model face competing external effects, which encourage them to under-invest in research due to the traditional incomplete internalization of research payoffs and to over-invest because they do not internalize the destruction of the previous monopolist's profits. In line with previous research, Aghion and Howitt find under-investment to be the more likely equilibrium. While their model leads to creative destruction, it continues to abstract from Schumpeterian entrepreneurship—the focus is on technical invention rather than entrepreneurial innovation and implementation.

sCorriveau (1994) also models uncertainty of innovation leading to creative destruction. In place of Aghion and Howitt's product innovations, Corriveau models a single-good economy with process innovations that make production easier or cheaper. Corriveau combines and extends both Romer's endogenous growth model and Kydland and Prescott's real business cycle model: unlike Romer, his model provides for business cycles; and, unlike Kydland and Prescott, his model provides for endogenous technology.

Innovation follows a Poisson distribution whose mean increases in the resources spent on research—thus no individual firm can guarantee an innovation, and the innovative prospects of other firms are also unknown. Zero, one, or many firms might innovate in a period. The simple addition of innovative uncertainty to an otherwise straightforward model yields an accurate description of overall economic growth and plausible business cycles. These results suggest that issues of information and uncertainty are central to the macroeconomics, and that economists neglect such issues at a cost.

The two creative destruction models simplify Schumpeter's idea of entrepreneurship and thereby lose key elements: whereas these models focus on *technical* innovation, Schumpeter emphasized *entrepreneurial* innovation. The essence of his entrepreneurship is not in technical progress, but in the application of technical progress to the production of marketable goods or processes. The distinction is subtle, but important. In these two models, research investment leads uncertainly to innovation, but, given that a firm has innovated, they will reap monopoly profits. This uncertainty—as well as traditional knowledge externalities—leads to under-investment in research. An appropriate system of research taxes and subsidies can thus yield a Pareto-improving allocation of resources.

Uncertainty in entrepreneurial application has different implications. If the implementation of innovations is not deterministic but instead depends on entrepreneurs' experience and abilities, then local marketplace information, credit markets, and other factors can affect outcomes. If there are feedback loops between entrepreneurship on the one hand and marketplace information and credit on the other, then the Pareto-improving solution takes a different form: one-time subsidies to entrepreneurs provide the spark that entrepreneurship needs to become self-sustaining—unlike the continuous subsidies required in the technical uncertainty world. To the extent that marketplace information and credit markets are geographically asymmetric, the ideal system of subsidies will vary across places. Accounting for spatial deviations in information and uncertainty yields fundamentally different conclusions.

Furthermore, unsuccessful research endeavors in the Corriveau model are simply lost causes: the time spent benefits no one. Investment in unsuccessful entrepreneurial projects, on the other hand, has positive externalities: unlike the privacy afforded by unsuccessful research, entrepreneurs fail in full public view. While the entrepreneur experiences a loss, other entrepreneurs can learn from her missteps by improving upon her idea or redirecting their time towards more viable projects.

The nature of entrepreneurship may result in further financial and political difficulties. Private research and development is conducted by established firms, whereas Schumpeterian entrepreneurship is conducted by nascent firms. Established firms can more readily access credit, and government lobbying is conducted solely by established firms. There is no voice provided for potential future firms. If entrepreneurship encourages income growth, then such difficulties can stifle economic development. Entrepreneurship presents a particularly thorny policy problem, and an exploration of uncertainty in invention provides an incomplete description of entrepreneurship.

Empirical Growth Accounting

Greg Mankiw, David Romer, and David Weil (1992) offer a growth accounting that "takes Robert Solow seriously." They present a traditional Solow model with Cobb-

Douglas production, and then append an aggregate human capital term. They find that the traditional Solow model variables—the savings rate and the population growth rate—explain over half of cross-country differences, and that the directions of the effects are as predicted, but not their magnitudes. The augmented model, on the other hand, yields both the predicted signs and a close approximation of their hypothesized magnitudes. The authors stress that the Solow model does not predict overall convergence but that each country will converge to its own steady state, which are functions of the rates of savings, depreciation, and population growth. Furthermore, they find that after accounting for savings and population growth rates, countries display roughly the rate of convergence predicted by the augmented Solow model—roughly 2% per year. While these findings do not necessarily contradict Romer's hypothesis of increasing returns, they do make the case that the augmented Solow model is accurate enough to be of continued use in empirical macroeconomic comparisons of growth and convergence.

Crihfield and Panggabean (1995) further extend the Mankiw et al augmented Solow model. In place of the Cobb-Douglas production function, the authors utilize a Constant Elasticity of Substitution production function. Instead of the country-level focus of Mankiw et al or the state-level data of e.g. Barro and Sala-i-Martin (1992), Crihfield and Panggabean use US Metropolitan Statistical Areas as their unit of analysis. MSAs are defined based upon commuting patterns and allow for a large, uniform, high-quality dataset that accounts for economic units that cross state lines, such as the four-state New York City MSA. In addition to private human and physical capital investment, the authors measure public capital investment. To account for the potential endogeneity of investment and output, the authors utilize a two-stage approach, with factor market regressions producing the inputs for the growth regression. The authors find that while local government capital investment promotes local employment growth, neither local nor state government investment promotes income growth, and may be detrimental. They find the expected signs for physical and human capital investment.

Hammond and Thompson (2008) use a similar sub-state approach to Crihfield and Panggabean. In place of Metropolitan Statistical Areas, they use “commuting zones”. Commuting zones, like MSAs, are defined based on commuting patterns but also include rural areas and thus allow for an examination of urban/rural differences. Like Crihfield and Panggabean, the authors find that public capital investment does not have a positive effect on income—the coefficient is uniformly negative and only statistically significant in some specifications. They compare the CES production form to the Cobb-Douglas case and are unable to reject the Cobb-Douglas specification. Additionally, their reported rate of income convergence is a low 1.1%, much smaller than the 2% country-level rate reported by Mankiw et al.

They also find physical capital investment to have a significant positive effect in rural but not urban areas. The physical capital result suggests that urban economies are compositionally different than rural ones. Alternatively, urban economies may be near their steady-states, in which case the capital stock per worker grows at the relatively small rate of technical progress. Rural areas, conversely, have more room for physical capital accumulation.

Their results show that human capital investment has a positive effect in both urban and rural areas, but that its effect is greater in urban areas. Human capital may be more valuable in urban areas due to knowledge spillover effects—one worker’s or firm’s knowledge can spill over and make others more productive. Alternatively, the one-sector production model may be inaccurate; perhaps the "urban good" requires human capital whereas the "rural good" does not. In any event, the differences between urban and rural areas remain underexplored in the current growth literature.

The current paper follows Hammond and Thompson in many details: human capital specification, capital investment data, and the use of regional data including commuting zones. Because they are unable to reject the Cobb-Douglas case, this paper reverts to the Cobb-Douglas specification of Mankiw et al. In light of the past work on public capital, this paper replaces the term with a measure of local entrepreneurship, termed "entrepreneurial capital".

Entrepreneurship and Growth

While Schumpeter provided an early analysis of the relationship, the marriage of entrepreneurship and growth was empirically consummated only recently. David Audretsch (1995) found that sectors with high rates of investment in new knowledge experience higher startup rates. Audretsch interprets this to mean that knowledge spillovers are greater in industries with heavy knowledge generation—due to, for instance, former employees starting new firms. He does not explicitly link entrepreneurship with growth but merely with research and knowledge spillovers. The jump to growth, however, is not a major leap; Audretsch and others have bridged the gap.

Glaeser et al (1992) aimed to determine the nature of city-level externalities, and pitted three alternative views against one another: the Marshall-Arrow-Romer focus on intra-sector externalities and monopoly, the Michael Porter focus on intra-sector externalities and competition, and the Jacobs focus on inter-sector externalities. The authors find support for Jacobs's view: in-sector technical innovation is not the crux of growth, which instead depends on a broad array of agents pursuing ideas generated across a diversity of sectors.

Acs, Audretsch, Braunerhjelm, and Carlsson (2008) proposed a theoretical framework linking the more subjective entrepreneurship literature to the objective literature on the sources of growth. Their "Knowledge Spillover Theory of Entrepreneurship" explains "where opportunities come from, how knowledge spillovers occur and how occupational choice arises in the context of existing corporations that lead to new firm formation." They model firms separately from entrepreneurial agents; these agents use knowledge spillovers from existing firms to start new firms. Established firms invest in research and pursue rival and excludable innovations—but their research also results in non-rival and non-excludable knowledge spillovers. Opportunities left unexploited by established firms can be pursued by entrepreneurs. The knowledge spillover theory incorporates entrepreneurship much as Schumpeter envisioned: entrepreneurs taking common technical knowledge and turning it into profitable economic knowledge. It does not discount innovation by existing firms and elegantly combines the two processes.

Acs and Armington (2005) investigated the interrelationship of entrepreneurship, geography, and economic growth. They focused on the broader city level in order to capture localized agglomeration effects. Measuring "economic growth" in terms of employment growth, they find a robust relationship between the level of entrepreneurship and growth at the metropolitan level. The authors find that firms in their third to fifth years are responsible for a larger share of employment growth than their numbers would predict—that is, successful startups are the drivers of employment growth. The Acs and Armington approach lacks both a formal growth model underlying their exhaustive correlational regressions and an exploration of the impact of entrepreneurship on income. Despite these drawbacks, their empirical work firmly establishes the relationship between entrepreneurship and increased economic activity.

Audretsch, Keilbach, and Lehmann (2006) hypothesized an "entrepreneurship capital" as a separate input, and thereby partially overcome the drawbacks of the Acs and Armington model. Their intangible entrepreneurship capita is the subset of social capital that encourages entrepreneurial activity. The authors assume that there are constant returns to capital and labor together, so that human and entrepreneurship capital lead to increasing returns to all inputs. This deviates from Mankiw et al and others, which assume constant returns to all inputs and explain divergence through other means. Whatever entrepreneurship capital actually entails, the authors suppose that its presence will be reflected in the actual level of entrepreneurship. They measure entrepreneurship by the new firm startup rate: the propensity for an individual in a given locale to start a new firm. Their simple model includes a Cobb-Douglas production function to model German city-level data; they find the coefficient on entrepreneurship capital to be positive and significant in both aggregate and intensive formulations. That is, they find that a higher propensity of workers to start firms is correlated with higher income levels. The authors also find the effect of entrepreneurship to be stronger when they limit their conception of entrepreneurship capital to firms within high-research sectors. This suggests that research spillovers contribute to entrepreneurial activity—consistent with Acs et al.

Henderson and Weiler (2010) explored the spatial and temporal effects of entrepreneurship on growth. Their results further support the view that entrepreneurship fuels employment growth. They find that these effects are felt most at the county level and are strongest in dense, urban counties. These results suggest a critical mass of population below which entrepreneurs face systemic challenges such as a lack of resources like "business plans, accounting, legal, marketing, production, and financial and management skills" that urban entrepreneurs may take for granted.

These entrepreneurship and growth models answer some of the challenges raised above: they consider the entrepreneurial process separately from the knowledge generation process, and explore the geographical asymmetries of knowledge. However, they also neglect some aspects of entrepreneurship. First, the correlational empirics are just that: correlations. Plausible theoretic interpretations could suggest that causality instead runs from economic growth to entrepreneurship, or entrepreneurship could be merely a channel for growth and not a causal input. The results of Audretsch et al would hold in either case. The "channel" view would preclude policy actions supporting entrepreneurship: if the underlying cause is left unaddressed, policies supporting entrepreneurship will be pushing on a string.

Second, both marketplace information and uncertainty are neglected. Even Acs et al, which provides an explicit model of entrepreneurship and growth with a theoretical justification for causal assumptions, does not explain how entrepreneurs—with the same information—arrive at different conclusions about project viability than established firms. While risk-averse firms combined with risk-neutral entrepreneurs, or differing opportunity costs, could explain these divergent conclusions, these explanations are not readily testable, and may be incomplete. In any case, the accuracy of viability assessments may also vary across places according to potential entrants' information about markets. In places where entrepreneurs have relatively precise information—and uncertainty is minimized—entrepreneurs will be better equipped to capitalize on the human capital externalities of Acs et al.

This paper incorporates the role of marketplace information in determining entrepreneurial investment decisions. Because entrepreneurial activity provides marketplace information, the relationship is cyclical. Specifically dynamic informational externalities both result from and lead to entrepreneurship. The next section examines the literature on the economics of information in anticipation of incorporating its insights.

Marketplace Information

Akerlof (1970) explored the implications of asymmetric information and accompanying uncertainty in the market for used cars. Buyers are unable to distinguish between high-quality used cars and lemons. Akerlof extends his analysis to insurance, labor market discrimination, dishonesty in business dealings, and credit markets in developing countries. Non-market institutional solutions include reputation-based solutions such as brand names, chains, and professional licenses. When such institutions are lacking, transactions decline and credit availability suffers: lending is limited to situations in which uncertainty is reduced—for instance, within families or small communities. Unsurprisingly, Akerlof also finds that asymmetric information tends to increase interest rates, further limiting credit. He concludes that information asymmetry may “explain many economic institutions” and that “business will suffer” in locales lacking such institutions.

Stiglitz and Weiss (1981) explained credit rationing through adverse selection and poorly aligned incentives and examined the effect that of more expensive credit on the quality of a loan. A higher price will either “discourage safer investors, or [induce] borrowers to invest in riskier projects.” In their model, lenders will ration arbitrarily among borrowers who appear identical, and borrowers are unable to overcome this rationing by paying a higher interest rate. They relate their model to efficiency wage models, another circumstance in which principals respond to uncertain and endogenous quality by restricting the quantity. They conclude that the “Law of Supply and Demand” is not a law: when prices have sorting and incentive affects, the resulting equilibrium may be inefficient relative to the standard neoclassical model.

Stiglitz and Weiss (1983) incorporated termination as a response to uncertainty. In their original model, lenders ration credit rather than raising the price, and here employers terminate workers in response to poor performance rather than lowering wages. In their simple two-period model, terminated agents are superior to their replacements. Despite this differential, equilibria exist where the termination of poor performance is optimal from the firm’s perspective: if the increased profit the firm receives from underpaying in the first period as a preemptive threat against failure exceeds the increased profits from retaining the experienced agent in the second period, then the equilibrium result is termination. In this case, a government ban on termination would be Pareto-improving: such a ban would encourage firms to reduce wages in response to poor performance and thus the labor market would clear while firm output would increase. The common thread between their previous paper and this one is the non-marginal behavior on the part of lenders and firms: instead of risking the adverse qualitative responses that higher interest rates and lower wages may entail, the principal simply cuts ties to the agent.

Greenwald, Stiglitz, and Weiss (1984) explore the macroeconomic effects of uncertainty. First, the authors incorporate equity markets into their analysis of credit market imperfections by showing that equity markets are characterized by adverse selection. They show that a negative economic shock will increase the uncertainty of cash flows—increasing the cost of equity at precisely the moment that such equity is most needed. The result is a model of business cycles based upon asymmetric information.

In “A Model of Redlining” (1993), Lang and Nakamura propose a dynamic informational externality resulting in geographic asymmetry to explain the seemingly irrational lending choices involved in mortgage redlining. In a neighborhood with a large number of recent home sales, bank appraisals in the neighborhood are precise. In a neighborhood with few recent home sales, bank appraisals are more variable. Due to the uncertainty of appraisal accuracy in the second neighborhood, banks require higher down payments in the second neighborhood relative to the first. If potential buyers face capital constraints, these higher down payments will result in fewer transactions in the second neighborhood—and thus the informational paucity will persist in the following period. The first neighborhood will continue to have a relatively high number of transactions, providing the requisite information to future buyers. This path dependent model shows the potential impact of credit market failures on broader economic outcomes. The current paper proposes a similar dynamic externality in the context of new firm funding decisions. Increased information with regard to the prospects of entrepreneurs could increase lending and fuel economic growth.

Weiler (2000) takes a game theoretic approach to model the behavior of pioneer and settler firms in low-information locales. The game is played sequentially: one firm can either enter the market or not; successful entry results in monopoly profits while unsuccessful entrants lose some fixed costs. Successful pioneers will be followed by a second firm, reducing profits to normal competitive level. The first firm's entry decision will follow from the perceived probabilities and payoffs of success and failure. Weiler highlights the case of a craft brewing firm considering entry in downtown Denver—an industry with large up-front costs and a market that was, at the time, relatively run-down. Unsurprisingly, the firm in question did not enter the market until the city government subsidized loans to the firm's founder. After this firm tested the waters, other businesses soon followed—leading to a resurgence of the area. This case study exemplifies the thesis of the current paper: entrepreneurship will be limited in information-poor areas, but increased entrepreneurial activity can spur a self-reinforcing cycle.

Weiler, Hoag and Fan (2006) consider localized information and associated external effects in the context of academic research of economic opportunities. The authors focus on the low-information "market fringe". Private agents will pursue projects for which the private net present value is positive, and they form expectations as to the probability of success based on the quantity of information available. For projects in which the "true" probability of success is higher than perceived, increases in information will increase the private net present value. However, following Weiler (2000), a successful project will lead to benefits external to the firm, namely “subsidiary industries, local services, and general community development.” These externalities present an opportunity for Pareto-improving action: if academic research leads private agents to reevaluate and pursue a previously marginal project, the resulting social returns could exceed the cost of the research. The authors develop an empirical framework and ascertain that the potential social returns to research are great enough to justify funding. The current paper takes a similar theoretical approach, but with information provided not by private or academic research but rather by the successes and failures of entrepreneurs.

Hausmann and Rodrik (2003) explore patterns of economic development with a model of uncertainty and entrepreneurship, the basis of which is not far from that pursued here. In their model of a small open economy, developing countries can choose to specialize in any of a spectrum of modern industries. However, entrepreneurs do not know the underlying cost function of any of these industries; this uncertainty discourages entrepreneurs and limits the process of “discovering what a country is good at producing.” Their stylized model does not allow for direct testing; however, they provide evidence supporting corollary hypotheses. While applied to countries rather than cities, the parallels are clear: low-information environments impede investment and slow development.

The common theme of these papers is that uncertainty and asymmetric information tend to limit the extent of markets. The loss in welfare—and the policies to reduce this loss—vary according to market in question. Asymmetric information reduces welfare in the used car market, and trust-building institutions can improve outcomes. Housing market redlining also reduces welfare, and its dynamic informational externalities mean that welfare losses are similarly dynamic, but that a one-time reduction in uncertainty could reduce future red-lining and improve welfare.

If the dynamic information externality associated with entrepreneurial activity encourages economic growth, the potential harm is even greater than in the housing market. Weiler et al show that the lack of information limits economic activity at the market fringe, and Weiler shows the potential for positive dynamic externalities—providing evidence for this web of relationships. Like Greenwald et al, the current paper builds from the microeconomic incidence of asymmetric information to macroeconomic effects—in this case, economic growth. This paper proceeds by linking the cyclical relationship between entrepreneurial activity and marketplace information with economic growth by providing both a theoretical foundation and empirical evidence for a causal relationship.

Chapter Three

Theoretical Motivation

Empirical evidence shows that entrepreneurship is positively correlated with economic growth. While there may be reasons to believe that causality runs from growth to entrepreneurship, this paper provides theoretical justification and empirical evidence that suggests the reverse. The reasoning rests on the premise that the entrepreneur's pursuit of opportunity produces information about the marketplace. Other agents—entrepreneurs, banks, etc—use this information to update their expectations about the viability of projects. As these expectations are refined, local agents become better at choosing projects: they avoid likely failures and focus on likely successes, reducing the variability of project outcomes. As the perceived riskiness of projects declines, banks invest more. This process produces a scenario in which there are more successful businesses investing more, hiring more, and producing more innovations—that is, a world of increased economic growth.

Entrepreneurship has a dual role: it is both the process by which new ideas are turned into new productive firms and the process by which marketplace information is revealed. Prior literature has explored the first aspect and neglected the second. In the theory of entrepreneurship and growth developed by Acs et al, entrepreneurs utilize knowledge spillovers from established firms to produce useful innovations. As established firms research, they produce more "knowledge" than they use: some ideas they pursue, and others they neglect. In their model, entrepreneurs pursue neglected ideas and thereby produce "extra" growth—that is, growth that would not have occurred merely from the new research. This result arises because different agents—firms and entrepreneurs—assign different expected values to the pursuit of new ideas: where firms see unfruitful endeavors, entrepreneurs see an opportunity for profit. However, their model does not propose a structure for the formation of expectations. This paper remedies this deficiency by focusing on the second of entrepreneurship's dual roles: the provision of marketplace information.

Weiler, Hoag, and Fan envision marketplace information as an input to production for entrepreneurial projects, alongside capital and labor. For some enterprises, physical capital must be purchased as a setup-cost (with an ongoing opportunity cost). The up-front nature of information provision is similar in that its procurement occurs prior to establishing a business. Unlike physical capital, however, there is not a clear marketplace in which to purchase marketplace information. An entrepreneur contemplating entry to a specific market can commission research as to the costs they will face, potential markets for their product, and likely rates of return. Such research is costly, and Weiler et al discuss the hesitance of private actors to undertake such research.

However, potential entrants have another avenue by which to procure marketplace information: the success and failure of past entrepreneurs in the same and related markets. This subset of marketplace information is referred to herein as "Entrepreneurial Capital". Because such information is non-rival and non-excludable—it can be used simultaneously by many potential entrants and any observer has access to it—entrepreneurial capital is a public good and thus subject to associated market failures. Furthermore, entrepreneurial capital is largely transactional: unlike other types of marketplace information, it cannot be purchased but instead is gleaned from the past actions of entrepreneurs. In other words, entrepreneurial capital is the result of a dynamic externality associated with entrepreneurship—and is subject to the market failures associated with externalities.

Project information also differs between entrepreneurs and lenders. Stiglitz and Weiss detailed the shortcomings of credit markets in such situations. If the gap between entrepreneurs' and lenders' assessments is diminished by higher levels of entrepreneurial capital, then this gap may further limit entrepreneurial activity and asymmetric outcomes.

Finally, geographic differences in entrepreneurial capital may result in asymmetric outcomes due to agglomeration effects. Entrepreneurial capital is partially location-specific: the viability of projects varies across places, and the information itself may be subject to barriers of transmission. Because entrepreneurial capital is a public good, however, it can be utilized by many people at the same time. Large, dense locales have more people utilizing the available entrepreneurial capital, in addition to the improved information transmission possibilities in large cities.

Unlike other investment goods, entrepreneurial capital is a public good: a given amount of entrepreneurial capital can be used repeatedly, and is freely available to others in a locale. Because of the external benefit, a competitive market will also produce too little entrepreneurship relative to the social optimum. Unlike other public goods, however, entrepreneurial capital results from transactions which can be affected by informational asymmetries—asymmetries which may be more prevalent in areas lacking entrepreneurial capital. The market failure is thus multi-layered: under-investment in the informational public good leads to an under-provision of entrepreneurship itself, which inhibits the development of entrepreneurial capital. The following section presents a theoretical model which develops the ideas suggested by this theoretical overview.

Chapter Four

A Model of Entrepreneurship and Information

The theoretical model presented here is not a fully-fledged model of growth but instead accounts for the informational externality of entrepreneurship and highlights the relationship between past and current entrepreneurship. The extension from increased levels of entrepreneurship to growth is hypothesized, although not modeled explicitly. Finally, a traditional growth model with entrepreneurial capital is presented.

For any given entrepreneurial endeavor, there is an underlying probability distribution across various states of the world representing different outcomes: large profits, normal profitability, small losses, abject failure, et cetera. Entrepreneurial capital reveals the shape of the distribution. Increased accumulation shifts entrepreneur's perspectives across a spectrum from "true uncertainty" to risk: entrepreneurs begin with no knowledge of the underlying distribution and increases in entrepreneurial capital describe the asymptotic movement towards precise knowledge of the distribution. An infinite amount of entrepreneurial capital would not lead to guaranteed success, but would enable entrepreneurs to precisely weigh the likelihood of various payoffs.

Entrepreneurial capital here is strictly transactional: it can only be accumulated by observation of entrepreneurs' entries and outcomes. Entrepreneurial capital is strictly increasing in the number of firm entries. Entrepreneurs draw on the current stock of capital when determining whether to pursue a project. The expected private payoff of a project is given by weighting the value of the payoffs across K states of the world by the perceived probabilities of these outcomes. The payoffs are denoted V_k and the estimated probabilities p_k^e. The probabilities are functions of the amount of entrepreneurial capital. For simplicity, the model assumes that entrepreneurs—due to risk aversion, for instance—are more likely to underestimate the probability of successful outcomes in the face of extreme uncertainty while placing undue weight on negative outcomes.[1]

$$Expected\ Private\ Value = \sum_{k=1}^{K} p_k^e * V_k \qquad (1)$$

An entrepreneur will enter the market if the expected private value is positive, or, if facing multiple potential projects, the entrepreneur will pursue the project with the highest expected value.

Entrepreneurs ignore the social gains when evaluating projects. Her success or failure will increase the stock of entrepreneurial capital for future entrepreneurs; there are positive social benefits. Large profits indicate that this market (or related markets) will bear fruit for other entrepreneurs; abject failure will steer entrepreneurs from this market and towards other, more viable, projects. A socially optimal decision rule must include the external social benefit that accrues across the various states of the world, denoted here B_k.

$$Expected\ Social\ Value = \sum_{k=1}^{K} p_k^e * [V_k + B_k] \qquad (2)$$

Because entrepreneurial capital does not decrease regardless of outcome, the expected social value will necessarily exceed the expected private value. The divergence between private and social benefits clearly results in too few entrepreneurial projects.

A reasonable extension depends on the existence of diminishing returns to entrepreneurial capital. Such an assumption is not unreasonable: the success or failure of

[1] The model does not depend on the assumption of risk aversion. Overestimation of the probability of success will also result in sub-optimal investment—too many entrepreneurs will pursue less profitable projects and neglect more viable opportunities. As more new firms fail than expected, future entrepreneurs will update their expectations and avoid similar projects in favor of other, more viable projects.

the first few market entrants provides a good deal of information as to the market's viability, whereas the entry of the hundredth firm provides much less information—at that point, entrepreneurs are fine-tuning approximate estimates rather than constructing estimates from scratch. Diminishing returns lead to geographically asymmetric outcomes: locales with larger initial capital stocks will glean smaller external benefits from entry. In the language of the model, such locales have smaller values of B_k, and thus expected private and social value will be closely aligned and entry decisions will be nearly socially optimal. Thin markets with small entrepreneurial capital stocks will have larger values of B_k, meaning entry decisions will be suboptimal. The assumption of diminishing returns implies path dependency.

Not all projects require the same amount of entrepreneurial capital. A small-town entrepreneur considering starting a McDonald's franchise can form more accurate *a priori* estimates of the probability of success than can an entrepreneur considering opening a French pâtisserie. Entrepreneurs pursuing more generalist projects—either catering to basic needs, like a grocery store, or providing a well-known commodity, like a franchise with corporate backing—require less local knowledge than those pursuing specialist projects. The success or failure of such a project is unlikely to provide much additional information to future entrepreneurs: the ability of a town to support a McDonald's says very little about the viability of the pâtisserie, whereas the success of the pâtisserie provides a great deal of information: perhaps other international-themed restaurants will also find success. Better still, other entrepreneurs might reason that consumers with a taste for French pastries will also appreciate, say, an art gallery or a specialty bookstore. Such reasoning would be in line with the theory of Jane Jacobs and the finding of Glaeser et al that inter-sector externalities are drivers of growth. In any event, the different requirements for and externalities from generalist and specialist projects implies that thin markets—those on the wrong end of the path dependency—may remain there even with some entrepreneurial activity.

This simple model—and supporting assumptions—implies that entrepreneurs will pursue fewer projects than would be socially optimal, that the entrepreneurial capital public good will therefore be under-supplied, that geographic informational asymmetries will result in path dependency, and that heterogeneous projects with differing informational inputs and external effects will further support path-dependent outcomes. The clear conclusion is that government intervention can increase entrepreneurial activity and lead locales from the sub-optimal equilibrium to the high-capital social optimum. Such a conclusion could leverage the strengths of both the public and private sectors. By subsidizing loans to entrepreneurs, the government could pool risk across the entire economy—thereby distributing the costs of entrepreneurship more widely, just as the external benefits are spread widely. With the external benefit thus accounted for, the private sector could thereby focus on pursuing its comparative advantage of entrepreneurial innovation.

Dynamic Extension

Following Weiler (2000), pioneers can capture monopoly rents in the short run, while settlers drive such profits to zero in the long run. The transformation from monopoly to competition increases welfare while reducing pioneer profits. This process is inherently dynamic: future settlers react to the pioneer's initial entry. However, future entrepreneurs do not face a simple choice of entry, but choose between projects in a variety of sectors. This section extends the previous accounting of external benefits to entrepreneurship by considering a multifaceted understanding of the externalities and entry choices.

First, a successful pioneer in a sector gains monopoly profits until the entry of a second firm. A successful second firm will necessarily reduce these profits. If this competition follows either Cournot competition or Bertrand competition with product differentiation, the profits will be driven to zero slowly. The following analysis implicitly assumes such a process, although the results are not dependent on this assumption: an assumption of Bertrand competition simply speeds the process of profit destruction.

In this formulation, marketplace information and entrepreneurial capital are partially sector-specific: the external effects of entry to a sector are greater in that sector than in others. For a given sector, the entrepreneur's expected payoffs across various states of the world depends on the number of current firms. For inherently viable projects—that is, industries in which the underlying probability distribution is relatively favorable—the entry of additional firms will have two countervailing impacts: additional firms will decrease any monopoly profits of incumbents and decrease the uncertainty of entry for other potential entrants.

The first few firms in a sector may thus increase the expected payoff. In a low-information environment where initial estimates of the probability distribution vastly underestimate the probability of positive outcomes, a successful initial entrance may cause other entrepreneurs to revise their estimated distribution drastically upward. This revision may swamp the effect of decreased monopoly rent, thereby causing the expected payoff to entry to increase. This case is more plausible in a particularly low-information environment—that is, a thin market with a small stock of entrepreneurial capital. In such a case, there are particularly large external benefits to initial firm entrance—that is, there is a great divergence between social and private benefits. Therefore this dynamic extension, with its endogenous payoffs and probability distributions, strengthens the initial conclusions: thin markets have the most to gain from entrepreneurship. The greater divergence between social and private benefits in this dynamic extension leads to an equilibrium that is even more suboptimal than the original model implied.

The previous assumption of decreasing returns to scale implies that this circumstance cannot last: eventually, perceived expectations will align with the underlying probability of various outcomes. At this point, a firm's entrance will only diminish the expected payoff to further entry by decreasing the available monopoly rent. This implies that the underlying probability distribution is partially endogenous. As the number of incumbent firms increases, the probability that profits will be positive for a new firm is likely to decline in any given state of the world. Firm entry will eventually drive the expected payoff downward monotonically.

Both the original model and this extension lead to the conclusion of a path-dependent model with multiple equilibria: one with high levels of entrepreneurship and information, and one with low, but both with a small expected private payoff to entry. The external benefits of entry imply that only the high-information equilibrium also has a small expected social payoff. Schumpeter and Jacobs both conclude that low-entrepreneurship locales will stagnate while high-entrepreneurship locales will experience sustained growth. This model supports their conclusions. Entrepreneurs in places with low levels of entrepreneurial capital are less likely to pursue new and specialized innovations and more likely to pursue generalized projects or those with corporate backing—and there isn't much innovation at K-Mart. Acs and Armington empirically established that entrepreneurship is positively correlated with employment growth, and this model's framework—combined with the theoretical contributions of Schumpeter, Jacobs, and others—justifies an exploration of the effect of entrepreneurship on overall output growth.

Derivation of the Growth Model

This paper's empirical model follows Mankiw et al, Crihfield and Panggabean, and Hammond and Thompson in augmenting the basic Solow growth model. Following Hammond and Thompson's failure to reject the Cobb-Douglas specification, this paper reverts to the Cobb-Douglas assumption of Mankiw et al. As Hammond and Thompson reject the inclusion of public capital, this paper replaces it with entrepreneurial capital. The basic production function is now given by

$$Y = K^{\alpha} H^{\beta} E^{\gamma} (AL)^{1-\alpha-\beta-\gamma} \tag{3}$$

where notation is standard: "Y" is output, "K" physical capital, "H" human capital, "A" the level of technology, "L" labor, and "E" the novel component of entrepreneurial capital. All variables are functions of time as usual. Labor and technology grow exogenously at rates "n" and "g" respectively, and the units of effective labor grow at rate "$n + g$". As usual, "exp" denotes the exponential function to reduce notational confusion.

$$L(t) = L(0) * \exp(nt) \tag{4}$$

$$A(t) = A(0) * \exp(gt) \tag{5}$$

The model uses variables in terms of output or stock per effective unit of labor: $y = Y/AL$, $k = K/AL$, $h = H/AL$, and $e = E/AL$. This paper makes the standard assumptions that all forms of capital depreciate at the same rate δ and that one unit of output can either be consumed or costlessly converted into any of the three forms of capital. These definitions imply the following equations of motion:

$$\dot{k}(t) = s_k y(t) - (n + g + \delta)k(t) \tag{6}$$

$$\dot{h}(t) = s_h y(t) - (n + g + \delta)h(t) \tag{7}$$

$$\dot{e}(t) = s_e y(t) - (n + g + \delta)e(t) \tag{8}$$

Setting each of these equations equal to zero; substituting the production function for $y(t)$; and solving $k(t)$, $h(t)$, and $e(t)$ gives steady-state values of the three capital goods as functions of the parameters and the income share invested in each form of capital:

$$k^* = \left[\frac{{s_k}^{1-\beta-\gamma}{s_h}^{\beta}{s_e}^{\gamma}}{n+g+\delta}\right]^{1/1-\alpha-\beta-\gamma} \tag{9}$$

$$h^* = \left[\frac{{s_h}^{1-\beta-\gamma}{s_k}^{\alpha}{s_e}^{\gamma}}{n+g+\delta}\right]^{1/1-\alpha-\beta-\gamma} \tag{10}$$

$$e^* = \left[\frac{{s_e}^{1-\alpha-\beta}{s_k}^{\alpha}{s_h}^{\beta}}{n+g+\delta}\right]^{1/1-\alpha-\beta-\gamma} \tag{11}$$

Substituting the steady state values into the original production function and taking logs yields an equation giving income per capita as a function of the various parameters and shares.

$$\ln(Y/L) = \ln\big(A(0)\big) + gt + \frac{\alpha}{1-\alpha-\beta-\gamma}\ln(s_k) + \frac{\beta}{1-\alpha-\beta-\gamma}\ln(s_h) + \frac{\gamma}{1-\alpha-\beta-\gamma}\ln(s_e) - \frac{\alpha+\beta+\gamma}{1-\alpha-\beta-\gamma}\ln(n + g + \delta) \tag{12}$$

This equation extends the initial regression equation in Mankiw et al by including entrepreneurship. Specifically, it states that income per worker is a function of the level of technology; the rates of population growth, technological growth, and depreciation; and the share of output invested in manufacturing, human, and entrepreneurial capital. Like Mankiw et al, it assumes that all economies are at their steady-state equilibria. This assumption may be warranted for the economies of American cities—certainly, it is more plausible for this dataset than for the country-level data that Mankiw et al used. Hammond and Thompson find evidence of convergence for cities, but the rate of convergence that they uncover—1.1% per year—is very small. This point will be discussed more thoroughly following the complete development of the model.

The possibility that economies are not at their steady states must be accounted for; this paper presents results based on a "steady state" specification and a "convergence" specification. Previous studies have therefore modified the previous equation to include convergence to steady state. The change in output per person from a base period to some period t is, by definition, a fraction of the difference between the base period and the steady state values.

$$\ln\left(\frac{Y}{L}\right)_t - \ln\left(\frac{Y}{L}\right)_0 = (1-\pi)\left[\ln\left(\frac{Y}{L}\right)^* - \ln\left(\frac{Y}{L}\right)_0\right] \tag{13}$$

The starred term indicates the steady state value. The fraction $(1-\pi)$ accounts for economies' convergence to their own unique steady states. Inserting the steady-state equilibrium above into this equation gives the final theoretical result, given by Equation Fourteen:

$$\ln\left(\frac{Y}{L}\right)_t - \ln\left(\frac{Y}{L}\right)_0 = (1-\pi)\Big[\ln\big(A(0)\big) + gt - \frac{\alpha+\beta+\gamma}{1-\alpha-\beta-\gamma}\ln(n+g+\delta) + \frac{\alpha}{1-\alpha-\beta-\gamma}\ln(s_k) + \frac{\beta}{1-\alpha-\beta-\gamma}\ln(s_h) + \frac{\gamma}{1-\alpha-\beta-\gamma}\ln(s_e) - \ln\left(\frac{Y}{L}\right)_0\Big] \tag{14}$$

Finally, the convergence term is distributed to provide the final functional form for the convergence regression.

$$\ln\left(\frac{Y}{L}\right)_t - \ln\left(\frac{Y}{L}\right)_0 = (1-\pi)\ln\big(A(0)\big) + (1-\pi)gt - (1-\pi)\frac{\alpha+\beta+\gamma}{1-\alpha-\beta-\gamma}\ln(n + g + \delta) + (1-\pi)\frac{\alpha}{1-\alpha-\beta-\gamma}\ln(s_k) + (1-\pi)\frac{\beta}{1-\alpha-\beta-\gamma}\ln(s_h) + (1-\pi)\frac{\gamma}{1-\alpha-\beta-\gamma}\ln(s_e) - (1-\pi)\ln\left(\frac{Y}{L}\right)_0 \quad (15)$$

The two specifications—the initial one without an initial income term, and the second with the term—reflect two economic possibilities. The first models economies as if they are at their steady-state equilibria, while the second instead accounts for convergence to those equilibria.

In the first case, variations in income *levels* are determined by the rates of capital investment. For two otherwise identical places, the one that invests more in physical, human, or entrepreneurial capital will have a higher income in its steady state. Because this specification assumes that economies are in their steady states, theory predicts that places with higher rates of investment will have higher income (after accounting for population growth and depreciation).

In the second specification, income growth *rates* are regressed on the same capital investment rates, as well as initial income. The model implies a unique steady state for any combination of investment rates. An economy with a given set of investment rates may be at any point along the time-path of convergence to that unique steady state. The diminishing returns to capital investment dictate that for any given investment rates, income growth rates will be slower the nearer an economy is to its steady state. The inclusion of initial income captures this effect and implies that deviation in income growth rates can be attributed strictly to deviation in investment rates.

The approach here is purely cross-sectional: instead of analyzing income growth over time, it takes a static snapshot and explores the deviations in income between places.

The limited time frame of the data (outlined in the next section) and the lagged value approach it necessitates can be reconciled readily with this income-level specification: under the traditional assumption that investment rates are exogenous and constant, steady-state income levels can be derived from rates of investment, population growth, depreciation, and technical change.

While the same ought to hold true for growth rates, the time period under consideration is short enough to be heavily influenced by the business cycle. Furthermore, plausible rates of convergence are estimated to be around 2% per year. Even if US cities were only 10% of the way to their steady states in 1870, at this rate they would now be more than 94% of the way there. Between this likely high degree of convergence and a dataset equipped to handle steady-state analysis, the focus on the steady-state specification is appropriate. The analysis thus focuses on the initial steady-state version.

Both specifications are estimated below to determine the empirical validity of the previously outlined theory, which posited a causal relationship with entrepreneurial capital fueling economic growth.

Chapter Five

The Data

Mankiw et al uses country-level data for their empirical estimation. However, Lucas, Jacobs, Glaeser, and others emphasize the importance of city-level externalities in determining growth, suggesting that the country may not be the relevant economic unit for growth analysis. Economic output of the United States is made up of the economic output of the many states, and the output of each state is made up of the output of its cities and towns. Growth in Manhattan is partially dependent on conditions in the other boroughs, surrounding cities, and nearby metropolitan areas. But is Manhattan influenced more by Seattle's economy than by, say, Toronto's? An open question, perhaps, but one would not be surprised to find that Seattle's economy is more influenced by that of Vancouver, British Columbia, than by that of Manhattan. Country-level analysis suppresses information about sub-national economic dynamics.

The same problem applies to state level analysis among the United States. More than half of the counties in New Jersey, for instance, lie within the Metropolitan Statistical Area of New York City. Treating New Jersey as a separate and distinct economic unit ignores the presumable influence that the much larger New York economy has on that of New Jersey.

Economic units grow within, around, and across political borders. However, data is collected according to political boundaries, and US counties are the elementary unit of economic data reporting. Commuting zones—aggregations of counties constructed using commuting patterns by the Economic Research Service of the United States Department of Agriculture—allow for another interpretation of the elementary economic unit.[2] Because commuting zones aim to be inclusive of factor markets, they can justifiably be modeled as unique economic units. Counties allow for similar treatment on a smaller geographic scale: while many commuters cross county lines, domestic workers comprise a majority of the labor force in most counties.

This paper uses both the county and commuting zone measures. Unlike states or countries, counties and commuting zones are small enough to account for geographically localized determinants of income, such as human and entrepreneurial capital externalities. Also, US locales share similar access to technology, access to education, culture, and institutions—at least relative to the relative heterogeneity of cross-country analysis.

The US Office of Management and Budget categorizes counties as metropolitan, micropolitan, or rural. Because the micropolitan classification was only created recently, past work relied on a simpler distinction between metropolitan and non-metropolitan. Commuting zones take their classification from the largest component county: if one county in a commuting zone is metropolitan, then the entire commuting zone is metropolitan.

Output is measured by personal income per worker. Income and labor force data come from the BEA. Income data—and all other dollar denominated data—is first transformed into real 2007 dollars using the GDP deflator calculated by the BEA. The rate of labor force growth is calculated for each county from BEA data.

Manufacturing capital investment rates are calculated from the new capital expenditures by manufacturing sector firms in 1992, 1997, and 2002—data for which

[2] Both commuting zones and Metropolitan Statistical Areas are aggregations of counties based on commuting patterns. Commuting zones—unlike MSAs—include every county in the country, not just those that include cities or large towns.

comes from the 1992 Census of Manufactures and the 1997 and 2002 Economic Censuses. The investment rates are given by the share of total income: expenditures divided by personal income. The average rate over the three years serves as a proxy for the share of output invested in manufacturing capital. The depreciation rate is calculated for each county from the 1992 Census of Manufactures. Human capital is captured by the total number of bachelor's degree holders divided by the number of employees, as of the 2000 Census. This serves as a proxy for the share of output invested in human capital.

This paper includes nine different measures of entrepreneurial capital to determine the nature of the informational externality. All of the measures look at some aspect of turnover—firm births and deaths. The first four are weighted by employment: $(B+D)/L$; B/L; D/L; and $B/L \text{ and } D/L$, where $B = Births$, $D = Deaths$, and $L = employment$. Despite similarities, the first and fourth measures are subtly but crucially distinct: the first measure assumes that a marginal firm birth and a marginal firm death have identical impacts on entrepreneurial capital while the fourth has a separate term for each to capture divergent impacts.[3]

The next four measures are instead weighted by firm: $(B+D)/F$; B/F; D/F; and $B/F \text{ and } D/F$. The final measure is simply B/D, which assumes an inverse impact of births and deaths on entrepreneurial capital. Each measure is intended to serve as a proxy for the share of output invested in entrepreneurial capital. Firm dynamics data comes from the Census Department.[4]

---

[3] Of course, the fourth measure necessitates an additional structural parameter. The basic model therefore becomes $Y = K^{\alpha}H^{\beta}(B/L)^{\gamma}(D/L)^{\zeta}(AL)^{1-\alpha-\beta-\gamma-\zeta}$. The interpretation of the results remains unchanged.

[4] Because the specification deals in elasticities, the entrepreneurial or human capital measures do not have to be precise estimates of investment rates: as Mankiw et al show, it is enough that they are linear transformations with the same intercept—assumed here to be zero.

To account for potential endogeneity, this paper uses lagged values of the explanatory variables as regressors. Specifically, the output share estimates come from capital investment data between the years of 1990 and 2002. Income growth per worker is measured from the years 2003 to 2007, and is presented as a compound annual average growth rate. The particular time period—2003 to 2007—was chosen to minimize the impact of the business cycle on the data while still ensuring a large number of entrepreneurial capital observations, for which data is only readily available from 1998 onward. The firm birth and death counts are given by total firm activity for the period 1998-2002. The employment-weighted measures use average employment during this period; the firm-weighted measures use the number of established firms in 1998. Manufacturing and human capital figures are already calculated over lagged periods.

There are 3,141 counties and county equivalents, including a number of independent cities that are largely integrated with the surrounding counties. Upon aggregating the independent cities with surrounding counties, there are 3,111 counties. Of these, 3,082 are used in the county sample. Four counties' borders were redrawn to create a new county in 2003 and are not in the regression analysis, while another twenty-four counties have negative implied rates investment or growth. Because the model calls for taking the natural logs of these rates, the regression analysis excludes these counties. Of the twenty-nine dropped counties, seven are metropolitan (including the five with new borders), five are micropolitan, and seventeen are rural. The ERS aggregates the 3,111 counties into 709 commuting zones, all of which are included in the analysis. The counties excluded due to redrawn boundaries belong to the same commuting zone, allowing their inclusion.

Table One presents summary statistics of the data for counties; Table Two presents the same for commuting zones. The summary statistics only include the counties used in the analysis. Dollar values are in 2007 dollars. The employment-weighted measures are in firms per thousand workers; firm-weighted are per single firm. Income growth is the compound average annual growth rate from 2003 to 2007.

Table One (a)
Summary Statistics for Counties

Variable	All Counties		Metro Counties		Non-Metro Counties	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
2007 Income	$60,934	$15,029	$69,309	$18,088	$56,383	$10,655
2003 Income	$59,714	$14,228	$67,554	$17,051	$55,452	$10,214
Income growth	0.5%	1.6%	0.6%	1.5%	0.4%	1.6%
B/L	22.2	7.1	23.3	7.1	21.7	6.9
D/L	21.7	5.7	21.5	5.5	21.8	5.8
B/F	0.61	0.16	0.67	0.17	0.57	0.15
D/F	0.59	0.12	0.61	0.11	0.58	0.12
Population growth rate	0.4%	2.0%	1.3%	2.1%	0.0%	1.8%
Depreciation rate	6.8%	0.8%	6.8%	0.8%	6.7%	0.8%
Degree Share	20.9	8.1	25.8	9.7	18.3	5.5
Capital Share	2.2%	3.0%	2.3%	3.3%	2.1%	2.8%
Number of Counties	3,082	--	1,074	--	2,008	--

Table One (b)
Summary Statistics for Counties (continued)

Variables	Micro Counties		Town Counties	
	Mean	Std. Dev.	Mean	Std. Dev.
2007 Income	$57,051	$10,920	$56,044	$10,505
2003 Income	$55,772	$10,363	$55,290	$10,138
Income growth	0.6%	1.3%	0.3%	1.7%
B/L	21.0	6.5	22.0	7.1
D/L	20.6	5.2	22.5	6.0
B/F	0.57	0.13	0.57	0.16
D/F	0.56	0.10	0.58	0.12
Population growth rate	0.2%	1.7%	-0.2%	1.8%
Depreciation rate	6.8%	0.9%	6.7%	0.8%
Degree Share	19.3	5.8	17.8	5.2
Capital Share	2.5%	2.4%	1.9%	3.0%
Number of Counties	678	--	1,330	--

Table Two (a)
Summary Statistics for Commuting Zones

Variables	All CZs		Metro CZs		Non-Metro CZs	
	Mean	Std. Dev.	Mean	Std Dev	Mean	Std. Dev.
2007 Income	$55,582	$8,269	$59,428	$8,931	$52,425	$6,087
2003 Income	$54,316	$7,382	$57,700	$7,942	$51,539	$5,518
Income growth	0.5%	1.1%	0.7%	0.9%	0.4%	1.3%
B/L	22.1	5.8	21.7	4.9	22.4	6.5
D/L	21.5	4.7	20.3	3.6	22.4	5.2
B/F	0.60	0.13	0.63	0.13	0.57	0.13
D/F	0.58	0.09	0.59	0.08	0.57	0.10
Population growth rate	0.4%	1.2%	0.8%	1.0%	0.0%	1.2%
Depreciation rate	6.8%	0.9%	6.9%	0.8%	6.7%	1.0%
Degree Share	20.5	5.7	23.2	5.7	18.4	4.7
Capital Share	2.1%	1.8%	2.4%	1.7%	1.8%	1.8%
Number of CZs	709	--	316	--	393	--

Table Two (b)
Summary Statistics for Commuting Zones (continued)

Table Two (b)	Micro CZs		Town CZs	
	Mean	Std. Dev.	Mean	Std. Dev.
2007 Income	$53,514	$5,215	$51,090	$6,790
2003 Income	$52,168	$4,822	$50,768	$6,195
Income growth	0.64%	1.04%	0.13%	1.46%
B/L	21.5	5.2	23.6	7.6
D/L	21.2	3.9	23.9	6.1
B/F	0.57	0.11	0.58	0.15
D/F	0.56	0.08	0.58	0.12
Population growth rate	0.11%	1.14%	-0.04%	1.33%
Depreciation rate	6.75%	0.95%	6.58%	1.03%
Degree Share	18.8	4.5	18.0	4.8
Capital Share	2.15%	1.53%	1.39%	1.95%
Number of CZs	216	--	177	--

Chapter Six

Summary of Predictions

The theory developed previously generates an array of hypotheses with regards to the signs of the many variables, as well as their relative magnitudes between metropolitan, micropolitan, and town-based regions, and between counties and commuting zones. This section discusses the various predictions and provides a summary table.

Due to the positive external effects of entrepreneurship elucidated previously, the parameter on entrepreneurial capital ought to be positive in all cases. Furthermore, the parameter ought to be larger in cities. This is partially due to scale effects: cities have more people to take advantage of increased information. Cities also offer easy access to the legal, financial and other services that entrepreneurs require. Finally, urban labor markets are thicker, so successful entrepreneurs can more readily find employee matches to sustain their new firms. While the marginal increase in information from a new firm is likely to be greater in a thin rural market than in a city, the ability of urban entrepreneurs to capitalize on this information implies that the parameter will likely be larger for metropolitan areas than non-metropolitan areas, and larger for micropolitan areas than towns.

The relative magnitude of the estimates for counties and commuting zones depend on the extent of the informational spillovers of entrepreneurial activity. Do entrepreneurs in Queens learn from the actions of entrepreneurs in Brooklyn? Henderson and Weiler found that entrepreneurship has a stronger effect in its own county than surrounding counties, and the hypothesis here follows this: the parameter ought to be larger for counties than for commuting zones. Entrepreneurs in Queens do learn from those in Brooklyn, but they glean more information from other entrepreneurs in Queens.

Both theory and empirical evidence suggest that the exponent on human capital ought to be positive in all cases. Acs et al provide theoretical justification and Hammond and Thompson provide empirical evidence that human capital is more productive in metropolitan areas than non-metropolitan. Human capital is associated with geographically-localized knowledge spillovers, and again, large dense urban places take advantage of these spillovers better than sparsely populated rural areas. While human capital spillovers manifest at a variety of distances, many are highly localized and do not reach beyond neighborhoods or cities, and thus ought to be stronger for counties than entire commuting zones (Fu 2007). The human capital parameter thus ought to be positive in all cases, larger in metropolitan areas than micropolitan, larger for micropolitan areas than towns, and larger for counties than commuting zones.

For physical capital, the Cobb-Douglas exponent should be positive. However, this dataset only measures manufacturing capital investment, for which there are structural differences between metropolitan and non-metropolitan areas. While the share of workers employed in the manufacturing sector has decreased across the country, the decrease has been more drastic in metropolitan areas. Accordingly, Hammond and Thompson find that manufacturing investment enters positively in non-metropolitan areas, but negatively (though without significance) in metropolitan areas. Similar results are expected here: manufacturing investment should impact income negatively in metropolitan areas and positively in rural areas, with micropolitan areas likely somewhere in between. Manufacturing capital—unlike entrepreneurial and human capital—has no external effects. Accordingly, the county and commuting zone estimates should be the same.

Finally, this paper presents two specifications: one which assumes that economies are at their steady states and one that relaxes this assumption. The null hypothesis is that $y(0)$, the initial income term, will have a zero coefficient. The alternative hypothesis of a negative coefficient means that initial income affects the rate of income growth and implies that economies are converging to their steady states. As discussed previously, a rejection of the null does not mean the steady-state model is wrong: a high degree of convergence would mean that the steady-state model is "close enough".

Table Three presents these hypotheses. The predicted outcomes are always represented by the alternative hypothesis, H_a. The expected signs for metropolitan and non-metropolitan areas only diverge for manufacturing capital; all other parameters are expected to have the same sign. The metropolitan, micropolitan, and rural ordering is hypothesized for both county and commuting zone specifications; the county and commuting zone ordering is likewise hypothesized for all three subsets. No prediction is made with regards to the relative magnitude of the $y(0)$ coefficient as there is no reason to presume a systematic difference between types of geographic area.

Table Three
Summary of Hypotheses

Hypotheses	Metro		Micro		Rural		Relative Magnitudes			
Term	H_0	H_a	H_0	H_a	H_0	H_a	County/CZ	Metro	Micro	Rural
α	≥0	<0	≤0	>0	≤0	>0	--	Negative	Middle	Largest
β	≤0	>0	≤0	>0	≤0	>0	County	Largest	Middle	Smallest
γ	≤0	>0	≤0	>0	≤0	>0	County	Largest	Middle	Smallest
$y(0)$	≥0	<0	≥0	<0	≥0	<0	--	--	--	--

While theory does not provide a solid hypothesis for one measure of entrepreneurial capital over the others, the different measures do lend themselves to different interpretations. Measures including firm startups alone in the numerator preclude a role for learning from failed firms, so the differential between a measure with firm deaths and one without can provide insight into the informational "value added" of those deaths. Whereas the simple startup rate measures assume firm deaths to be neutral, the birth to death ratio measure explicitly presumes an inverse relationship between births and deaths. The measure $(B + D)/L$, on the other hand, presumes that the marginal firm birth and death will have identical (and presumably positive) impacts. The relative performance of the full assortment of measures could lend insight into the process of information generation among entrepreneurs.

The other divide amongst the measures is between the employment-weighted and the firm-weighted measures. The high degree of correlation between the two measures suggests that the results should be comparable: after all, the difference is between a denominator with the number of firms and one with the total number of employees at those firms. A systematically better performance by employment-weighted measures would suggest that the propensity of an individual to start a new business is closer to the heart of the matter than mere startup rates. Given that the underlying theoretical model is structured around *individuals* assessing project viability, such a finding could help substantiate the view that entrepreneurial activity provides marketplace information upon which other entrepreneurs can act.

Chapter Seven

Empirical Results

These results explore the relationship between entrepreneurial capital and economic growth across a number of variables. The results are presented as a series of comparisons. After each comparison, the more useful and insightful results are kept so as to narrow the focus for the next comparison.

The first comparison examines the potential for structural differences between different sizes of regional economies: can metropolitan, micropolitan, and town economies be usefully measured together, or does aggregation ignore important information? The aggregated sets—all three subsets together, and the combined non-metropolitan subset—are compared to the three disaggregated subsets, and found wanting: aggregation neglects systematic differences amongst the three subsets. They are thus discarded in favor of examining the three subsets separately.

Continuing with the theme of aggregation, the second comparison analyzes the geographic extent of the entrepreneurial externality: does it function identically in counties and commuting zones, or is it sufficiently localized that the effects are diminished at the aggregative commuting zone level? Entrepreneurial activity has a much greater effect—and the model explains more income deviation—at the county level, upon which the remainder of the analysis focuses.

Third, the steady-state and convergence hypotheses are compared. While both models support the general hypothesis, the steady-state model provides more consistent results and a better fit to the data. While not disproved, the convergence hypothesis is laid aside as the steady-state analysis provides a clearer overall picture of regional economies.

Fourth, the various measures of entrepreneurial capital are compared to explore the nature of the entrepreneurial externality. The employment-weighted measures consistently outperform the firm-weighted measures across all subsets, supporting the view that people—and not firms—are the relevant agents when it comes to learning and acting upon geographically localized knowledge. The results do not provide consistent results sufficient to analyze the differential impacts of firm births and firm deaths. Thus three employment-weighted measures are retained for the remaining section.

Finally, the three types of counties—metropolitan, micropolitan, and town—are compared to explore systematic differences between the three. The data supports the conclusion that entrepreneurial capital has the greatest impact in metropolitan counties, a positive but smaller impact in micropolitan areas, and no impact in town areas.

A technical note before progressing to the results: the model implies that the coefficients sum to zero, but this restriction is rejected in many cases. In fact, it is rejected in all of the steady-state, county-level, employment-weighted results upon which the section has focused. A plausible explanation is that the model assumes exogenous employment growth of rate "n"—a potentially invalid assumption in the context of regional economies, as locations with high incomes can attract mobile workers from lower-income places. In any event, unrestricted versions of these regressions produce largely comparable results. While such versions complicate parameter derivation and interpretation, the results are not substantially different qualitatively or quantitatively. If anything, they support the points made here with even greater parameter differentiation that the restriction suppresses.

Full Results and Subset Aggregation

Tables Four through Seven present the full results, beginning with the county results for the steady-state specification. The first column states the measure of entrepreneurial capital used. Asterisks indicate statistical significance at the 10% level with a two-tailed test.

Table Four (a)
All Counties, Steady State

EC	α	SE	-	β	SE	-	γ	SE	-	ζ	SE	-	$\bar{R}^2$
--	-.02	.00	*	.22	.01	*							.20
(B+D)/L	-.01	.00	*	.26	.01	*	-.05	.02	*				.21
B/L	-.02	.00	*	.24	.01	*	-.03	.02	*				.20
D/L	-.01	.00	*	.27	.01	*	-.06	.02	*				.21
B/L,D/L	-.01	.00	*	.25	.01	*	.17	.03	*	-.21	.04	*	.22
(B+D)/F	-.01	.00	*	.29	.01	*	-.13	.02	*				.23
B/F	-.01	.00	*	.27	.01	*	-.10	.02	*				.22
D/F	-.01	.00	*	.30	.01	*	-.14	.02	*				.24
B/F,D/F	-.01	.00	*	.29	.01	*	.13	.03	*	-.25	.04	*	.25
B/D	.00	.00		.36	.02	*	-.28	.05	*				.29

Metropolitan Counties, Steady State

EC	α	SE	-	β	SE	-	γ	SE	-	ζ	SE	-	$\bar{R}^2$
--	-.05	.01	*	.27	.02	*							.32
(B+D)/L	-.05	.01	*	.18	.02	*	.14	.03	*				.36
B/L	-.05	.01	*	.18	.02	*	.15	.02	*				.36
D/L	-.06	.01	*	.20	.02	*	.11	.03	*				.35
B/L,D/L	-.05	.01	*	.18	.02	*	.25	.06	*	-.11	.07		.37
(B+D)/F	-.05	.01	*	.28	.02	*	-.03	.03					.32
B/F	-.05	.01	*	.27	.02	*	-.01	.03					.32
D/F	-.05	.01	*	.29	.02	*	-.05	.04					.32
B/F,D/F	-.05	.01	*	.28	.02	*	.14	.07	*	-.17	.09	*	.33
B/D	-.04	.01	*	.36	.03	*	-.22	.09	*				.35

Table Four (b)

Micropolitan Counties, Steady State

EC	α	SE	-	β	SE	-	γ	SE	-	ζ	SE	-	$\bar{R}^2$
--	-.02	.01	*	.20	.04	*							.19
(B+D)/L	-.02	.01	*	.14	.03	*	.08	.04	*				.21
B/L	-.02	.01	*	.15	.03	*	.08	.03	*				.21
D/L	-.02	.01	*	.14	.03	*	.09	.04	*				.21
B/L,D/L	-.02	.01	*	.14	.03	*	-.02	.06		.11	.07		.21
(B+D)/F	-.02	.01	*	.21	.04	*	-.02	.03					.19
B/F	-.02	.01	*	.21	.04	*	-.03	.03					.19
D/F	-.02	.01	*	.21	.04	*	-.01	.04					.19
B/F,D/F	-.02	.01	*	.21	.04	*	-.08	.06		.06	.07		.19
B/D	-.01	.01		.27	.04	*	-.15	.07	*				.22

Town Counties, Steady State

EC	α	SE	-	β	SE	-	γ	SE	-	ζ	SE	-	$\bar{R}^2$
--	.01	.00	*	.15	.02	*							.14
(B+D)/L	.01	.00	*	.15	.02	*	.00	.02					.14
B/L	.01	.00	*	.15	.02	*	.00	.02					.14
D/L	.01	.00	*	.15	.02	*	.00	.02					.14
B/L,D/L	.01	.00	*	.15	.02	*	.00	.04		.00	.04		.14
(B+D)/F	.01	.00	*	.19	.02	*	-.06	.03	*				.15
B/F	.01	.00	*	.19	.02	*	-.06	.02	*				.15
D/F	.01	.00	*	.19	.02	*	-.06	.03	*				.15
B/F,D/F	.01	.00	*	.19	.02	*	-.02	.04		-.04	.04		.15
B/D	.02	.00	*	.23	.02	*	-.13	.05	*				.17

Non-Metropolitan Counties, Steady State

EC	α	SE	-	β	SE	-	γ	SE	-	ζ	SE	-	$\bar{R}^2$
--	.00	.00		.16	.02	*							.14
(B+D)/L	.00	.00		.15	.02	*	.01	.02					.14
B/L	.00	.00		.15	.02	*	.01	.02					.14
D/L	.00	.00		.15	.02	*	.01	.02					.14
B/L,D/L	.00	.00		.15	.02	*	.01	.03		.01	.04		.14
(B+D)/F	.00	.00		.20	.02	*	-.06	.02	*				.15
B/F	.00	.00		.20	.02	*	-.05	.02	*				.15
D/F	.00	.00		.20	.02	*	-.06	.02	*				.15
B/F,D/F	.00	.00		.20	.02	*	-.02	.03		-.03	.04		.15
B/D	.01	.00	*	.25	.02	*	-.15	.04	*				.18

Table Five presents the county results for the convergence specification.

Table Five (a)

All Counties, Convergence

EC	α	SE	-	β	SE	-	γ	SE	-	ζ	SE	-	Y(0)	SE	-	$\bar{R}^2$
--	.01	.02		.47	.05	*							-.03	.01	*	.02
(B+D)/L	.01	.02		.47	.09	*	-.01	.10					-.03	.01	*	.02
B/L	.01	.02		.38	.08	*	.11	.09					-.03	.01	*	.02
D/L	.02	.02		.54	.10	*	-.11	.12					-.03	.01	*	.02
B/L,D/L	.02	.02		.40	.07	*	.95	.28	*	-.89	.31	*	-.03	.01	*	.03
(B+D)/F	.01	.02		.41	.08	*	.10	.12					-.03	.01	*	.02
B/F	.01	.02		.33	.07	*	.23	.10	*				-.02	.01	*	.02
D/F	.02	.02		.49	.10	*	-.04	.15					-.03	.01	*	.02
B/F,D/F	.02	.02		.38	.07	*	.96	.30	*	-.85	.35	*	-.03	.01	*	.03
B/D	.02	.02		.49	.14	*	-.05	.27					-.03	.01	*	.02

Metropolitan Counties, Convergence

EC	α	SE	-	β	SE	-	γ	SE	-	ζ	SE	-	Y(0)	SE	-	$\bar{R}^2$
--	-.04	.03		.48	.06	*							-.04	.01	*	.03
(B+D)/L	-.04	.03		.36	.08	*	.15	.09					-.04	.01	*	.03
B/L	-.04	.03		.33	.08	*	.19	.08	*				-.05	.01	*	.03
D/L	-.04	.03		.41	.10	*	.09	.11					-.04	.01	*	.03
B/L,D/L	-.03	.03		.34	.08	*	.60	.37		-.44	.41		-.05	.01	*	.04
(B+D)/F	-.04	.03		.26	.06	*	.40	.09	*				-.04	.01	*	.05
B/F	-.04	.03		.24	.06	*	.41	.08	*				-.04	.01	*	.05
D/F	-.05	.03	*	.29	.07	*	.34	.10	*				-.04	.01	*	.04
B/F,D/F	-.03	.02		.26	.06	*	.64	.35	*	-.26	.37		-.04	.01	*	.05
B/D	-.07	.04	*	.22	.09	*	.53	.17	*				-.03	.01	*	.05

Micropolitan Counties, Convergence

EC	α	SE	-	β	SE	-	γ	SE	-	ζ	SE	-	Y(0)	SE	-	$\bar{R}^2$
--	-.09	.06		.48	.18	*							-.03	.02	*	.03
(B+D)/L	-.08	.05		.19	.13		.35	.16	*				-.04	.02	*	.04
B/L	-.08	.05		.19	.13		.35	.16	*				-.04	.02	*	.04
D/L	-.09	.05		.21	.13		.32	.16	*				-.04	.02	*	.04
B/L,D/L	-.07	.05		.20	.13		.40	.39		-.05	.38		-.04	.02	*	.04
(B+D)/F	-.09	.06		.40	.21	*	.13	.20					-.03	.02	*	.03
B/F	-.09	.06		.39	.19	*	.15	.18					-.03	.02	*	.03
D/F	-.09	.07		.42	.22	*	.10	.22					-.03	.02	*	.03
B/F,D/F	-.08	.06		.41	.21	*	.35	.49		-.22	.57		-.03	.02	*	.03
B/D	-.08	.07		.72	.40	*	-.41	.70					-.04	.02	*	.03

Town Counties, Convergence

EC	α	SE	-	β	SE	-	γ	SE	-	ζ	SE	-	Y(0)	SE	-	$\bar{R}^2$
--	.05	.02	*	.26	.06	*							-.06	.01	*	.03
(B+D)/L	.05	.02	*	.13	.10		.14	.11					-.06	.01	*	.03
B/L	.05	.02	*	.07	.11		.22	.11	*				-.06	.01	*	.03
D/L	.05	.02	*	.21	.10	*	.05	.11					-.06	.01	*	.03
B/L,D/L	.05	.02	*	.17	.10	*	.65	.27	*	-.52	.27	*	-.05	.01	*	.04
(B+D)/F	.05	.02	*	.21	.08	*	.06	.12					-.06	.01	*	.03
B/F	.05	.02	*	.16	.08	*	.15	.11					-.05	.01	*	.03
D/F	.05	.02	*	.28	.08	*	-.03	.13					-.06	.01	*	.03
B/F,D/F	.06	.02	*	.25	.08	*	.62	.28	*	-.58	.32	*	-.05	.01	*	.04
B/D	.05	.02	*	.25	.09	*	.01	.23					-.06	.01	*	.03

Table Five (b)
Non-Metropolitan Counties, Convergence

EC	α	SE	-	β	SE	-	γ	SE	-	ζ	SE	-	Y(0)	SE	-	$\bar{R}^2$
--	.03	.02		.32	.06	*							-.04	.01	*	.02
(B+D)/L	.03	.02		.19	.08	*	.15	.09					-.05	.01	*	.02
B/L	.02	.02		.13	.09		.22	.09	*				-.04	.01	*	.02
D/L	.03	.02		.26	.08	*	.06	.10					-.05	.01	*	.02
B/L,D/L	.03	.02	*	.22	.08	*	.75	.28	*	-.60	.28	*	-.04	.01	*	.03
(B+D)/F	.03	.02		.30	.08	*	.03	.12					-.04	.01	*	.02
B/F	.03	.02		.23	.08	*	.13	.11					-.04	.01	*	.02
D/F	.03	.02		.36	.09	*	-.06	.14					-.05	.01	*	.02
B/F,D/F	.03	.02	*	.33	.08	*	.71	.29	*	-.68	.34	*	-.04	.01	*	.03
B/D	.04	.02	*	.39	.12	*	-.13	.26					-.05	.01	*	.02

Table Six presents the commuting zone results for the steady-state specification.

Table Six (a)
All Commuting Zones, Steady State

EC	α	SE	-	β	SE	-	γ	SE	-	ζ	SE	-	$\bar{R}^2$
--	.00	.00		.16	.02	*							.12
(B+D)/L	.00	.01		.24	.02	*	-.13	.03	*				.18
B/L	.00	.01		.23	.02	*	-.11	.03	*				.16
D/L	.00	.01		.25	.02	*	-.14	.03	*				.20
B/L,D/L	.00	.00		.23	.02	*	.19	.07	*	-.30	.08	*	.22
(B+D)/F	.00	.00		.25	.03	*	-.18	.04	*				.19
B/F	.00	.01		.23	.02	*	-.13	.03	*				.16
D/F	.00	.00		.26	.03	*	-.19	.04	*				.21
B/F,D/F	.00	.00		.24	.02	*	.20	.07	*	-.35	.10	*	.23
B/D	.01	.01	*	.33	.04	*	-.37	.14	*				.27

Metropolitan Commuting Zones, Steady State

EC	α	SE	-	β	SE	-	γ	SE	-	ζ	SE	-	$\bar{R}^2$
--	-.05	.01	*	.20	.03	*							.27
(B+D)/L	-.05	.01	*	.21	.03	*	-.03	.04					.27
B/L	-.05	.01	*	.21	.03	*	-.03	.04					.27
D/L	-.05	.01	*	.21	.03	*	-.02	.04					.27
B/L,D/L	-.05	.01	*	.21	.03	*	-.04	.11		.01	.12		.27
(B+D)/F	-.05	.01	*	.23	.03	*	-.09	.05					.28
B/F	-.05	.01	*	.23	.03	*	-.08	.05	*				.28
D/F	-.05	.01	*	.23	.03	*	-.08	.06					.28
B/F,D/F	-.05	.01	*	.23	.03	*	-.05	.11		-.03	.13		.28
B/D	-.03	.01	*	.35	.06	*	-.43	.20	*				.36

Table Six (b)

Micropolitan Commuting Zones, Steady State

EC	α	SE	-	β	SE	-	γ	SE	-	ζ	SE	-	$\bar{R}^2$
--	-.01	.01		.08	.03	*							.04
(B+D)/L	-.01	.01		.05	.03		.05	.05					.05
B/L	-.01	.01		.06	.03	*	.04	.04					.04
D/L	-.01	.01		.04	.03		.07	.05					.06
B/L,D/L	-.01	.01	*	.03	.03		-.14	.08	*	.20	.09	*	.08
(B+D)/F	-.01	.01		.08	.03	*	-.01	.05					.04
B/F	-.01	.01		.09	.03	*	-.02	.04					.04
D/F	-.01	.01		.07	.03	*	.01	.05					.04
B/F,D/F	-.01	.01	*	.07	.03	*	-.17	.09	*	.17	.10	*	.06
B/D	.00	.01		.13	.03	*	-.13	.10					.07

Town Commuting Zones, Steady State

EC	α	SE	-	β	SE	-	γ	SE	-	ζ	SE	-	$\bar{R}^2$
--	.00	.01		.12	.06	*							.08
(B+D)/L	.00	.01		.15	.07	*	-.03	.05					.08
B/L	.00	.01		.10	.07		.01	.04					.08
D/L	.01	.01		.18	.07	*	-.06	.05					.09
B/L,D/L	.01	.01		.15	.06	*	.22	.11	*	-.25	.13	*	.12
(B+D)/F	.01	.01		.21	.06	*	-.14	.06	*				.14
B/F	.00	.01		.19	.06	*	-.10	.05	*				.11
D/F	.01	.01		.22	.06	*	-.16	.06	*				.16
B/F,D/F	.01	.01		.21	.05	*	.17	.12		-.31	.15	*	.18
B/D	.01	.01		.20	.06	*	-.14	.17					.10

Non-Metropolitan Commuting Zones, Steady State

EC	α	SE	-	β	SE	-	γ	SE	-	ζ	SE	-	$\bar{R}^2$
--	.01	.01		.10	.04	*							.07
(B+D)/L	.01	.01		.11	.04	*	-.01	.03					.07
B/L	.01	.01		.10	.03	*	.01	.03					.07
D/L	.01	.01		.12	.04	*	-.02	.03					.07
B/L,D/L	.01	.01		.11	.03	*	.12	.08		-.13	.10		.08
(B+D)/F	.01	.01		.16	.04	*	-.10	.04	*				.10
B/F	.01	.01		.14	.04	*	-.07	.04	*				.09
D/F	.01	.01		.16	.04	*	-.10	.05	*				.11
B/F,D/F	.01	.01	*	.16	.03	*	.08	.09		-.17	.11		.11
B/D	.01	.01	*	.18	.03	*	-.15	.12					.10

Table Seven presents the convergence specification for commuting zones.

Table Seven (a)

All Commuting Zones, Convergence

EC	α	SE	-	β	SE	-	γ	SE	-	ζ	SE	-	Y(0)	SE	-	$\bar{R}^2$
--	-1.37	14.6		10.35	105.0								.02	.02		.03
(B+D)/L	-.90	6.3		7.94	51.7		-2.14	15.2					.01	.02		.03
B/L	-1.40	15.5		10.39	110.1		.38	5.2					.02	.02		.03
D/L	-.52	2.2		5.36	20.2		-2.35	9.8					.01	.02		.03
B/L,D/L	-.07	.14		1.21	1.1		4.49	5.4		-4.53	5.63		.00	.02		.07
(B+D)/F	-1.34	14.7		9.64	101.3		.88	9.1					.02	.02		.03
B/F	-.73	4.5		3.92	21.5		3.52	20.0					.02	.02		.03
D/F	-1.00	9.1		9.71	83.8		-3.47	32.7					.01	.02		.03
B/F,D/F	-.07	.15		1.06	1.1		4.64	6.1		-4.39	6.12		.01	.02		.07
B/D	-1.03	13.5		12.60	162.1		-6.20	88.2					.01	.02		.03

Metropolitan Commuting Zones, Convergence

EC	α	SE	-	β	SE	-	γ	SE	-	ζ	SE	-	Y(0)	SE	-	$\bar{R}^2$
--	.81	.97		-.28	.85								.01	.02		.12
(B+D)/L	1.24	2.6		-.18	1.1		-.89	2.6					.01	.02		.12
B/L	1.28	2.8		-.20	1.2		-.95	2.7					.01	.02		.12
D/L	1.18	2.4		-.16	1.0		-.77	2.3					.01	.02		.12
B/L,D/L	1.28	2.9		-.19	1.2		-.76	3.1		-.18	3.31		.01	.02		.12
(B+D)/F	5.82	59.2		1.17	10.5		-11.8	124.5					.02	.02		.14
B/F	6.18	67.2		.81	7.6		-12.4	138.1					.02	.02		.14
D/F	3.56	21.8		.80	4.3		-6.69	43.6					.02	.02		.14
B/F,D/F	5.65	58.8		1.21	11.1		-4.99	50.8		-6.51	75.21		.02	.02		.13
B/D	1.07	2.6		-.11	.8		-.88	4.2					.01	.02		.12

Micropolitan Commuting Zones, Convergence

EC	α	SE	-	β	SE	-	γ	SE	-	ζ	SE	-	Y(0)	SE	-	$\bar{R}^2$
--	-.20	.21		.21	.20								-.06	.04		.07
(B+D)/L	-.16	.15		.01	.18		.29	.31					-.06	.04		.08
B/L	-.15	.14		-.01	.19		.34	.32					-.06	.04		.09
D/L	-.17	.17		.06	.18		.21	.29					-.06	.04		.07
B/L,D/L	-.15	.18		.07	.19		1.11	1.28		-.79	1.14		-.05	.05		.09
(B+D)/F	-.19	.19		.10	.18		.20	.34					-.06	.05		.07
B/F	-.19	.19		.07	.18		.27	.34					-.06	.05		.08
D/F	-.20	.21		.14	.18		.11	.34					-.06	.04		.07
B/F,D/F	-.19	.24		.18	.21		1.21	1.61		-1.00	1.55		-.04	.05		.09
B/D	-.19	.22		.33	.31		-.28	.87					-.06	.05		.07

Town Commuting Zones, Convergence

EC	α	SE	-	β	SE	-	γ	SE	-	ζ	SE	-	Y(0)	SE	-	$\bar{R}^2$
--	.05	.05		.64	.35	*							-.02	.04		.04
(B+D)/L	.06	.05		.98	.63		-.35	.40					-.02	.04		.04
B/L	.05	.05		.76	.52		-.12	.30					-.02	.04		.04
D/L	.06	.05		1.11	.67	*	-.51	.47					-.03	.04		.06
B/L,D/L	.06	.04		.83	.43	*	.96	.82		-1.28	1.03		-.04	.04		.08
(B+D)/F	.05	.05		.67	.40	*	-.05	.32					-.02	.04		.04
B/F	.05	.05		.55	.34		.14	.30					-.02	.04		.04
D/F	.05	.05		.75	.43	*	-.21	.39					-.03	.04		.04
B/F,D/F	.05	.04		.55	.27	*	1.09	.96		-1.13	1.13		-.04	.04		.07
B/D	.04	.06		.49	.47		.22	.63					-.02	.04		.04

Table Seven (b)
Non-Metropolitan Commuting Zones, Convergence

EC	α	SE	-	β	SE	-	γ	SE	-	ζ	SE	-	Y(0)	SE	-	$\bar{R}^2$
--	.01	.04		.56	.30	*							-.02	.03		.02
(B+D)/L	.01	.05		.66	.43		-.11	.27					-.02	.03		.02
B/L	.01	.04		.45	.30		.11	.21					-.02	.03		.02
D/L	.02	.05		.86	.58		-.33	.40					-.02	.03		.02
B/L,D/L	.04	.04		.62	.35	*	1.74	1.29		-1.84	1.44		-.03	.03		.07
(B+D)/F	.02	.05		.61	.36	*	-.10	.32					-.03	.03		.02
B/F	.01	.04		.47	.28	*	.15	.27					-.02	.03		.02
D/F	.02	.04		.74	.45		-.32	.44					-.03	.03		.02
B/F,D/F	.04	.04		.57	.29	*	1.73	1.30		-1.79	1.48		-.03	.03		.07
B/D	.02	.05		.68	.53		-.20	.78					-.03	.03		.02

The first pattern to highlight is the greater explanatory power of the disaggregated subsets. The $\bar{R}^2$ measures are greater for the metropolitan subset than the entire set in every case. Amongst the non-metropolitan areas, the $\bar{R}^2$ measures for the disaggregated subsets are comparable to or greater than the combined set in most cases. Furthermore, many parameter estimates are highly distinct between the subsets, including many with opposing signs in metropolitan and town areas; even the cases with no added explanatory power thus support disaggregation. The three disaggregated subsets provide the most complete and accurate picture of the functioning of local economies. The aggregated sets are therefore discarded and the remainder of the analysis will focus on the disaggregated subsets: metropolitan, micropolitan, and town.

Counties and Commuting Zones

Aggregating all types of counties together produces less accurate results than disaggregation by population. This section focuses on another type of aggregation: do commuting zones—aggregations of counties—behave identically to their component counties? Theory suggests that the human and entrepreneurial capital externalities will promote growth in the county in which they occur, but that the geographic limitations of these externalities mean the benefits will not spill over to neighboring counties—or, at least, not to the same degree. The results support this supposition: commuting zones are, in fact, *less* than the sum of their parts.

Tables Eight and Nine reproduce the previous results to highlight this comparison: Table Eight provides the steady-state results while Table Nine provides the convergence results.

Table Eight (a)

Metropolitan Counties, Steady State

EC	α	SE	-	β	SE	-	γ	SE	-	ζ	SE	-	$\bar{R}^2$
--	-.05	.01	*	.27	.02	*							.32
(B+D)/L	-.05	.01	*	.18	.02	*	.14	.03	*				.36
B/L	-.05	.01	*	.18	.02	*	.15	.02	*				.36
D/L	-.06	.01	*	.20	.02	*	.11	.03	*				.35
B/L,D/L	-.05	.01	*	.18	.02	*	.25	.06	*	-.11	.07		.37
(B+D)/F	-.05	.01	*	.28	.02	*	-.03	.03					.32
B/F	-.05	.01	*	.27	.02	*	-.01	.03					.32
D/F	-.05	.01	*	.29	.02	*	-.05	.04					.32
B/F,D/F	-.05	.01	*	.28	.02	*	.14	.07	*	-.17	.09	*	.33
B/D	-.04	.01	*	.36	.03	*	-.22	.09	*				.35

Metropolitan Commuting Zones, Steady State

EC	α	SE	-	β	SE	-	γ	SE	-	ζ	SE	-	$\bar{R}^2$
--	-.05	.01	*	.20	.03	*							.27
(B+D)/L	-.05	.01	*	.21	.03	*	-.03	.04					.27
B/L	-.05	.01	*	.21	.03	*	-.03	.04					.27
D/L	-.05	.01	*	.21	.03	*	-.02	.04					.27
B/L,D/L	-.05	.01	*	.21	.03	*	-.04	.11		.01	.12		.27
(B+D)/F	-.05	.01	*	.23	.03	*	-.09	.05					.28
B/F	-.05	.01	*	.23	.03	*	-.08	.05	*				.28
D/F	-.05	.01	*	.23	.03	*	-.08	.06					.28
B/F,D/F	-.05	.01	*	.23	.03	*	-.05	.11		-.03	.13		.28
B/D	-.03	.01	*	.35	.06	*	-.43	.20	*				.36

Table Eight (b)

Micropolitan Counties, Steady State

EC	α	SE	-	β	SE	-	γ	SE	-	ζ	SE	-	$\bar{R}^2$
--	-.02	.01	*	.20	.04	*							.19
(B+D)/L	-.02	.01	*	.14	.03	*	.08	.04	*				.21
B/L	-.02	.01	*	.15	.03	*	.08	.03	*				.21
D/L	-.02	.01	*	.14	.03	*	.09	.04	*				.21
B/L,D/L	-.02	.01	*	.14	.03	*	-.02	.06		.11	.07		.21
(B+D)/F	-.02	.01	*	.21	.04	*	-.02	.03					.19
B/F	-.02	.01	*	.21	.04	*	-.03	.03					.19
D/F	-.02	.01	*	.21	.04	*	-.01	.04					.19
B/F,D/F	-.02	.01	*	.21	.04	*	-.08	.06		.06	.07		.19
B/D	-.01	.01		.27	.04	*	-.15	.07	*				.22

Micropolitan Commuting Zones, Steady State

EC	α	SE	-	β	SE	-	γ	SE	-	ζ	SE	-	$\bar{R}^2$
--	-.01	.01		.08	.03	*							.04
(B+D)/L	-.01	.01		.05	.03		.05	.05					.05
B/L	-.01	.01		.06	.03	*	.04	.04					.04
D/L	-.01	.01		.04	.03		.07	.05					.06
B/L,D/L	-.01	.01	*	.03	.03		-.14	.08	*	.20	.09	*	.08
(B+D)/F	-.01	.01		.08	.03	*	-.01	.05					.04
B/F	-.01	.01		.09	.03	*	-.02	.04					.04
D/F	-.01	.01		.07	.03	*	.01	.05					.04
B/F,D/F	-.01	.01	*	.07	.03	*	-.17	.09	*	.17	.10	*	.06
B/D	.00	.01		.13	.03	*	-.13	.10					.07

Town Counties, Steady State

EC	α	SE	-	β	SE	-	γ	SE	-	ζ	SE	-	$\bar{R}^2$
--	.01	.00	*	.15	.02	*							.14
(B+D)/L	.01	.00	*	.15	.02	*	.00	.02					.14
B/L	.01	.00	*	.15	.02	*	.00	.02					.14
D/L	.01	.00	*	.15	.02	*	.00	.02					.14
B/L,D/L	.01	.00	*	.15	.02	*	.00	.04		.00	.04		.14
(B+D)/F	.01	.00	*	.19	.02	*	-.06	.03	*				.15
B/F	.01	.00	*	.19	.02	*	-.06	.02	*				.15
D/F	.01	.00	*	.19	.02	*	-.06	.03	*				.15
B/F,D/F	.01	.00	*	.19	.02	*	-.02	.04		-.04	.04		.15
B/D	.02	.00	*	.23	.02	*	-.13	.05	*				.17

Town Commuting Zones, Steady State

EC	α	SE	-	β	SE	-	γ	SE	-	ζ	SE	-	$\bar{R}^2$
--	.00	.01		.12	.06	*							.08
(B+D)/L	.00	.01		.15	.07	*	-.03	.05					.08
B/L	.00	.01		.10	.07		.01	.04					.08
D/L	.01	.01		.18	.07	*	-.06	.05					.09
B/L,D/L	.01	.01		.15	.06	*	.22	.11	*	-.25	.13	*	.12
(B+D)/F	.01	.01		.21	.06	*	-.14	.06	*				.14
B/F	.00	.01		.19	.06	*	-.10	.05	*				.11
D/F	.01	.01		.22	.06	*	-.16	.06	*				.16
B/F,D/F	.01	.01		.21	.05	*	.17	.12		-.31	.15	*	.18
B/D	.01	.01		.20	.06	*	-.14	.17					.10

The $\bar{R}^2$ measures are a good starting point, and are generally higher for counties than commuting zones. The divergence is strongest for micropolitan areas—the county model clearly explains more deviation. The metropolitan and town subsets are not as definitive, but the county model still explains somewhat more deviation. The parameter estimates provide more evidence.

First, human capital: the parameter estimates support the notion of localized externalities. For the case without entrepreneurial capital, the human capital parameter is larger in metropolitan counties than commuting zones by a statistically significant amount; there is no overlap of one-tailed 90% confidence intervals. The inclusion of entrepreneurial capital diminishes the effect of human capital so that the county and commuting zone parameters are not statistically distinguishable.

The inclusion of entrepreneurship does not have the same effect at the micropolitan level: the human capital parameter is statistically larger for counties than commuting zones in all specifications. The town level does not provide this differentiation, but past work has suggested that human capital is less productive in places of lower population—so human capital is not particularly productive in town commuting zones, but rather is particularly unproductive in town counties. The human capital results suggest that the county level might be ideal, but the case is not closed.

Regardless of its effect on human capital parameters, the addition of entrepreneurial capital provides further evidence. For metropolitan commuting zones, the entrepreneurial capital parameter is negative in all cases, and significantly so in some. Meanwhile, the parameter is positive and significant in five cases at the county level.

Furthermore, there is no confidence interval overlap for any of the employment-weighted measures. The firm-weighted measures do not fully support this story, but neither do they reject it. Later results—and previously discussed theory—highlight the primacy of the employment-weighted measures, further supporting the view that entrepreneurial externalities are heavily localized, and that these externalities matter for growth.

A further point of support for the county over the commuting zone is provided by manufacturing capital. In this case, there is no statistical differentiation and little differentiation of any kind: the results are nearly identical for counties and commuting zones. Unlike human and entrepreneurial capital, manufacturing capital does not have geographically localized externalities, and therefore investment ought to have the same impact in counties as in county aggregates like commuting zones. Its consistency between the two geographic levels only highlights the divergent results for human capital, entrepreneurial capital, and the $\bar{R}^2$ measure.

The case is less clear for micropolitan and town counties, but still supports the county-level version. The entrepreneurial capital parameter values are larger for the county level in most cases, although not with statistical significance. Again, the $\bar{R}^2$ measures are mostly larger for counties; the measure is approximately four times larger for micropolitan counties. And, like human capital, there is theoretical support for the notion that entrepreneurial capital will be more effective at the metropolitan level; differentiation in non-metropolitan places is less expected.

While the evidence is slimmer for the non-metropolitan subsets, the greater explanatory power and suggestive parameter results for the county level are enough to support a focus on counties in the steady-state specification. The convergence specification results amplify this support; Table Nine shows these results.

Table Nine (a)

Metropolitan Counties, Convergence

EC	α	SE	-	β	SE	-	γ	SE	-	ζ	SE	-	Y(0)	SE	-	$\bar{R}^2$
--	-.04	.03		.48	.06	*							-.04	.01	*	.03
(B+D)/L	-.04	.03		.36	.08	*	.15	.09					-.04	.01	*	.03
B/L	-.04	.03		.33	.08	*	.19	.08	*				-.05	.01	*	.03
D/L	-.04	.03		.41	.10	*	.09	.11					-.04	.01	*	.03
B/L,D/L	-.03	.03		.34	.08	*	.60	.37		-.44	.41		-.05	.01	*	.04
(B+D)/F	-.04	.03		.26	.06	*	.40	.09	*				-.04	.01	*	.05
B/F	-.04	.03		.24	.06	*	.41	.08	*				-.04	.01	*	.05
D/F	-.05	.03	*	.29	.07	*	.34	.10	*				-.04	.01	*	.04
B/F,D/F	-.03	.02		.26	.06	*	.64	.35	*	-.26	.37		-.04	.01	*	.05
B/D	-.07	.04	*	.22	.09	*	.53	.17	*				-.03	.01	*	.05

Metropolitan Commuting Zones, Convergence

EC	α	SE	-	β	SE	-	γ	SE	-	ζ	SE	-	Y(0)	SE	-	$\bar{R}^2$
--	.81	.97		-.28	.85								.01	.02		.12
(B+D)/L	1.24	2.6		-.18	1.1		-.89	2.6					.01	.02		.12
B/L	1.28	2.8		-.20	1.2		-.95	2.7					.01	.02		.12
D/L	1.18	2.4		-.16	1.0		-.77	2.3					.01	.02		.12
B/L,D/L	1.28	2.9		-.19	1.2		-.76	3.1		-.18	3.31		.01	.02		.12
(B+D)/F	5.82	59.2		1.17	10.5		-11.8	124.5					.02	.02		.14
B/F	6.18	67.2		.81	7.6		-12.4	138.1					.02	.02		.14
D/F	3.56	21.8		.80	4.3		-6.69	43.6					.02	.02		.14
B/F,D/F	5.65	58.8		1.21	11.1		-4.99	50.8		-6.51	75.21		.02	.02		.13
B/D	1.07	2.6		-.11	.8		-.88	4.2					.01	.02		.12

At first glance, the convergence specification seems to favor commuting zones. For the metropolitan subset, the $\bar{R}^2$ measures are larger for commuting zones than counties. However, the parameter estimates provide a wildly different story. Not only is the initial income term not statistically significant for any commuting zone subset, but the term is *positive* for metropolitan commuting zones: all else equal, metropolitan commuting zones with higher incomes tend to grow faster. Of course, this atheoretic result is statistically insignificant—and past work focusing on earlier time periods found that metropolitan commuting zones are converging. This finding surely supports the view that the commuting zone does not provide the most accurate, useful model.

Table Nine (b)

Micropolitan Counties, Convergence

EC	α	SE	-	β	SE	-	γ	SE	-	ζ	SE	-	Y(0)	SE	-	$\bar{R}^2$
--	-.09	.06		.48	.18	*							-.03	.02	*	.03
(B+D)/L	-.08	.05		.19	.13		.35	.16	*				-.04	.02	*	.04
B/L	-.08	.05		.19	.13		.35	.16	*				-.04	.02	*	.04
D/L	-.09	.05		.21	.13		.32	.16	*				-.04	.02	*	.04
B/L,D/L	-.07	.05		.20	.13		.40	.39		-.05	.38		-.04	.02	*	.04
(B+D)/F	-.09	.06		.40	.21	*	.13	.20					-.03	.02	*	.03
B/F	-.09	.06		.39	.19	*	.15	.18					-.03	.02	*	.03
D/F	-.09	.07		.42	.22	*	.10	.22					-.03	.02	*	.03
B/F,D/F	-.08	.06		.41	.21	*	.35	.49		-.22	.57		-.03	.02	*	.03
B/D	-.08	.07		.72	.40	*	-.41	.70					-.04	.02	*	.03

Micropolitan Commuting Zones, Convergence

EC	α	SE	-	β	SE	-	γ	SE	-	ζ	SE	-	Y(0)	SE	-	$\bar{R}^2$
--	-.20	.21		.21	.20								-.06	.04		.07
(B+D)/L	-.16	.15		.01	.18		.29	.31					-.06	.04		.08
B/L	-.15	.14		-.01	.19		.34	.32					-.06	.04		.09
D/L	-.17	.17		.06	.18		.21	.29					-.06	.04		.07
B/L,D/L	-.15	.18		.07	.19		1.11	1.28		-.79	1.14		-.05	.05		.09
(B+D)/F	-.19	.19		.10	.18		.20	.34					-.06	.05		.07
B/F	-.19	.19		.07	.18		.27	.34					-.06	.05		.08
D/F	-.20	.21		.14	.18		.11	.34					-.06	.04		.07
B/F,D/F	-.19	.24		.18	.21		1.21	1.61		-1.00	1.55		-.04	.05		.09
B/D	-.19	.22		.33	.31		-.28	.87					-.06	.05		.07

Town Counties, Convergence

EC	α	SE	-	β	SE	-	γ	SE	-	ζ	SE	-	Y(0)	SE	-	$\bar{R}^2$
--	.05	.02	*	.26	.06	*							-.06	.01	*	.03
(B+D)/L	.05	.02	*	.13	.10		.14	.11					-.06	.01	*	.03
B/L	.05	.02	*	.07	.11		.22	.11	*				-.06	.01	*	.03
D/L	.05	.02	*	.21	.10	*	.05	.11					-.06	.01	*	.03
B/L,D/L	.05	.02	*	.17	.10	*	.65	.27	*	-.52	.27	*	-.05	.01	*	.04
(B+D)/F	.05	.02	*	.21	.08	*	.06	.12					-.06	.01	*	.03
B/F	.05	.02	*	.16	.08	*	.15	.11					-.05	.01	*	.03
D/F	.05	.02	*	.28	.08	*	-.03	.13					-.06	.01	*	.03
B/F,D/F	.06	.02	*	.25	.08	*	.62	.28	*	-.58	.32	*	-.05	.01	*	.04
B/D	.05	.02	*	.25	.09	*	.01	.23					-.06	.01	*	.03

Town Commuting Zones, Convergence

EC	α	SE	-	β	SE	-	γ	SE	-	ζ	SE	-	Y(0)	SE	-	$\bar{R}^2$
--	.05	.05		.64	.35	*							-.02	.04		.04
(B+D)/L	.06	.05		.98	.63		-.35	.40					-.02	.04		.04
B/L	.05	.05		.76	.52		-.12	.30					-.02	.04		.04
D/L	.06	.05		1.11	.67	*	-.51	.47					-.03	.04		.06
B/L,D/L	.06	.04		.83	.43	*	.96	.82		-1.28	1.03		-.04	.04		.08
(B+D)/F	.05	.05		.67	.40	*	-.05	.32					-.02	.04		.04
B/F	.05	.05		.55	.34		.14	.30					-.02	.04		.04
D/F	.05	.05		.75	.43	*	-.21	.39					-.03	.04		.04
B/F,D/F	.05	.04		.55	.27	*	1.09	.96		-1.13	1.13		-.04	.04		.07
B/D	.04	.06		.49	.47		.22	.63					-.02	.04		.04

In fact, there are no statistically significant results for commuting zones beyond a handful of seemingly outlandish results for town counties—the 1.11 parameter on human capital for instance. The atheoretic metropolitan result leads to errant parameter estimates and enormous standard errors, but neither the micropolitan nor the town subset provides consistent, useful results. In contrast, the county results present statistically significant, theoretically plausible results for all three subsets. Across all specifications, almost every term has its expected sign, and many of the parameters are significant. All of the initial income terms are negative and significant, in line with theoretical expectations. The manufacturing and human capital parameter values are within the ranges found in past work, and the entrepreneurship parameters are not out of line with expectation. By merely providing a workable approximation of expected results, the county level outperforms the commuting zone.

Between the steady-state and convergence specifications, there is ample support for a continued focus on the county level at the expense of commuting zones. The steady-state county results provide strong and consistent support for the hypotheses developed previously and in so doing, explain a greater portion of observed income deviation. Taken on their own, the commuting zone results would lead to a strong rejection of the hypothesis that entrepreneurial capital matters. While the results do not provide statistical differentiation from the county results in every case, the previously developed theory suggests that cases in which they do—that is, at the metropolitan level, and using employment-based measures—are the cases that matter most.

The overall picture is clear: entrepreneurial capital has a positive relationship with income at the county level, a relationship that is not maintained when counties aggregates are considered. The remainder of the analysis therefore focuses on the county level.

Steady State and Convergence

Tables Ten reproduces the above results for counties, and highlights the two competing hypotheses: one, that regional economies are at their steady states and two, that regional economies are still converging to said steady states.

Table Ten (a)
Metropolitan Counties, Steady State

EC	α	SE	-	β	SE	-	γ	SE	-	ζ	SE	-	Y(0)	SE	-	$\bar{R}^2$
--	-.05	.01	*	.27	.02	*							--	--	--	.32
(B+D)/L	-.05	.01	*	.18	.02	*	.14	.03	*				--	--	--	.36
B/L	-.05	.01	*	.18	.02	*	.15	.02	*				--	--	--	.36
D/L	-.06	.01	*	.20	.02	*	.11	.03	*				--	--	--	.35
B/L,D/L	-.05	.01	*	.18	.02	*	.25	.06	*	-.11	.07		--	--	--	.37
(B+D)/F	-.05	.01	*	.28	.02	*	-.03	.03					--	--	--	.32
B/F	-.05	.01	*	.27	.02	*	-.01	.03					--	--	--	.32
D/F	-.05	.01	*	.29	.02	*	-.05	.04					--	--	--	.32
B/F,D/F	-.05	.01	*	.28	.02	*	.14	.07	*	-.17	.09	*	--	--	--	.33
B/D	-.04	.01	*	.36	.03	*	-.22	.09	*				--	--	--	.35

Metropolitan Counties, Convergence

EC	α	SE	-	β	SE	-	γ	SE	-	ζ	SE	-	Y(0)	SE	-	$\bar{R}^2$
--	-.04	.03		.48	.06	*							-.04	.01	*	.03
(B+D)/L	-.04	.03		.36	.08	*	.15	.09					-.04	.01	*	.03
B/L	-.04	.03		.33	.08	*	.19	.08	*				-.05	.01	*	.03
D/L	-.04	.03		.41	.10	*	.09	.11					-.04	.01	*	.03
B/L,D/L	-.03	.03		.34	.08	*	.60	.37		-.44	.41		-.05	.01	*	.04
(B+D)/F	-.04	.03		.26	.06	*	.40	.09	*				-.04	.01	*	.05
B/F	-.04	.03		.24	.06	*	.41	.08	*				-.04	.01	*	.05
D/F	-.05	.03	*	.29	.07	*	.34	.10	*				-.04	.01	*	.04
B/F,D/F	-.03	.02		.26	.06	*	.64	.35	*	-.26	.37		-.04	.01	*	.05
B/D	-.07	.04	*	.22	.09	*	.53	.17	*				-.03	.01	*	.05

Table Ten (b)

Micropolitan Counties, Steady State

EC	α	SE	-	β	SE	-	γ	SE	-	ζ	SE	-	Y(0)	SE	-	$\bar{R}^2$
--	-.02	.01	*	.20	.04	*							--	--	--	.19
(B+D)/L	-.02	.01	*	.14	.03	*	.08	.04	*				--	--	--	.21
B/L	-.02	.01	*	.15	.03	*	.08	.03	*				--	--	--	.21
D/L	-.02	.01	*	.14	.03	*	.09	.04	*				--	--	--	.21
B/L,D/L	-.02	.01	*	.14	.03	*	-.02	.06		.11	.07		--	--	--	.21
(B+D)/F	-.02	.01	*	.21	.04	*	-.02	.03					--	--	--	.19
B/F	-.02	.01	*	.21	.04	*	-.03	.03					--	--	--	.19
D/F	-.02	.01	*	.21	.04	*	-.01	.04					--	--	--	.19
B/F,D/F	-.02	.01	*	.21	.04	*	-.08	.06		.06	.07		--	--	--	.19
B/D	-.01	.01		.27	.04	*	-.15	.07	*				--	--	--	.22

Micropolitan Counties, Convergence

EC	α	SE	-	β	SE	-	γ	SE	-	ζ	SE	-	Y(0)	SE	-	$\bar{R}^2$
--	-.09	.06		.48	.18	*							-.03	.02	*	.03
(B+D)/L	-.08	.05		.19	.13		.35	.16	*				-.04	.02	*	.04
B/L	-.08	.05		.19	.13		.35	.16	*				-.04	.02	*	.04
D/L	-.09	.05		.21	.13		.32	.16	*				-.04	.02	*	.04
B/L,D/L	-.07	.05		.20	.13		.40	.39		-.05	.38		-.04	.02	*	.04
(B+D)/F	-.09	.06		.40	.21	*	.13	.20					-.03	.02	*	.03
B/F	-.09	.06		.39	.19	*	.15	.18					-.03	.02	*	.03
D/F	-.09	.07		.42	.22	*	.10	.22					-.03	.02	*	.03
B/F,D/F	-.08	.06		.41	.21	*	.35	.49		-.22	.57		-.03	.02	*	.03
B/D	-.08	.07		.72	.40	*	-.41	.70					-.04	.02	*	.03

Town Counties, Steady State

EC	α	SE	-	β	SE	-	γ	SE	-	ζ	SE	-	Y(0)	SE	-	$\bar{R}^2$
--	.01	.00	*	.15	.02	*							--	--	--	.14
(B+D)/L	.01	.00	*	.15	.02	*	.00	.02					--	--	--	.14
B/L	.01	.00	*	.15	.02	*	.00	.02					--	--	--	.14
D/L	.01	.00	*	.15	.02	*	.00	.02					--	--	--	.14
B/L,D/L	.01	.00	*	.15	.02	*	.00	.04		.00	.04		--	--	--	.14
(B+D)/F	.01	.00	*	.19	.02	*	-.06	.03					--	--	--	.15
B/F	.01	.00	*	.19	.02	*	-.06	.02					--	--	--	.15
D/F	.01	.00	*	.19	.02	*	-.06	.03					--	--	--	.15
B/F,D/F	.01	.00	*	.19	.02	*	-.02	.04		-.04	.04		--	--	--	.15
B/D	.02	.00	*	.23	.02	*	-.13	.05					--	--	--	.17

Town Counties, Convergence

EC	α	SE	-	β	SE	-	γ	SE	-	ζ	SE	-	Y(0)	SE	-	$\bar{R}^2$
--	.05	.02	*	.26	.06	*							-.06	.01	*	.03
(B+D)/L	.05	.02	*	.13	.10		.14	.11					-.06	.01	*	.03
B/L	.05	.02	*	.07	.11		.22	.11	*				-.06	.01	*	.03
D/L	.05	.02	*	.21	.10	*	.05	.11					-.06	.01	*	.03
B/L,D/L	.05	.02	*	.17	.10	*	.65	.27	*	-.52	.27	*	-.05	.01	*	.04
(B+D)/F	.05	.02	*	.21	.08	*	.06	.12					-.06	.01	*	.03
B/F	.05	.02	*	.16	.08	*	.15	.11					-.05	.01	*	.03
D/F	.05	.02	*	.28	.08	*	-.03	.13					-.06	.01	*	.03
B/F,D/F	.06	.02	*	.25	.08	*	.62	.28	*	-.58	.32	*	-.05	.01	*	.04
B/D	.05	.02	*	.25	.09	*	.01	.23					-.06	.01	*	.03

The steady-state model has greater explanatory power than the convergence model for all three county subsets: for the steady state specification, the $\bar{R}^2$ measures are eight or nine times greater in the metropolitan subset, six or seven times greater in the micropolitan subset, and five times larger in the town subset. Despite the significance of the initial income term, the capital parameter estimates are much more consistent for the steady-state specification: manufacturing and human capital are statistically significant with expected signs in almost every case, and entrepreneurial capital parameters reflect hypothesized deviations across the three subsets. The convergence version features neither uniform significance nor any but a rough semblance to hypothesized entrepreneurial capital deviation.

Of course, this could be simply because the theory is wrong, but there is evidence against that hypothesis too: the entrepreneurial capital parameters in the steady-state version are not just reflective of *a priori* beliefs, but also show great consistency across types of measures. The employment-weighted measures are consistent within each subset, as are the firm-weighted measures. This consistency is lacking in the convergence model: while the results show the expected signs in many cases, the point estimates vary widely between measures. The convergence findings thus suggest that there is a relationship between entrepreneurship and income growth—but they simply don't provide the detail to venture further.

In any event, these results do not refute the view that regional economies are converging to their steady states: in fact, it claims that they are. This finding is not, however, enough to show that the convergence model provides a better picture of the economy than the steady-state model. As discussed previously, the theoretical model says that steady-state income levels are determined solely by an economy's unique investment rates. For an economy not at steady-state, income levels—and growth rates—are determined by these same investment rates as well as the location along the economy's convergence path. While the results do not conclusively prove that economies are at steady state or still converging, they are strongly suggestive of a third option: regional economies in the US have converged most of the way to their steady states.

The results show that capital investment rates explain a substantial portion of deviation in income *levels*, but a relatively small portion of deviation in income *growth rates*. Additionally, the steady-state parameters are very consistent across specifications. For an economy that has mostly converged to its steady state, a relatively large portion of income deviation will be determined by investment rates alone—leaving only a small portion of deviation to be explained by its convergence path. That is, the difference in income levels between an economy that is at 90% of its steady-state income and another which is at its steady state can be attributed primarily to its capital accumulation—that is, to its investment rates. So, even if an economy is still converging—and the results suggest they are—this process has a minimal influence on income levels. The results support this view.

Furthermore, the conception that economies are near their steady states also explains the relatively low explanatory power of the convergence regressions. For economies far from their steady states, idiosyncratic income changes from one period to the next will be overwhelmed by the strong growth provided by the early stages of capital accumulation. As these economies accumulate capital and thereby converge to their steady states, growth rates will slow. In an economy with no uncertainty—and thus no random shocks—growth rates could still be accurately modeled based on investment rates and the convergence path, no matter how close to steady-state.

However, in a world of uncertain, idiosyncratic income shocks—such as those caused by the business cycle—this relationship will be confounded, and the relationship between investment rates and growth *rates* will lose some explanatory power. This is precisely what the results find: while human and entrepreneurial capital investment rates are suggestive of higher growth rates—mostly positive and partly significant—the evidence is not overwhelming. To return to the previous point, the fortunate side effect of this convergence is that those same investment rates can explain a much greater portion of the deviation in income *levels*. Thus, regardless, of the actual state of regional economies—at steady state or still converging—the steady-state model provides a better model. The remainder of the analysis therefore focuses on these levels.

Measures of Entrepreneurial Capital

The next comparison is between the various measures of entrepreneurial capital, and Table Eleven reproduces the steady-state results to highlight these differences.

Table Eleven (a)
Metropolitan Counties

EC	α	SE	-	β	SE	-	γ	SE	-	ζ	SE	-	$\bar{R}^2$
--	-.05	.01	*	.27	.02	*							.32
(B+D)/L	-.05	.01	*	.18	.02	*	.14	.03	*				.36
B/L	-.05	.01	*	.18	.02	*	.15	.02	*				.36
D/L	-.06	.01	*	.20	.02	*	.11	.03	*				.35
B/L,D/L	-.05	.01	*	.18	.02	*	.25	.06	*	-.11	.07		.37
(B+D)/F	-.05	.01	*	.28	.02	*	-.03	.03					.32
B/F	-.05	.01	*	.27	.02	*	-.01	.03					.32
D/F	-.05	.01	*	.29	.02	*	-.05	.04					.32
B/F,D/F	-.05	.01	*	.28	.02	*	.14	.07	*	-.17	.09	*	.33
B/D	-.04	.01	*	.36	.03	*	-.22	.09	*				.35

Table Eleven (b)

Micropolitan Counties

EC	α	SE	-	β	SE	-	γ	SE	-	ζ	SE	-	$\bar{R}^2$
--	-.02	.01	*	.20	.04	*							.19
(B+D)/L	-.02	.01	*	.14	.03	*	.08	.04	*				.21
B/L	-.02	.01	*	.15	.03	*	.08	.03	*				.21
D/L	-.02	.01	*	.14	.03	*	.09	.04	*				.21
B/L,D/L	-.02	.01	*	.14	.03	*	-.02	.06		.11	.07		.21
(B+D)/F	-.02	.01	*	.21	.04	*	-.02	.03					.19
B/F	-.02	.01	*	.21	.04	*	-.03	.03					.19
D/F	-.02	.01	*	.21	.04	*	-.01	.04					.19
B/F,D/F	-.02	.01	*	.21	.04	*	-.08	.06		.06	.07		.19
B/D	-.01	.01		.27	.04	*	-.15	.07	*				.22

Town Counties

EC	α	SE	-	β	SE	-	γ	SE	-	ζ	SE	-	$\bar{R}^2$
--	.01	.00	*	.15	.02	*							.14
(B+D)/L	.01	.00	*	.15	.02	*	.00	.02					.14
B/L	.01	.00	*	.15	.02	*	.00	.02					.14
D/L	.01	.00	*	.15	.02	*	.00	.02					.14
B/L,D/L	.01	.00	*	.15	.02	*	.00	.04		.00	.04		.14
(B+D)/F	.01	.00	*	.19	.02	*	-.06	.03	*				.15
B/F	.01	.00	*	.19	.02	*	-.06	.02	*				.15
D/F	.01	.00	*	.19	.02	*	-.06	.03	*				.15
B/F,D/F	.01	.00	*	.19	.02	*	-.02	.04		-.04	.04		.15
B/D	.02	.00	*	.23	.02	*	-.13	.05	*				.17

The picture here is fairly clear: the employment-weighted measures are capturing a relationship between firm births and deaths that is almost wholly absent—or even reversed—when weighting by the number of incumbent firms. Given the very high correlation between employment and established firm count—the raw correlation is at or above 0.90 for all subsets—the strength of this distinction is somewhat surprising.

Looking at the single-term measures of entrepreneurial capital, the employment-weighted measures are larger by a statistically significant amount in most cases.[5] For metropolitan counties, there is no overlap using one-tailed 95% confidence intervals, there is no overlap. The employment-weighted measures are larger to the 90% level for

[5] The two-term measure of entrepreneurial capital—that is, the one allowing separate parameters for birth and death rates—gives inconsistent results across the three subsets.

the town subset. For micropolitan counties, the employment-weighted measures are larger to the 90% level in two of three cases, with the remaining case just missing: when using the firm death rate, there is no overlap when using up to 89.8% confidence intervals. Finally, the employment-weighted birth rate is larger than the birth to death ratio to the 95% level for all three subsets.[6]

Beyond statistical comparisons, the hypothesized positive relationship between firm-weighted measures of entrepreneurship and income simply does not exist. The firm-weighted measures are not statistically different than zero for metropolitan and micropolitan counties and are actually significantly *negative* in town counties.[7]

For all three subsets, the human capital parameter is larger when entrepreneurial capital included via a firm-weighted measure. For the metropolitan and micropolitan subsets, human capital is also larger when entrepreneurial capital is excluded. The difference is statistically significant in metropolitan counties: the inclusion of entrepreneurial capital—or the switch from a firm-weighted measure to an employment-weighted measure— leads to a measurable decrease in the human capital parameter as well an increase in the $\bar{R}^2$ measure. This is perhaps unsurprising; places with more education and job training may also encourage entrepreneurship.

For the micropolitan and town subsets, the human capital parameter is larger when using the firm-weighted measure than the corresponding employment-weighted measure. This difference is statistically significant to the 80% level for all four

[6] The apparent failure of the birth to death ratio is perhaps not too surprising. The form not only presupposes opposite income effects for firm births and deaths, but also specifies the specific form by which these effects interact. The assumptions underlying this measure are simply too strong: the actual relationship between firm turnover and income is obscured by the very narrow specification.

[7] This is an interesting result on its own: whereas firm turnover in large counties has no significant effect, it is negative in town counties. Like many results, this suggests a fundamentally different dynamic in town counties.

micropolitan cases and three of four town cases. While the difference is not as stark as the metropolitan subset, the general pattern remains: the inclusion of employment-weighted entrepreneurial capital measures diminishes the weight place on human capital.

Human capital appears to be a reasonable proxy for entrepreneurial capital: the inclusion of employment-weighted entrepreneurial capital terms does serve to increase the $\bar{R}^2$, but the increase is marginal for both metropolitan and micropolitan subsets. Again, that human capital would correlate with entrepreneurship is unsurprising. This effect provides further evidence that the employment-weighted measures are indicative of a relationship that the firm-weighted measures ignore. Whereas the inclusion of employment-weighted measures decreases the human capital parameter, the addition of firm-weighted measures has no effect. The firm weighted measures are unable to account for entrepreneurial capital, and so human capital takes on its original value—a value inflated by human capital's role as a proxy for the employment-weighted measures of entrepreneurial capital. While the increase in explanatory power is not great, neglecting entrepreneurial capital leaves aside valuable information as to the true causes of income variation between places.

In contrast to human and entrepreneurial capital, the manufacturing capital terms do not vary across different version of the model. In fact, they are almost entirely uniform within each subset. Again, this is unsurprising: manufacturing capital does not have localized externalities, nor is there any reason to suppose that it would be correlated with human or entrepreneurial capital. Its steadiness again suggests that the deviations across the other parameters are systematic. Because these systematic deviations fit within the theoretic framework developed previously, the conclusion is clear: the employment-weighted measures of entrepreneurial capital indicate a causal relationship between entrepreneurship and income.

The economic story to be drawn from these results is that people—and not firms—are the relevant agents when it comes to learning and acting upon geographically localized information. While firms are composed of individual people, these results show that localized information is intrinsic to those people, and they do not necessarily embed this information within the firms that employ them. Locales where individuals have a higher propensity to start new firms also have higher incomes—unlike locales where there is a high rate of new firms per established firm. These differential results suggest, again, that individuals are at the heart of new firm creation, and that entrepreneurs embed their geographically localized information within new firms.

Meanwhile, there are no clear winners amongst the employment-weighted measures. For each subset, the three single-term measures produce comparable parameter estimates and explain comparable portions of income deviation. The fourth measure, with its separable birth and death rates, produces inconclusive results that hinder comparison without providing any added explanatory power. The next section therefore explores the differences between metropolitan, micropolitan, and town counties while using the all three single-term employment-weighted measures: $(B + D)/L$, B/L, and D/L.

Metropolitan, Micropolitan, and Town Counties

Table Twelve narrows the focus of the previous results to highlight the structural differences between metropolitan, micropolitan, and town counties.

Table Twelve
Subset Comparison

Subset	EC	α	SE	-	β	SE	-	γ	SE	-	$\bar{R}^2$
Metropolitan	--	-.05	.01	*	.27	.02	*	--	--	--	.32
	(B+D)/L	-.05	.01	*	.18	.02	*	.14	.03	*	.36
	B/L	-.05	.01	*	.18	.02	*	.15	.02	*	.36
	D/L	-.06	.01	*	.20	.02	*	.11	.03	*	.35
Micropolitan	--	-.02	.01	*	.20	.04	*	--	--	--	.19
	(B+D)/L	-.02	.01	*	.14	.03	*	.08	.04	*	.21
	B/L	-.02	.01	*	.15	.03	*	.08	.03	*	.21
	D/L	-.02	.01	*	.14	.03	*	.09	.04	*	.21
Town	--	.01	.00	*	.15	.02	*	--	--	--	.14
	(B+D)/L	.01	.00	*	.15	.02	*	.00	.02		.14
	B/L	.01	.00	*	.15	.02	*	.00	.02		.14
	D/L	.01	.00	*	.15	.02	*	.00	.02		.14

Entrepreneurial capital has a somewhat greater impact in metropolitan counties than micropolitan, and a greater impact in both of those than in town counties. For all three measures, the difference is significant at the 95% level between metropolitan and town counties and at the 90% level between micropolitan and town counties. The difference between metropolitan and micropolitan counties is only significant to the 90% level when using the birth rate measure.

Looking at the $\bar{R}^2$ measures, it is clear that the model provides a better fit of metropolitan counties than micropolitan, and the worst fit in town counties. That is, differential rates of investment in manufacturing, human, and entrepreneurial capital account for a greater share of income deviation in metropolitan counties than non-metropolitan. Between the parameter estimates and the $\bar{R}^2$ differences, these results suggest that places with higher population—or population density—also have stronger relationships between entrepreneurship and income.

Moving beyond statistical tests, the entrepreneurial capital parameter for town counties is zero. The propensity for an individual to start a firm in a given town county has no relationship with that county's income level—unlike human and manufacturing capital, which both have a positive relationship with income. Of course, the standard error is positive, and so the true value might be non-zero, but only just. There a few possible interpretations of this result. For one, borrowing constraints might keep many potential entrepreneurs out of the market. There is also a high degree of heterogeneity amongst rural counties; perhaps enough have economies driven so heavily by external demand—perhaps for natural resources, or agricultural products—that firm creation and destruction does not reveal information about the local market in the way that it can in metropolitan counties. In any event, incomes in metropolitan and micropolitan counties are clearly tied to entrepreneurship, a finding which does not hold for the less populous town counties.

To further examine this relationship between county employment and entrepreneurship, Table Thirteen presents the regression results above along with two divisions of the metropolitan subset: one with the thirty densest counties, and one with the remaining 1,024. The dense division consists of those counties with at least 2,000 workers per square mile. The list of counties is largely unsurprising, including the principal counties of Boston, Philadelphia, Washington D.C., Chicago, San Francisco, and all five boroughs of New York City.[8]

Table Thirteen
Density Comparison

Subset	EC	α	SE	-	β	SE	-	γ	SE	-	$\bar{R}^2$
High Density	B/L	-.09	.05	*	.24	.11	*	.22	.12	*	.59
Metropolitan	B/L	-.05	.01	*	.18	.02	*	.15	.02	*	.36
Low Density	B/L	-.05	.01	*	.17	.02	*	.15	.02	*	.36
Micropolitan	B/L	-.02	.01	*	.15	.03	*	.08	.03	*	.21
Town	B/L	.01	.00	*	.15	.02	*	.00	.02		.14

[8] Similar results obtain for the other employment-weighted measures of entrepreneurial capital, as well as for other cutoffs, e.g. the forty densest counties. The entrepreneurial capital parameter actually increases further for smaller subsets, although the standard errors of all variables increase substantially.

A similar pattern holds: high-density metropolitan counties have larger parameter values for both entrepreneurial and human capital, although not to a statistically significant degree. Two other salient findings jump out: first, the removal of the thirty densest counties has an entirely negligible impact on the results—the decrease in the human capital term by 0.002 is the largest shift from the full metropolitan subset. Second, at 0.59, the $\bar{R}^2$ for the high-density division is substantially higher than any other regression specification covered. Not only are the parameter values somewhat larger for the high-density division, but they also explain a much greater portion of deviation than the low-density division.

While the differences are not statistically significant, the overall pattern whereby the relationship between entrepreneurship and income is larger and stronger in larger, denser counties is suggestive of the patterns predicted in the hypotheses. And of course, the findings are statistically significant in many cases: the entrepreneurial capital parameter is clearly larger in metropolitan counties than in town counties.

Summary of Results

Table Fourteen summarizes the predictions from the previous section. Bold terms indicate that the empirical results support the hypothesis at the 10% level of significance across at least half of the measurements for that subset.

Table Fourteen (a)
Summary of Hypotheses
Steady-State Specification

	Counties						Commuting Zones					
Subset:	Metro		Micro		Town		Metro		Micro		Town	
Term	H_0	H_a	H_0	H_a	H_0	H_a	H_0	H_a	H_0	H_a	H_0	H_a
α	≥0	**<0**	**≤0**	>0	≤0	>0	≥0	**<0**	≤0	>0	≤0	>0
β	≤0	**>0**	≤0	>0	≤0	**>0**	≤0	>0	≤0	>0	≤0	>0
γ	≤0	**>0**	≤0	**>0**	≤0	**>0**	≤0	>0	≤0	>0	≤0	>0

Table Fourteen (b)
Convergence Specification

	Counties						Commuting Zones					
Subset:	Metro		Micro		Town		Metro		Micro		Town	
Term	H_0	H_a	H_0	H_a	H_0	H_a	H_0	H_a	H_0	H_a	H_0	H_a
α	≥0	<0	≤0	>0	≤0	>0	≥0	<0	≤0	>0	≤0	>0
β	≤0	>0	≤0	>0	≤0	>0	≤0	>0	≤0	>0	≤0	>0
γ	≤0	**>0**	≤0	>0	≤0	**>0**	≤0	>0	≤0	>0	≤0	>0
$y(0)$	≥0	**<0**	≥0	<0	≥0	**<0**	≥0	<0	≥0	<0	≥0	<0

Again, the steady-state model and the county level provide the bulk of the supportable hypotheses. To summarize the key findings: (1) Entrepreneurial capital has a positive and significant effect on income levels. (2) Entrepreneurial capital has positive externalities that are geographically localized. (3) Employment-weighted measures of entrepreneurial capital are larger—and explain more income deviation—than firm-weighted measures. (4) Entrepreneurial capital is most effective in populous, dense cities.

Chapter Eight

Conclusions

The four results enumerated previously fit within a fairly straightforward economic story: individuals in thick markets observe the successes and failures of local firms, use this information to identify viable projects, and thereby promote income growth in their pursuit of these entrepreneurial endeavors. The empirical results support this view, and with it the idea that entrepreneurship has an underappreciated but significant causal relationship with economic growth.

Policy Implications

Because entrepreneurial activity produces an informational public good with dynamic externalities, policies that support entrepreneurship can pay dividends for economic growth. Following the successes documented in Weiler (2000), governments could provide explicit guarantees for loans to entrepreneurs. In that case, government guarantees to one entrepreneur began a cycle of self-sustaining growth that revitalized an area. The success in that case meant that the initial loans were repaid, and the eventual economic growth justified the risk. While success is not guaranteed *ex ante*, economic growth can lead to positive-sum outcomes, with the successful revitalization of a stagnant area covering the cost of loans to unsuccessful projects.

Funding from the federal or state level could be spread across multiple locales, allowing risk to be shared broadly. The US has a history of great labor mobility; workers have presumably based their locational choices partially on their economic prospects.

That is, as more promising industries and cities are identified, workers in declining jobs and areas relocate to more viable places. The increased information provided by expanded entrepreneurial activity would only aid these realignments.

Potential policies go beyond funding or guaranteeing loans. Governments can incent entrepreneurship by reducing the time and cost of starting a new business. Nudging individuals to save more could allow more entrepreneurs to enter regardless of their ability to secure lending. Policymakers ought to distinguish between policies that are good for entrepreneurship and ones that are good for "business"—that is, incumbent firms. Current firms may attempt to erect barriers to entry; governments ought to pursue policies that limit such barriers in favor of growth-fueling entrepreneurship. Aside from regulations, universities can research economic opportunities and provide localized information to potential entrants, as in Weiler, Hoag, and Fan.

Future Research

A great deal of work remains within this subject. One goal in extending this particular analysis is the development of a long-term dataset typical of previous research. While there is ample evidence supporting the validity of the steady-state analysis, the lack of empirical support for the convergence hypothesis might be partially due to cyclical factors obscuring the long-term trends. A deeper dataset would avoid this issue. Furthermore, the lagged structure of the analysis could be replaced by a two-stage approach in which factor market regressions provide estimates to utilize in the growth regression—side-stepping the issue of endogeneity while potentially improving the match between dependent and independent variables. Finally, an extended dataset would allow for direct comparison between the empirical results obtained herein and in previous work—enabling more detailed analysis of the value added of entrepreneurial capital.

The analysis of the entrepreneurial capital factor market implicit in a two-stage model would be insightful in its own right. Examination of the role of bank lending and other funding sources could help uncover the method and extent of transmission of marketplace information. The extent of information is not the only potential limiting factor for entrepreneurial activity. A full exploration of the various correlates of entrepreneurship and marketplace information would create a context from which to expand the analysis of growth.

Future research could also analyze the spatial extent of entrepreneurial spillovers. Counties and commuting zones provide a good start, but the results leave many unanswered questions. Are information flows between urban and suburban counties bidirectional, and are there extensive flows between suburban counties? Fu (2007) finds that human capital spillovers manifest in different ways at different distances from the block level to the city level, and the same may be true for entrepreneurial externalities. Is there a similar spectrum for marketplace information, with different elements limited by blocks, neighborhoods, and cities? The ideal policy approach to entrepreneurship depends on whether externalities are liable to be confined to individual neighborhoods or are likely to spread throughout the entire city and beyond.

While this paper differentiates between metropolitan areas, micropolitan areas, and town counties, it assumes the same underlying functional form for all. This assumption may not be warranted. If the technical progress that drives growth primarily occurs in cities, then a core-periphery model might better describe the economy. This could be the case because of firm locational choices and their research and development, human capital spillovers, and entrepreneurial externalities. Jacobs (1969) supposes that entrepreneurs in cities do indeed drive economic growth while rural areas are largely peripheral. If true, the proliferation of new firms in a rural area could reflect economic conditions elsewhere.

Extending the theoretical model into an explicit growth framework could improve upon this paper, which instead infers an empirical growth model from a theoretic discussion of entrepreneurial dynamic externalities. Greenwald, Stiglitz and Weiss and Corriveau show that the inclusion of uncertainty in lending and innovation could lead to business cycles. Acs et al shows how entrepreneurial agents pursuing knowledge spillovers can lead to sustained economic growth. Their endogenous firms are an important addition that could be expanded to include marketplace information. A fully realized model of entrepreneurship, marketplace information, and growth could further clarify the causes of economic growth and shed light on the usefulness of growth policies.

Beyond its effects on growth, entrepreneurship may have implications for business cycles. A proximate cause of the recent financial and economic crises was the over-expansion and subsequent collapse of real estate lending. If this lending reduced the credit available for entrepreneurs, then a plausible supposition would be that future economic growth is limited by a dearth of marketplace information. The incorporation of marketplace information and entrepreneurial activity into models of the business cycle could deepen the understanding of such cycles and analyze the efficacy of policies that combat recessions. An integrated analysis including entrepreneurial externalities with knowledge spillovers—and the uncertainty and asymmetric information endemic to both—would provide a more accurate picture of the economic functioning of cities and could improve the understanding of emergent phenomena like economic growth and business cycles..

Limitations

As discussed above, the chief limitation of this paper is the data. A more extensive dataset—one with a longer timeframe and a better match of investment rates and income growth—would allow for factor market analysis and a two-stage approach. An ideal dataset would also enable a greater analysis of the geographic nature and extent of entrepreneurial externalities.

Data on firm dynamics—beyond births and deaths—would allow a fuller analysis of the relationship between entrepreneurship, information, and growth. The limiting factor might not be entrepreneurship but, for instance, the ability of new enterprises to expand substantially upon initial success. While this paper highlights the information component of startup decisions, it is not the only component—and may not be the overriding one. Combined with more detailed firm data, a time series approach could evaluate the dynamic relationships between firm startups, deaths, and income.

Concluding Remarks

Entrepreneurship is a process of information revelation: the true shape of probability distributions of likely project outcomes is revealed through the trials and errors of entrepreneurs pursuing various projects. Their successes and failures inform the choices of later entrepreneurs, who enable economic growth to progress faster. However, these benefits have limits: the transmission and applicability of information leads to multiple equilibria and geographic asymmetries.

This general theoretical framework has found significant empirical support herein. Not only is entrepreneurial capital positively associated with growth, but secondary hypotheses are also supported: the effect is stronger in counties than commuting zones, the effect is stronger in large and dense places—findings which are in line with a view of marketplace information with limited transmissibility. And finally, the relative success of employment-weighted measures tentatively supports the view that marketplace information flows through individuals: it seems that firms alone do not produce sustained economic growth, but rather that individuals themselves survey the economic landscape and pursue projects accordingly. The evidence indicates that this process of entrepreneurship—and the information revelation which it entails—is crucial to sustained economic development.

References

Acemoglu, Daron, Simon Johnson, and James A. Robinson. 2001. "The Colonial Origins of Comparative Development: An Empirical Investigation." *The American Economic Review* 91(5):1369-1401.

Acs, Zoltan J., Pontus Braunerhjelm, David B. Audretsch, and Bo Carlsson. 2009. "The Knowledge Spillover Theory of Entrepreneurship." *Small Business Economics* 32(1): 15-30.

Aghion, Philippe, and Peter Howitt. 1992. "A Model of Growth Through Creative Destruction." *Econometrica* 60(2):323-351.

Akerlof, George A. 1970. "The Market for 'Lemons': Quality Uncertainty and the Market Mechanism." *The Quarterly Journal of Economics* 84(3):488-500.

Arrow, Kenneth J. 1962. "The Economic Implications of Learning by Doing." *The Review of Economic Studies* 29(3): 155-173.

Audretsch, David B. 1995. *Innovation and Industry Evolution*. London: MIT.

Audretsch, David B., Max C. Keilbach, and Erik Lehmann. 2006. *Entrepreneurship and Economic Growth*. Oxford: Oxford University Press.

Ács, Zoltán J., and Catherine Armington. 2006. *Entrepreneurship, Geography, and American Economic Growth*. Cambridge: Cambridge University Press.

Barro, Robert J. and Xavier Sala-i-Martin. 1992. "Convergence." *The Journal of Political Economy* 100(2):223-251.

Corriveau, Louis. 1994. "Entrepreneurs, Growth and Cycles." *Economica* 61(241):1-15.

Crihfield, John B. and Martin P.H. Panggabean. 1995. "Growth and Convergence in US Cities." *Journal of Urban Economics* 38 (2):138-165.

Fu, Shihe. 2007. "Smart Café Cities: Testing Human Capital Externalities in the Boston Metropolitan Area." *Journal of Urban Economics* 61(1):86-111.

Glaeser, Edward L., Hedi D. Kallal, José A. Scheinkman, and Andrei Shleifer. 1992. "Growth in Cities." *The Journal of Political Economy* 100(6):1126-1152.

Greene, William H. 2008. *Econometric Analysis*. 6th ed. Upper Saddle River, NJ: Pearson/Prentice Hall.

Greenwald, Bruce, Joseph E. Stiglitz, and Andrew Weiss. 1984. "Informational Imperfections in the Capital Market and Macroeconomic Fluctuations." *The American Economic Review* 74(2):194-199.

Hammond, George W. and Eric C. Thompson. 2008. "Determinants of Income Growth in Metropolitan and Nonmetropolitan Labor Markets." *American Journal of Agricultural Economics* 90(3):783-793.

Hausmann, Ricardo and Dani Rodrik. 2003. "Economic Development as Self Discovery." *Journal of Development Economics* 72(2):603-633.

Jacobs, Jane. 1970. *The Economy of Cities*. New York: Vintage.

Krugman, Paul. 1987. "The Narrow Moving Band, the Dutch Disease, and the Competitive Consequences of Mrs. Thatcher: Notes on Trade in the Presence of Dynamic Scale Economies." Journal of Development Economics 27 (1-2):41-55.

Lang, William W. and Leonard I. Nakamura. 1989. "Information Losses in a Dynamic Model of Credit." *The Journal of Finance* 44(3):731-746.

Lucas, Robert. 1988. "On the Mechanics of Economic Development." *Journal of Monetary Economics* 22(1):3-42.

Mankiw, N. Gregory, David Romer, and David N. Weil. 1992. "A Contribution to the Empirics of EconomicGrowth." *The Quarterly Journal of Economics* 107(2):407-437.

Rappaport, Jordan. 1999. "Local Growth Empirics." CID Working Paper #23, Harvard University.

Romer, Paul M. 1986. "Increasing Returns and Long-Run Growth." *The Journal of Political Economy* 94(5):1002-1037.

————. 1990. "Endogenous Technological Change." *The Journal of Political Economy* 98(5):S71-S102.

Schumpeter, Joseph Alois. 1934. *The Theory of Economic Development; an Inquiry into Profits, Capital, Credit, Interest, and the Business Cycle*. Trans. Redvers Opie. Cambridge, MA: Harvard University Press.

Smith, Adam. 1776. *An Inquiry into the Nature and Causes of the Wealth of Nations*. London: W. Strahan and T. Cadell.

Solow, Robert M. 1956. "A Contribution to the Theory of Economic Growth." *The Quarterly Journal of Economics* 70(1):65-94.

————. 1957. "Technical Change and the Aggregate Production Function." *The Review of Economics and Statistics* 39(3):312-320.

Stiglitz, Joseph E. and Andrew Weiss. 1981. "Credit Rationing in Markets with Imperfect Information." *The American Economic Review* 71(3):393-410.

————. 1983. "Incentive Effects of Terminations: Applications to the Credit and Labor Markets."*The American Economic Review* 73(5):912-927.

Uzawa, Hirofumi. (1965). "Optimum Technical Change in An Aggregative Model of Economic Growth." *International Economic Review* 6(1):18-31.

Weiler, Stephan. 2000. "Pioneers and Settlers in Lo-Do Denver: Private Risk and Public Benefits in Urban Redevelopment." *Urban Studies* 37(1):167-179.

Weiler, Stephan, and Jason Henderson. 2010. "Entrepreneurs and Job Growth: Probing\ the Boundaries of Time and Space." *Economic Development Quarterly* 24(1):23-32.

Weiler, Stephan, Dana Hoag, and Chuen-Mei Fan. 2006. "Prospecting for Economic Returns to Research: Adding Informational Value at the Market Fringe." *Journal of Regional Science* 45(2):289-311.