The Endogenous Economic Decline of Old Industrial Regions

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University Honors in International Studies and Economics
Fall 2007/Spring 2008
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Abstract:

The goal of this study is to understand the endogenous forces behind the relative economic decline of old industrial regions. This study finds that industries, and the firms and workers in them, often lose their dynamism and their capacity to learn, change, and reinvent themselves over time. Local economies dominated by aging industries are at risk of decline on two fronts: the natural maturation of the resident industry will threaten local employment levels, and unanticipated, superior technological innovations will often challenge the very existence of the industry and render it obsolete. Regional decline is therefore attributed to evolutionary factors such as path dependence, industrial lock-in, and the entrenched specialization of sticky factors of production. As three case studies show, however, it is in this specialization that a region's comparative advantage often lies, and from where a proverbial phoenix can rise from the ashes and lead to economic renewal.

Introduction:

The decline of industrial regions across the developed world has been a regular feature of the changing economic landscape for the past several decades. The popular simple explanation is that the firms located in these regions cannot compete with low cost, low wage competitors from abroad, and are therefore forced to close productive facilities, leaving joblessness and an income void in their wake. The skilled but specialized and less-educated redundant workers lucky enough to find a job must accept unskilled, low paid work. The effects are exacerbated by multipliers and accelerators, painting a rather dismal picture.

While all this is ostensibly true, the reality of the situation is quite complex. The decline of firms or industries is an intrinsic force within capitalism, a system that depends on change for growth and progress. It is also inevitable that any competition will yield winners and losers – market competition is no different and it is this that keeps the economy efficient and maximizes welfare. That firms and industries decline is then obvious and indeed desirable from a dynamic efficiency perspective. That this decline has serious adverse welfare implications on the locales in which those firms' and industries' workers live is an intuitive extension.

But the story of regional decline, while it closely parallels the story of industrial decline, is different in very important ways. The decline of a firm or industry certainly has negative and spatially concentrated effects – local incomes, employment, and investment all fall – that reverberate through the local economy. But if a region is conceptualized as a clustering of individual units of the factors of production in space[1], then an explanation of regional decline must explain why, along with the decline of a firm or industry, the returns to the owners of these local units of the factors of production also decline.

That is exactly what this study sets out to accomplish. The analysis will look at both the demand and the supply sides of the equation using a primarily evolutionary framework. The underlying hypothesis is that there are forces intrinsic to industrial microeconomies that sow the seeds of eventual decline. Indeed the economic benefits that firms and industries derive from a location in one period may reveal themselves as the origins of the region's decline in the next. The organization of the local industry is the primary impetus behind regional decline; the specialization of the factors of production is the primary cause for *prolonged* regional decline; and the lack of an entrepreneurial and innovative disposition bred by mature industrial relations is responsible for the lack of an emergence of new sources of growth and new demand for labor. In short, it will be shown that the capacity to adjust to changing economic circumstances does not exist in regions experiencing decline.

This analysis is unique in that it considers the entire trajectory of regional economic development, emphasizing the importance of history, context and evolution. The economic conditions prevailing in a region in one period cannot be explained without looking to the preceding one. Here, a regional economy is not taken as exogenously given, but rather as the cumulative product of the evolution of a (multiple) localized system(s) of production.

[1] This is the definition of a region that should be used henceforth.

What makes regional analysis particularly interesting is stickiness – once production is established in a location, capital and labor take root. Characteristics of the localized system of production will determine how that system reacts to exogenous changes in economic conditions. Since economic decline appears to be pervasive in old industrial regions, it will be argued that heavy industry and manufacturing-based systems share common characteristics that make adjustments to economic changes difficult. This lack of adjustment capacity is what truly drives regional decline.

This study aims to unify the literature on economic change, evolutionary economics, and economic geography to offer a comprehensive and generalizable explanation for regional decline. Much of the value of this paper lies in its synthesis of these related yet siloed sub-disciplines of economics and geography, to which independent analysis will, hopefully valuably, be added.

The other major contribution of this study is an empirical test of the hypothesis that intrinsic characteristics of localized industrial systems of production (industrial regions) explain the lack of economic dynamism and innovation in old industrial regions that fails to mitigate decline. Regression analysis is used to determine whether or not the dominance of industry in a region influences growth in other sectors.

To demonstrate the relevance and applicability of the analysis, this paper includes three brief case studies following the development of regions with differing industrial structures suffering similar economic distresses. Three dissimilar regions in three different countries were chosen to control for institutional factors and to identify common explanatory factors, if they exist, for the old industrial regions' economic malaise. The regions chosen were Rochester, New

York in the United States, the West Midlands in the United Kingdom, and the Ruhr Area (*Ruhrgebiet*) in Germany.

The Rochester region is relatively small, but is home to what once was one of the world's most innovative and advanced optics and imaging clusters. The West Midlands, the birthplace of the industrial revolution, is an industrial region historically dominated by a few very large firms with a proliferation of vertical linkages to smaller suppliers in a rigid hierarchy. The Ruhr Area also hosts several large industrial firms, but is different in its local industrial organization and geographic serendipity. Coal and iron ore deposits, complemented by natural transport links (the Ruhr and the Rhine Rivers), made the emergence of a massive iron and steel complex almost inevitable. Its proximity to major national and international markets also reinforced the region's comparative advantage; the Ruhr forms the core of a larger agglomeration in the state of *Nordrhein-Westfalen* and lies at the heart of an integrated European market.

Literature Review and Theoretical History:

While the approach of this paper towards regional decline is unique, it is neither the first to tackle the subject nor the first to do so using an evolutionary economic framework. Indeed it seems that Economic Geography and Evolutionary Economics have found each other to be rather prolific bedfellows.[2] Much of the literature, indeed almost all of the literature that I encountered (which admittedly is far from everything in the field), focused on either the development course of particular regions or on theory and debates so abstract as to be borderline useless to those of us with a practical penchant. Their success on the region-specific front comes at the cost of generalizability; their findings are specific to that particular region, with its particular economic structure and its particular history. Most, too, take the pre-decline economic structure as

[2] See: Frenken, K., (ed.), *Applied Evolutionary Economics and Economic Geography*, Cheltenham: Edward Elgar, 2007.

exogenously given. In such studies, regional development loses part of its endogeneity and is no longer seen as the flipside of the cumulative process. This genre of literature describes why a region declines but neglects, by and large, to describe how it got to that point and why the evolution of the regional economy matters.

The most prolific strand of literature in regional development focuses on the local forces driving regional *success*. This literature, descendent from Marshall's 1919 account of the locally-derived competitive advantages enjoyed by Lancashire textile firms,[3] has been spawned by the success of regions (and the firms located in them) like Silicon Valley and the concentration of high tech, innovative, flexible, specialized production in the south of Germany and Northern Italy, for example.[4] This literature, while related, is not particularly relevant to this paper. A discussion about the elements that led to one region's success is inherently different from one on the elements that led to another's decline. It is still tempting to link one region's failings in the modern economy to the absence of the forces behind another's success, but this is a very limiting launching pad for an analysis on regional decline.

In light of this, the literature on regional decline is much smaller than it first appears. Boschma and Lambooy provide a thorough and worthwhile review of the various contributions and varied theories related to the topic, but do so only to highlight the deficiencies of piecemeal theories that fail to account for prolonged, pervasive decline and the lack of adjustment capacity exhibited by old industrial regions.[5]

Chisolm (1990) lays the theoretical foundations of regional economics bare in *Regions in Recession and Resurgence*, a theoretical work that follows the evolution of the discipline itself.[6]

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[3] Marshall, A., *Industry and Trade*, London: Macmillan, originally published 1919.
[4] Saxenian, 1994; Camagni, 1995b; Lazerson & Lorenzoni, 1999; Toedtling (1994), among others.
[5] Boschma, Ron and Lambooy, Jan, "The Prospects of an Adjustment Policy Based on Collective Learning in Old Industrial Regions," *GeoJournal*, Vol. 49, No. 4, 1999.
[6] Chisolm, Michael, *Regions in Recession and Resurgence*, London: Unwin Hyman, 1990.

The building blocks of regional economics turn out to be essentially the same as those of neoclassical trade theory: regions, like countries (spatial entities in themselves), have a comparative advantage in the production of certain goods. There is also a domestic (local) market. Regional incomes will depend on the size of that local market (the value of what is produced and consumed locally), and the value of net exports. A region's comparative advantage may lie in natural resources, factor endowments, cost differentials, and product differentiation, but it also exhibits historicity and may be rooted in cumulative processes involving knowledge and technology.[7]

North similarly conceptualizes an economic region as cohesion around an export base; an economic region is home to certain factors of production bound in a spatially defined system of production that share an interdependent fate and future in the market.[8] This conceptualization is a useful starting point for out understanding here, though it will by modified and used to explain regional decline differently from North. He identifies four sources of regional decline, though he does not develop them: declining demand for a region's exports; natural resource exhaustion; increased relative costs of land and labor[9]; and technological developments that change the composition of factor inputs.[10] While all these are relevant, no attempts were made to explain why regional systems did not recover. After all, if the economy is by nature changeful, we need to know what made these regions experiencing relative decline exceptionally ill-able to adapt and change.

At the birth of the regional science field after WWII, regional economic malaise was most often attributed to deficient demand for a region's exports. This very Keynesian problem

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[7] Ibid., p14-5.
[8] North, Douglass, "Location Theory and Regional Economic Growth," *The Journal of Political Economy*, Vol. 63, No. 3, June 1955, p257.
[9] Known today as 'dispersion forces' in the literature on agglomeration economies and urbanization.
[10] North, 1955, p253.

had obvious Keynesian solutions: policymakers should redistribute demand. Since government has no influence on total demand for the products of most regions, and since the problematic manifestation of regional decline is not industry decline itself but rather the resulting unemployment, the solution is to redistribute demand for labor from growing regions to depressed ones.[11]

The Keynesian approach is unsatisfactory because it is static and fails to take innovation and technological change into account. It may be true that demand for a region's goods and labor falls *because* a region's firms are doing poorly. But the real questions are why those firms are uncompetitive and why resources are not reallocated efficiently within the region. Out of this grew the supply-side, neoclassical approach.

In a neoclassical framework, a region in economic distress is a region in disequilibrium. Localized unemployment is the spatial manifestation of the failure of wages to adjust when the demand for labor falls so the returns to the factors of production equalize across space.[12] Since wages are sticky and labor is not perfectly mobile though, it is unrealistic to imagine that regional economic dislocation will resolve itself on its own. If this disequilibrium persists, then there is a systemic inefficiency in the economy due to factor immobility and sticky wages.

This view interprets relative regional decline as a readjustment. Wages *should* fall as value or product of labor falls. Employment *should* contract as less labor is required to produce the same amount of goods, or as fewer locally produced goods are demanded. Regional income *should* fall relatively as the value of its product falls in the market. Democratically elected policymakers will be reluctant to adopt such an unemotional stance, however. The immobility of labor and the stickiness of wages "prevent" readjustment and exacerbate regional economic

[11] Chisolm, 1990, p74.
[12] Ibid., p32, 60.

woes, but they are realities with which policymakers must reckon. The fatalistic nature of the neoclassical approach has kept the field of regional development searching for other answers.

The fatalistic answers offered by neoclassicism are alluringly logical at first glance. Indeed letting a region "die out" may be the economically sensible thing to do. That would be a painfully slow and inefficient process though. Once production is established in a region, a labor force establishes itself too, and other assets, such as schools and universities, hospitals and amenities, if not research institutions and public sector facilities, establish themselves as well. All of these are sticky in space.

The Rise of Local Industrial Districts, or 'Milieus'

Intangible assets will accumulate as well. If local firms are specialized or a specific industry or sector is dominant, then the labor force will be specialized as well. Thus local labor becomes a region- and industry-specific asset. Specialization increases productivity in the given sector, and the region has (and its firms enjoy) a comparative advantage rooted in specialized know-how.

Marshall's study on textile production in Lancashire identified "something in the air" that explained the competitiveness of firms located in the region.[13] This phrase gave birth to the term 'industrial district.' In such a district, firms themselves often specialize in inputs and services, all related and centered around the core product (in this case, textiles). The labor force is specialized, and transaction costs are kept low because of proximity and the easy flow of information. Importantly, tacit knowledge (called "uncodified" knowledge, in contemporary literature) abounds locally, but dissipates across space. This has changed with technology and

[13] Marshall, A., *Principles of Economics*, London: Macmillan, 1920.

the increased accessibility of information, but face-to-face contact is still paramount to innovation and at the core of modern industrial districts' comparative advantages.[14]

Berndt (1998) points out two inseparable contradictions facing firms in the capitalist system: firms must be agile and adaptable in order to survive market competition, but they are simultaneously temporally and spatially bound.[15] Fixed capital stocks and specialized labor skills accumulate, as do personal ties, shared conventions, and business practices around them. As time progresses firms and the systems to which they are tethered (taking the form of a regional economy) face inertial forces that institutionalize current conditions. These conditions may be the very basis for a firm's success and comparative advantage in one period but do not guarantee success in the next, when market conditions change. The point at which an industrial milieu goes from being enabling to constraining is difficult to determine.

The Innovative Milieu

The significance of another intangible, culture, is increasingly acknowledged as quite important for regional development and particularly for innovation.[16] Innovation requires a certain inclination towards what could be rather than what is. It involves thinking outside the box and challenging the status quo. Some people are better at doing this than others, and those people tend to be more educated, more mobile, more accepting of diversity, and likely to concentrate around similar people. Creativity and talent are often related. The implication is that some regions may develop a comparative advantage in innovation.

The flipside is that some regions will have a comparative *dis*advantage in innovation. Regions with hierarchical employment structures, where class divisions are strong, where

[14] Storper, 1995; Storper and Venables, 2004; Saxenian, 1994
[15] Berndt, Christian, "Ruhr Firms between Dynamic Change and Structural Persistence – Globalization, the 'German Model' and Regional Place Dependence," *Transactions of the Institute of British Geographers*, New Series, Vol. 23, No. 3, 1998, p332.
[16] Florida, Richard, *The Rise of the Creative Class*, New York: Basic Books, 2002.

diversity, modernity, and, at the risk of sounding trite, progress, go unappreciated will probably export their best, brightest, and most innovative minds. Innovation requires creativity, imagination and an unrestrained intellect. Importantly, it requires talent and an appreciation of its exercise. It is true that talented people are everywhere though, and this is good news for regional development. But it is reasonable to believe that talent will cluster to some degree in these Floridian "creative class" milieus or and almost exclusively in areas where skills are compensated appropriately (cities).

This is not to say the innovation and R & D in the United States will occur only in the progressive enclaves on the coasts and in large cities. First of all, innovations differ immensely in nature and purpose. Corporate R & D can occur almost anywhere. But relevant to the analysis here are only innovations that drive regional development. The fruits (profits) of such innovations must then remain primarily local. The nature of the firms and industries in a region therefore influences the existence and nature of innovative activity. The lack of innovation in old industrial regions should be attributable to the lack of innovative capacity or tendency in those regions' firms.

Certain forms of industrial organization may not be conducive to innovation. The West Midlands, a region which will be looked at in depth later, serves as an example of a region home to a very hierarchical production system. The region's economy is dominated by a few large mostly automotive firms and a network of smaller suppliers dependent almost entirely on the demand from these few firms. The automotive sector thrives on scale economies, not continuous, drastic innovation. Its suppliers must meet strict product requirements, not invent their own.

Industrial organization across regions, not just within them, matters too. Innovation by multi-plant firms is an interesting case, where the benefits of an innovation are repatriated to or invested in another region. The region in which the innovation occurs gains little beyond the wages of the developer. This demonstrates the extent to which a firms' fate can be decoupled from that of the region where it is located. What really matters for regional development is what is produced in a region and what jobs it creates, both in quantity and quality. A region may then be better served by small and medium sized firms as opposed to large, multi-plant ones. Smaller firms are less footloose, less likely to leave the region, more likely to reinvest in the region, and create a diversity of jobs at all levels.

What sort of environment fosters small and medium-sized firms (SMEs)? The characteristics are quite similar to those that foster innovation too. An appreciation of risk-taking and the entrepreneurial spirit are absolute prerequisites. Both of these are intangible and immeasurable, elements that are "in the air." A local milieu that is conducive to start-ups and entrepreneurship will be more resilient in the face of adverse market developments than one that is not.

The existence of an SME sector is not in and of itself a guarantor of prolonged regional prosperity though. The orientation of these firms matters. If, as in the West Midlands and the Ruhr, these firms exist in a rigid hierarchy as suppliers to larger, more dominant firms in the region, then most of the potential dynamic benefits offered by a thriving SME sector will not materialize. If their market is established and the demand facing them unlikely to grow or change, then these firms are at risk of complacency, inertia, and constrained cognition.[17]

[17] Grabher, G., "The Weakness of Strong Ties. The Lock-in of Regional Development in the Ruhr Area," in Grabher, G., (ed.), *The Embedded Firm. On the Socio-economics of Industrial Networks*, London: Routledge, 1993, pp. 255-277.

The Product Cycle

This paper concerns itself with old industrial regions. What connect these regions as relevant units of analysis are shared characteristics of the industries located within them. Specifically, "old" industrial regions are home to "old" industries, or rather "mature" industries in the product-cycle literature, which demonstrates that industries actually age along largely similar trends.[18] Markusen (1985) further applies this model to regional development.[19]

There are four stages in the product cycle model, which industry cycles, without innovation, correspond to as well.[20] The first stage involves the initial innovation of the product and birth of the industry. Just one producer exists initially, the technology and know-how are specialized and concentrated, the product is costly and the profit margins are high. The observed high profits, accompanied by the dissemination of the technology and know-how, induce new firms to enter the market. This ushers in the second phase in which in the industry expands. Increased competition from new entrants reduces the cost of the product, but also erodes profits (which are still high). Product variety and substitutes are introduced. Investment in the industry and attempts at incremental innovations and product improvements are widespread.

Eventually the product becomes standardized and the industry enters maturity (stage three). Product differentiation is minimal as production techniques and quality both converge. Firms compete on cost, or try to exploit brand name recognition to charge a slightly higher price through monopolistic competition. The capital to labor ratio is high and getting higher as firms attempt to minimize costs and increase profits through mechanization. Economies of scale

[18] Vernon, R., "International Investment and International Trade in the Product Cycle," *Quarterly Journal of Economics*, Vol. 80, 1966, pp. 190-207.
[19] Markusen, A., *Profit Cycles, Oligopoly, and Regional Development*, Cambridge, MA: MIT Press, 1986.
[20] See Appendix 3 for a table summarizing the effects of the product cycle on an industry from which the next few paragraphs are adapted, copied from Markusen (1985).

become more important and the industry consolidates, cutting the capital to labor ratio even more. Industry concentration rises, potentially to the point of oligopoly; entry is minimal.

In the final stage, which may be delayed for quite some time, the industry enters decline. It is rare for an industry to disappear completely, so this stage is best thought of as the terminal decline of the domestic productive capacity of an industry. This is the stage of disinvestment, where profits are minimal if not negative, the industry is highly concentrated, and labor is being shed rapidly. The industry peters out because the product became obsolete. The market has more or less vanished. Firms in the relevant product market that failed to diversify will go under; firms that remain are large and presumably in related sectors, so economies of scale and scope are exhausted.

The effects of the fourth stage are intuitive. If the market for a good disappears, then firms in that market must either diversify out of that market or close. Workers in that industry will become unemployed and capital will be sold or abandoned. Little insight is needed to understand the effects of this on the region. It is the third stage that is decisive for the industry and most interesting and relevant to regional decline.

This stage will last as long as no insurgent substitute products or production processes appear, which would render the core industry obsolete. Either way, growth is unlikely, especially in employment. Indeed workers will be laid off and production will likely move away from the original region to one with lower costs and a more restive labor force, if workers were unionized at all (which is likely enough in the mature/old industries under consideration here). Administrative services and white collar jobs, including R & D may remain but it is not guaranteed, as the Rochester case study will demonstrate.

Positively, if firms in the industry in this stage oligopolize, then they will accrue extra-normal profits. These can be used to diversify into other sectors and can also lead to an increase in white-collar employment as business strategy and management increase in importance. Firms will be large at this point, however, so investment and employment could be expanded in other regions instead of the core one.

An industry in this stage may support a region but not contribute to its growth. Importantly, growth prospects may diminish as stagnation continues. The industry becomes the dominant force in the local factor markets and even in people's minds. It has a monopsony on labor and talent. Entrepreneurship is not supported because the dominant industry is expected to sustain the region and offer "good" jobs. Entrenchment of sorts occurs, where the region and the industry (and the employees and their families linking the two) come to share an identity.[21] The longer this stage progresses, the deeper the entrenchment, and the higher the vulnerability of the region to destabilizing forces, like demand shocks or Schumpeterian innovations.

Schumpeterian Innovation

Schumpeterian innovation is the most interesting from a regional perspective. Process and product innovations may keep an individual firm afloat by ensuring its competitiveness. Schumpeterian innovation is larger though, is iconoclastic. It does not simply lower the costs of production for a firm or augment the differentiation of a product. It drives economic change and, in some cases, regional growth and decline directly. Schumpeter said it best himself:

> "…the competition from the new commodity, the new technology, the new source of supply, the new type of organization – competition which commands a decisive cost or quality advantage and which strikes not at the margins of the profits and the

[21] See Markusen's (1985) case studies on Pittsburgh and Detroit.

> outputs of the existing firms but at their foundations and their very lives...” is fuels the capitalist economic engine.[22]

Innovation changes the very market in which a firm finds itself competing; it rewrites the rules of the game and prompts a metamorphosis in the industry *from within*.[23] The process is constant but the weeding out, or ‘selection,’ varies in intensity and rapidity. Firms and industries at some point awake to find themselves in a new and changed competitive environment. Just like in biological evolution, only the fittest and most adaptable survive.

Economic Evolution and Path Dependency

In the changed environment a surviving actor is not fundamentally different though, he has merely adapted to changed circumstances while not changing his identity. The path of his development is traceable. Present characteristics were determined in part by characteristics in the preceding period. The future course of evolution is then dependent on the path along which it has been traveling already – thus the term “path dependency.” As Walker rephrases it for firms, “choices made in the past – technologies embodied in machinery and product design, firm assets gained as patents of specific competencies, or labor skills acquired through learning – influence subsequent choices of method, designs, and practices.”[24]

An aggregation of related economic actors (like an industry) will develop/evolve in a similar manner, though their evolution will be twofold: an evolutionary path *within* the group will supplement the broader evolutionary path *of* the group. This can be thought of as an industry environment changing within a market environment, with a selection (competition) process taking place in each. The geography of production depends on the choices of firms and the

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[22] Schumpeter, Joseph, *Capitalism, Socialism and Democracy*, London: Allen & Unwin, 1943, p84.
[23] Ibid., p83.
[24] Walker, R., “The Geography of Production,” In Sheppard, E. and Barnes, T., (eds.), *A Companion to Economic Geography*, Oxford: Blackwell, 2001, p. 126.

impacts of these choices on industries and production patterns in space.[25] For example, once an innovation yields a new product (technology), it establishes a *technological trajectory* down which the industry producing that good/technology will evolve through incremental innovations and product improvements. If this industry localizes, then the technological trajectory does accordingly. The term trajectory is useful because it invokes irreversibility, which is a key implication of choice. Up to a decision point any number of paths could have been taken, but once the decision is met a node along a path, from which future choice sets much come, is established.[26] Choices, too, will be influenced by place to the extent that actors exist in and are influenced by localized systems of production (linkages among firms, factors and industries).[27]

Origins of a Regional Economy: Industrial Localization

Take for a moment a national economy with fixed endowments, perfectly mobile labor, and perfectly immobile capital distributed randomly across the country. Labor will distribute itself across space in order to equalize returns to it, which will be according to the amount of capital in any given place, assuming all labor is homogenous and undifferentiated. So the population of any given region in this country should be proportional to the number of employment opportunities it offers in the initial period.

An initially random distribution of capital is not prohibitively unrealistic[28], though a map of any country will show that the distribution is not even. This is because as time goes on, as the economy evolves, agglomeration and specialization forces change the economic landscape. Since this is not a one good economy, the capital randomly distributed through space must be

[25] Martin, Ron and Sunley, Peter, "Path Dependence and Regional Economic Evolution," *Journal of Economic Geography*, Vol. 6, July 2006, pp. 395-437.
[26] Nelson, R., and Winter, S., "Forces Generating and Limiting Concentration under Schumpeterian Competition," *Bell Journal of Economics*, Vol. 9, No. 2, Autumn 1998.
[27] See: Arthur, Brian, Industry Location Patterns and the Importance of History, Increasing Returns, and Path Dependency in the Economy, Michigan: Michigan University Press, 1994, pp. 49-67.
[28] Luck plays a huge role in distribution of economic activity because the chances of stumbling upon an innovation are stochastic (Nelson and Winter, 1982 & 1998).

specialized and industry-specific, though any given industry may find its capital distributed in more than one location. This, too, is quite plausible: the localized origins of many industries can be attributed to simple luck – an innovative resident or geological serendipity (the existence of natural resources).[29] One region may be endowed with a larger share of capital than another, and may have capital from multiple sectors present.

As soon as time begins in the model, labor becomes specialized according to the sector in which it is employed. Some of this labor may remain more substitutable or flexible after specialization than others. The productivity of specialized laborers increases, giving real benefits to firms employing it. As time goes on, some firms perform well while others do not, and employment will change accordingly. Also, the chances of new firms or industries sprouting up (new, exogenous capital forming) is an increasing probability function of the number of people in a region and some other variable capturing residents' proclivity to found a firm or innovate a new product (a proxy for culture, which will henceforth be called "alpha"). There is a higher probability that this capital will be in the same or related sector to that region's existing economic base, simply because of the specialized knowledge in that region.[30]

By adding even minimal mobility to industry-specific capital, it is clear that related industries may cluster after a critical mass of firms and specialized assets, including labor, is reached that makes such a move economically beneficial. The forces that drive this are called localization forces.[31] Firms in related industries derive real economic benefits from clustering around each other. Collectively they are able to exploit economies of scale *external* to any individual firm. Marshall originally identified three distinct sources of benefits from localization: labor market pooling, the relatively lower-cost provision of specialized inputs, and

[29] Krugman (1992) offers many examples.
[30] In future research, developing a mathematical formula for this would be quite instructive.
[31] Krugman, P., *Geography and Trade*, Cambridge, MA: MIT Press, 1992, pp. 35-67.

information sharing, or technological spillovers.[32] Shared infrastructure and the localized existence of industry-specific assets and institutions are also important.[33] These

Firms in a localized industry share a specialized – and therefore more productive – labor force. Laborers can command a higher premium for their skills as well and find themselves fortuitously positioned in the market. Close proximity among related firms, which are often links in the same supply chain, encourages quality and a degree of specialization and cooperation in the production process that puts involved firms at a competitive advantage. An inter-firm division of labor takes place, minimizing risk and organizing the localized industry most productively through specialization, much like Adam Smith's famous pin factory but on an industry scale. Though unquantifiable, few would argue that face-to-face contact is less efficient, less productive, or less conducive to innovation and idea generation – and hence industry competitiveness – than remoteness.[34]

Market transaction costs between firms for intermediate goods are thus reduced and the prospects of process and product innovations within the industry are enhanced. The third source of benefits, informational and technological spillovers, is related. Industry expertise is concentrated and its development nurtured. New innovations diffuse quickly in the region because they are readily appreciated and communicated, keeping this region's firms one step ahead. Ideas are tossed around, developed further, and reformulated without formality. The expertise and requisite channels also exist to commercialize or capitalize upon the new ideas.

<u>The Agglomeration of Economic Activity[35]</u>

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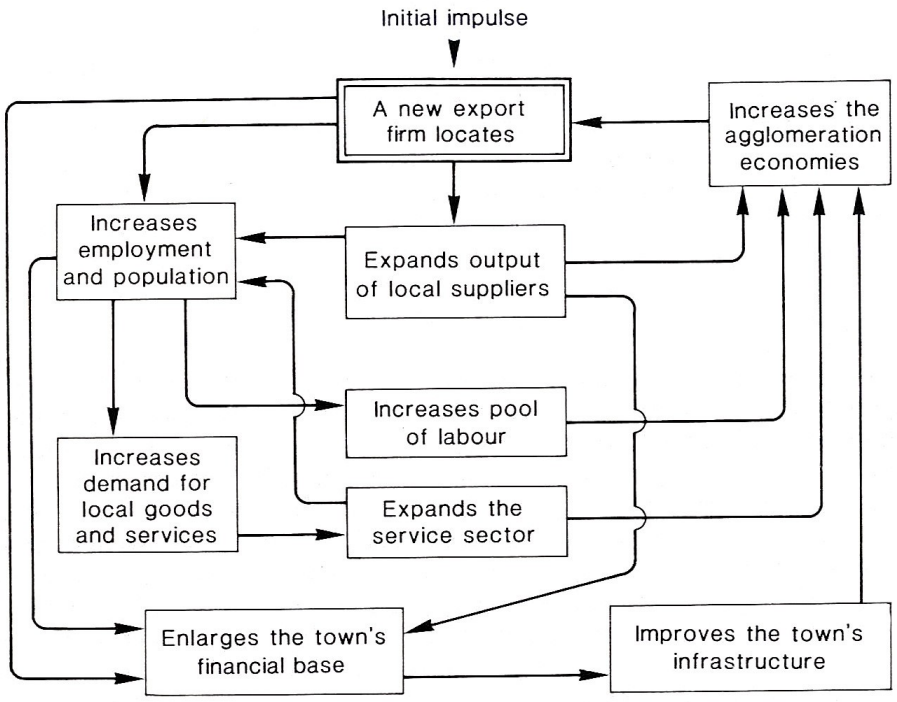
[32] Marshall, 1920.
[33] Grabher, 1993, pp. 255-277; Storper, 1995, p44.
[34] Storper, Michael and Venables, Anthony, "Buzz: Face-to-Face Contact and the Urban Economy," *Journal of Economic Geography*, Vol. 4, Iss. 4, August 2004, pp. 351- 370.
[35] Ottaviano, Gianmarco and Thisse, Jacques-Francios, "Agglomeration and Economic Geography," in Henderson, J. Vernon and Thisse, Jacques-Francios, (eds.), *Handbook of Regional and Urban Economics*, Vol. 4: Cities and Geography, Amsterdam: Elsevier, 2004, pp. 2563-2608.

When transportation costs are added into the equation, the drive towards localization is tempered as the industrial concentration, depending on its location in the larger spatial market, loses some of its gravity.[36] It is rational for a firm to locate as near its suppliers as possible, so as to minimize input costs which increase as some function of distance and difficulty of transport. Since a rational firm will also want to locate near its consumers to keep final prices as competitive as possible, the ideal location is some equilibrium distance between input suppliers and consumers that minimizes costs on both ends. The importance of external economies in the industry for firm competitiveness and the degree of transportation costs will ultimately determine the equilibrium outcome. Recall also that capital is not completely and costlessly mobile; any stickiness may prevent industry concentration through firm migration if the costs of localizing outweigh the benefits.

But the final firm in a supply chain will, all else equal, choose to locate nearest its largest consumer market, where it will also be kept abreast of changes in consumer tastes. The larger consumer markets are likely the very areas where most capital was laid down in the initial random distribution.[37] Therefore, larger markets will attract more firms and industries, making them larger in turn. The pooling of various specialized labor forces creates a more diversified labor force and increases the probability of innovating in or across any given sector(s). This trend is reinforced by the emergence of more diversified services for this diverse industrial base and a greater supply of more diverse assets. Agglomeration is then reinforcing over time because it increases the region's chances of spawning new firms and industries.

The figure below, adopted from Chisolm (1990), illustrates the process by which cumulative regional growth and agglomeration occur.[38]

[36] Krugman, 1992. Note that the localization of an industry in a large market will *augment* the concentration's gravity.
[37] Though since the course of economic change is unpredictable, so too is the equilibrium distribution of capital.
[38] Chisolm, 1990, p66.



Transportation costs are by no means *infinitely* high though, the factors of production are not perfectly mobile, and some industries will always be dependent on geographically sticky natural resources at the very least. Agglomeration is not complete then and this is reinforced by other so-called dispersion forces.[39] Wages tend to be higher in agglomerations because of pooling, and the price of another factor of production, land, gets bid up quite high. This may negate any cost savings from proximity to consumer markets, especially since there is no one central agglomeration and a giant hinterland spanning the rest of the country, but rather several agglomerations of different sizes spread also somewhat randomly through space.

Specialization, Diversification, and Regional Path Dependency

The significance of these forces for regional decline is their impact on diversification. A more specialized region should, all else equal, be more susceptible to economic decline than a diversified one. Additionally, a more specialized region should be more susceptible to *relative*

[39] Krugman, 1992.

economic decline than a more diversified one because the chances of spawning new firms and new industries are *relatively* lower.[40]

Therefore, a region's susceptibility to decline is likely directly related to how that region came into being as an economic unit in the first place; whether it formed around a single industry, and whether it was able to create or attract new industries. Some specialized regions (or the firms in them rather) are certainly able to reinvent themselves to remain competitive, but this is not guaranteed. The Rochester case study will show how firms in the optics and imaging sectors actually had to move some functions out of the region in order to remain competitive in the face of an iconoclastic innovation that challenged the industry at its core. Specialization and the localization of an industry should make it more competitive along the established technological trajectory, but as soon as this trajectory suddenly and fundamentally shifts, specialization can quickly turn into a liability.

Central to the degree to which specialization is an asset or a liability are the external links of a region. Naturally, possessing good information about all aspects of one's relevant market is essential to competitiveness and success. This knowledge will be more complete the more links a firm (or localized collection of firms in any given industry) has to its consumers, the more profligate its networks within the industry and across sectors, and the deeper its channels of information to the broader market. Presumably, better information will enable firms to perceive and act to suppress nascent competitive or innovative threats before they materialize.

Insularity is a key threat for a region. The economic progress subsists off change and relentless, unceasing competition. "Progress" involves continuous improvement from one state to another. Growth and prosperity are driven by innovation, new products and processes.

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[40] Depending on the nature of the specialization though – one might say that Silicon Valley, for example, has a comparative advantage in innovation itself.

Schumpeter captured this reality when he coined the term creative destruction.[41] The engine of a dynamic economy is the machine that renders the existing obsolete. Producers must outrun this machine. Any complacency or insularity will eventually be punished by competition. Firms not attuned to an ever-changing market will be unable to compete for long.

The term "lock-in" usefully captures and modifies this concept of insularity.[42] As explained by Malmberg and Maskell:

> "…a dense local milieu[43] might, in addition to enhancing innovative behavior and industry dynamics, create lock-in situations, i.e. situations where the local structure becomes so narrowly focused on a particular type of economic activity (technology, organization, market behavior) that it is unable to shift into a new development track if, for example, there is an overall change in the demand structure in that industry."[44]

Three types will be mentioned here: cognitive, functional, and technological lock-in.[45] Cognitive lock-in refers to the human tendency to interpret events under uncertainty with imperfect information through a lens which interprets events using a set of established heuristics based on what one knows and has experienced before.[46] When a firm is conditioned to expect certain market trends (including stability), then it may interpret any deviation from the expected not as a fundamental threat but as a fleeting anomaly.

Cognitive lock-in was present in each of our three case studies. When market conditions, having been taken as axiomatic for years, changed unexpectedly, decision-makers relied on their

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[41] Schumpeter, 1943.
[42] See Appendix 2 for a summary of the different forms of regional lock-in from Martin and Sunley, 2006.
[43] The concept of an 'innovative milieu' is Camagni's (1995, p. 318); he defines an innovative milieu, very similar to a Marshallian industrial district, as having, "…strong elements of local entrepreneurship; close interaction and cooperation among firms and relevant externalities associated with specialized labor markets [which] enhance the competitiveness of the production fabric."
[44] Malmberg, A. and Maskell, P., "Towards an Explanation of Regional Specialization and Industry Agglomeration," *European Planning Studies*, Vol. 5, 1997, p38.
[45] Grabher, 1993, p260.
[46] Nelson and Winter (1982) provide a good analysis on heuristics and firm behavior starting on p.15.

usual heuristics and first tried to cut costs by squeezing the margins, laying off staff, and increasing labor productivity through training and mechanization rather than innovate. Functional lock-in is closely related and refers to the tendency of firms enjoying long-term stability in the market because of close relations with their customers, for example, to fall into a routine geared solely to production for that market.

Technological lock-in is an intriguing phenomenon. At its core is the tendency of firms or industries to establish themselves around a product instead of around a market. Producers become defined by the product they sell rather than the market they serve. This should not be interpreted as the market for a good, but rather as the need that products in a market satisfy. As a firm evolves from the filler of a market void to the producer of the product that fills that void, the firm can become oblivious to the rise of other products that fill the same void in a different, presumably improved, manner. The established industry continues down the established technological trajectory and focuses on incremental improvements to the initial innovation rather than completely new innovations that may serve the same purpose.

Rochester provides a superior example of a localized industry on an *inferior* technological trajectory. The imaging and optics cluster located there was originally one of the most innovative and competitive in the world. But the industry failed to perceive the fundamental threat posed to it by the digital revolution, and has been struggling to regain its footing and technological preeminence ever since. Indeed because of a combination of a lack of external links and cognitive lock-in the firm failed to perceive the inferiority of its technological trajectory (film-based photography) given new developments in the market and the changing nature of the competition.[47]

[47] The question why the film industry should choose to produce non-film products is legitimate, but emphasizes the point that an industry becomes linked to a product rather than the market it serves, and decoupling the two is quite difficult. But a firm's capital stock is specified for the production of a specific product, so it is difficult for any fundamental transformation to take place immediately. I find the dilemma fascinating.

Once an industry establishes itself, labor becomes specialized to its needs and industry-specific knowledge accumulates. Information relevant to that industry is better in the region in which that industry is located than anywhere else. This means that innovations along or branching off from the relevant technological trajectory will likely occur where that trajectory is located in space. A region therefore enjoys a comparative advantage not just in the present industry, but in *potential* and *related* industries as well. This bodes well for regional renewal.

In sum, regional path dependency implies that a region's industrial base in one period directly influences the region's industrial base in the next. Recall that an industry does not necessarily concentrate in one single location, but may do so to some degree in several. The depth of the links (either directly or indirectly through the market) between firms in the same industry will determine the extent to which technological trajectories in the same industry differ across regions. There is still a random chance that an innovation in an unrelated sector will establish a new industry in the region as well, but this will be ignored here.

Regional Scenarios in Competitive Evolution

Nelson and Winter (1998) constructed a formal model of how the competitive process yields winners and losers and so shapes the marketplace.[48] Importantly, firms are not homogeneous; they differ in capabilities, procedures, and decision-making rules. Firms will react to market signals differently, and exhibit different propensities for innovation. Firms that innovate – meaning firms that improve on the core product or increase productivity internally – successfully are rewarded with higher returns and increased market shares. These benefits make them more likely to be successful in the next period, as they have increased resources to leverage.

[48] Nelson and Winter, 1998.

The intensity of competition is decisive in determining certain industry characteristics like the pace of innovation. Both the product cycle model and Nelson and Winter's evolutionary model show industries concentrating over time. In theory, this should lead to decreased competition, but there is no way of determining relative intensity conclusively. If we assume for a moment that concentration *does* lead to decreased competition and consequently less innovation, then regions may be particularly vulnerable to decline. Not only do industries rationalize as they mature, but the pace of evolution along the established technological trajectory slows as well.

Firm resiliency and adaptability, along with innovative ability, are key to success and longevity. How these firm characteristics relate to regions will depend on the industrial organization within those regions. Three organizations will be considered here: 1) an undiversified region dominated by a single, large firm with a few backward linkages in a single, concentrated, mature industry, 2) an undiversified region home to several firms of varying sizes occupying various positions in the production chain in the same mature industry, and 3) a diversified region with several firms in several industries.

Region one is the most likely to suffer deep decline. In this mature industry innovations are slow and incremental. Competition among the remaining large firms is no longer fierce. Relationships are established and have been for quite some time. The backwardly-linked firms have been producing for the dominant firms their entire lives. They exist to produce for those firms, which in turn exists to produce the established product. The competition that does occur is largely cost-based, so the dominant players and their suppliers are all pressured to mechanize and reduce their labor forces. There is little knowledge in the region outside of the dominant industry, so chances are small that another industry will arise.

Little entrepreneurship exists since the region has been dominated by a few large employers for so long. Cognitive, functional, and technological lock-in are all present. Growth potential is low in this mature industry, so there is little reason to enter the market or start a spin-off firm in a related one. Risk aversion is likely pervasive too, since risk-taking is not rewarded in a region that subsists off the established.[49] Years or generations of working in a rigid hierarchy ingrain class-consciousness and constrain an individual's perceived opportunity set. Institutionalized labor relations take the form of strong unions, which may or may not be antagonistic to managers and capital and will likely object to drastic changes in strategy in the industry.[50] These socio-cultural factors have real economic impact: they impede innovation, slow the pace of change, and extinguish any flickering entrepreneurial tendencies. But they are also naturally developed characteristics adapted to and by the reigning environment.

There is however the chance that the dominant firms in the industry are still competitive and remain attuned to the market and cognizant of competitive threats. Such an industry will not be immune to competitive pressure, however. But it utilizes its accumulated resources to its advantage, keeping it if not one step ahead of nascent competitors, at least prepared to compete with (and potentially adopt) an unknown technology. Its cognition perceives nascent threats and it is the *potential* competition that keeps the firm innovative and competitive (much like the threat of entry will discipline a monopolist). This firm will still render workers redundant as it seeks to reduce costs, but this adverse impact on the region may be mitigated by the presence of R & D, market analysis, and other high-paid employment that exploits the localized (and, in this case, externally linked) knowledge. This dynamism on the part of the dominant firms will spillover along its networks of suppliers into the industry as a whole.

[49] Boschma and Lambooy, 1999, p393 discusses the effects of different regional industrial configurations on relative risk aversions.
[50] See Markusen, 1985, Table 3.1.

The second possible industrial organization presented here is actually not that dissimilar from the first, though the outcome of the competition may be. As Storper (1995) points out, industrial districts generally arise around an inter-firm division of labor.[51] Tacit, non-codifiable knowledge flows freely between firms. Risk is spread. Firms enjoy external economies of scale instead of internal ones, and they are likely more flexible because of it. Rigid hierarchies among equal-sized firms are rare. Competitive discipline is felt at every link in the supply chain, and all of the many pairs of eyes are scanning for innovative opportunities at each of their respective links in the supply chain. If economies of scale in R & D are important, however, the collection of smaller firms may be at a disadvantage. Their specialized capital stocks are not transferable and their limited financing options would make full-scale reinvention difficult. But the "alpha" can be expected to be higher in the region of small firms that has a history of successful entrepreneurship on a small scale.[52] Scenario two therefore exhibits a less ambiguous and slightly positive propensity for innovation and success in the face of intense competition.

The third scenario is ideal for a region. Not only does economic diversification mitigate the effects of the decline of any one industry or firm on the region (other employment opportunities exist, for example), but it also increases the chances of innovation in that sector and also across sectors. It is more likely that a new industry will originate in a diversified region too, since knowledge and networks flow between industries as specialized labor pools and mixes.

Even if an ostensibly diversified region is really just an agglomeration of several insular industries, there is a better chance that some will be young and growing, that some will have external links, that the infrastructure already exists which another industry will find advantageous, and that, by sheer numbers, more nascent entrepreneurs exist that have also been

[51] Storper, 1995, p13.
[52] Schumpeter anointed entrepreneurial capacity the fourth factor of production, which I would tend to agree with.

less impressioned by a dominant firm or suffer from constrained cognition. Path dependency still matters, but in a diversified region these paths overlap and make new combinations. Finally note that, as the economy transitions to a service sector economy, a more diverse region will spawn a more diverse set of services, all else equal. This further mitigates the decline of mature industries, or at least eases the transition.

Case Studies

That is what the theoretical and intuitive analysis thus far would lead us to expect. Now, let us take a look at three different old industrial regions home to three different mature industries with three different industrial organizations. The first is Rochester, New York, home to (and dominated by) an optics and imaging cluster. After that we will venture across the pond to the West Midlands in England, a region dominated by a few very large industrial enterprises. We will conclude with the Ruhr area of Germany, an agglomeration economy that formed around coal and ore deposits and is now positioned in the center of an integrated European market. The rationale behind choosing regions in different countries was to control for institutional factors and demonstrate as best as possible that the forces at work are indeed intrinsic aspects of economics and industry. This is not to say that regional decline is an inevitability that must be accepted without judgment, but rather to acknowledge that it is natural and can be explained.

Rochester, New York, USA

Rochester is an example of a region that lost its luster, going from a world-renowned center for innovation and excellence in optics, imaging, and to some degree also electronics, to a handicap on resident firms as the market underwent a fundamental change.

The optics and imaging cluster was first established by a group of skilled German immigrant lens crafters who settled in the area from another world-renowned optics cluster in Jena, Gemrany in the late 1800s.[53] Their specialized knowledge was planted here like a seed as arbitrarily as their settlement decision was met (representing the random element in the model introduced earlier). Around this specialized knowledge an industry grew, innovated, and pushed and shaped the frontiers of related technological trajectories. The region was and still is home to a few large firms like Kodak, Xerox, and Bausch & Lomb, and a plethora of smaller ones in the same and related sectors.

Bausch & Lomb is a direct descendent of the German lens crafters and was the first firm to mass-produce eyeglasses, goggles and microscopes. Kodak was a spin-off from this industry. In 1906 a firm called Haloid was established as a maker of specialty photographic paper and in 1960 itchanged its name to Xerox as it became the world's top producer of photocopiers. At the region's peak around 1965, Kodak had over 90% of the world consumer film market, Xerox had 75% of the photocopier market, and Bausch & Lomb 40% of the world market in eyeglasses.[54]

A subsector of the region's industries became locked into an existing technology and corresponding technological trajectory based on film. These firms, despite their global reach, failed to recognize the threat posed to their core product and industry by digital photography – the descendent of a different, localized technological trajectory elsewhere. This is a prime example of fixating on and establishing oneself around a product as opposed to a market. These firms were at the vanguard (indeed, were the vanguard) of film-based photography but were slow to perceive and recognize the implications of the dual shift in technology and consumer preferences that supported the rise of digital photography.

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[53] Safford, Sean, "Searching for Silicon Valley in the Rust Belt: The Evolution of Knowledge Networks in Akron and Rochester," MIT Industrial Performance Center, Working Paper IPC-04-001, January 2004.
[54] Ibid., p20.

The industrial district in Rochester was then locked into an inferior technological trajectory. For too long it misinterpreted the nature of the competition it was facing – that it was Schumpeterian, attacking the industry at its very foundations – because of cognitive lock-in. Innovation along the existing technological trajectory was undertaken, but the industry still lost market share because its technology was fundamentally inferior.

The largest firms did have external links and resources on hand. This allowed them to tap into other innovative milieus and industrial (well, post-industrial in this case really) districts where the superior technological trajectory was established and progressing. Xerox and Kodak both opened R&D facilities in Silicon Valley, for example. Xerox also moved its headquarters to suburban Connecticut. I would infer that Xerox expected the milieu there to be richer and that they would derive real economic benefit from proximity to other corporate functions and strategists, and from tapping into a pool of specialized labor much deeper than in Rochester. Locating administration and strategy nearest the largest corporate market in the world seems sensible for a firm specializing in office equipment for simple informational purposes (consumer preferences) too.

But Rochester did not lose all of its optics and imaging employment and these firms moved select functions from the region; they did not abandon it altogether. This is partially because many related products were produced in the region, not just cameras and film. The market for all of them did not collapse and the expertise of the workforce was not rendered completely irrelevant or irreconcilable with the new technology.[55] The regional milieu in fact had existing links to the superior technology – Xerox was going digital and powerhouses like IBM also had operations in the region. The region and its firms had global links at all levels

[55]For a discussion on learning see: Maskell, P., and Malmberg, A., "Localised Learning and Industrial Competitiveness," Paper presented to the Regional Studies European Conference on "Regional Futures," Gothenburg, 6-9 May 1995.

(four of the top thirty patenters in the region are foreign[56]).[57] Rochester's core industries were mature but modern and changing rapidly; innovation was not a foreign concept and skilled labor was employed. The culture of the region and its industrial organization arguably mitigated the extent of the region's decline and invigorate today its future prospects for renewal.

The region's recovery has in actuality been sluggish however. Regional employment growth per year from 1990-2004 was 0.08%, ranking Rochester 176 out of 179 in the country. [58] Average wages grew only 2.77% and Rochester ranked 162. Wages themselves in 2004 were 9.08% lower than the national average. Patenting activity is still high; 26.92 were issued per capita in 2004, well above the national average of 7.29, but growth is low from this high base. Finally, the number of traded establishments in the region has grown slowly over the 1990-2004 period at a rate of 1.94% per year (a rank of 145 out of 179).

Rochester then, while still home to some innovative activity, has not capitalized on its assets to raise wages, increase employment, or found new firms. The below average performance of the region implies that it has not been able to escape its malaise and diversify successfully. The bright spot – patenting activity – is still dominated by firms linked to the region's core cluster around optics, imaging and electronics. Indeed 77% of all patents in the past ten years are accounted for by Xerox and Kodak, and nearly half of all patents are in the Optics, Imaging and Electronics cluster.[59]

In conclusion, more ideas existed in the larger cities and richer dialogues existed in innovative milieus like Silicon Valley. Rochester was at a disadvantage in part because it lacked

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[56] "Rochester-Batavia-Seneca Falls, NY Economic Area: Patents by Organization," Harvard Business School Institute for Strategy and Competitiveness, 2008.
[57] See Appendix 1 for a schematic depiction of knowledge networks in Rochester from Safford, 2004.
[58] "Rochester-Batavia-Seneca Falls, NY Economic Area: Economic Performance Indicators, 2004," Harvard Business School Institute for Strategy and Competitiveness, 2008.
[59] "Rochester-Batavia-Seneca Falls, NY Economic Area: Patents by Organization," Harvard Business School Institute for Strategy and Competitiveness, 2008.

size and diversity, and in part because another technology, originally unrelated, branched into and eventually superseded its own. Both of these are natural consequences of an ever (and ever more rapidly) changing economy. Eventually new ideas *should* arise which challenge and are superior to established modes of behavior. Eventually innovations in one sector *should* permeate the economy and influence the trajectory of others. This enhances welfare and makes previously occupied resources available to be employed in new, more valuable positions. All the while the economy forges ahead and market participants either adapt to a changed environment – as Rochester is – or suffer prolonged decline in returns to now obsolescent factors of production.

The West Midlands, United Kingdom

In the early 1970s Manners, et al., in their study on regional development in Britain, noted, "No other major industrial region of Britain has enjoyed such sustained economic progress, over so long a period and with so little interruption, as the West Midlands."[60] They later refer to it as a region of "unabated – even accelerating – expansion" and praise the region's high rate of firm births, its intense but versatile specialization in metalworking, engineering, and vehicle manufacturing, and healthy population growth and labor force participation rate.[61]

A decade later the region was suffering. The region was the hardest hit in the UK by the 1979 recession. Its unemployment rate grew faster than anywhere else in the country and leveled off at three times the national average in 1983. The region had hemorrhaged over 225,000 jobs between 1978 and 1983, over one third of the pre-recession total.[62] The relative economic decline of the region is captured in regional GDP per capita figures, which were 8% greater than the national average in 1965 but 10% lower by 1981.[63]

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[60] Manners, Gerald, et al., *Regional Development in Britain*, London: Wiley, 1972, p180.
[61] Ibid., p180, 184.
[62] Marshall and Mawson, "The West Midlands," in Damesick, P. and Wood, P., *Regional Problems, Problem Regions, and Public Policy in the United Kingdom*, Oxford: Clarendon Press, 1987, p95.
[63] Ibid., p99.

The region was heavily dependent on manufacturing. Over 40% of employment was in this sector, compared with 28% nationally. Four related sectors, vehicles, metal goods, mechanical engineering, and metal manufacturing, employed over half of the region's labor and over 30% of all employment was in large plants.[64] The region's industrial organization began changing fundamentally when the dominant resident industries began losing their competitiveness in the 1960s and started to rationalize through redundancy and restructuring. Overcapacity meant that firms were reluctant to invest and decreased profitability cut into R & D and innovation spending on behalf of smaller firms. Large firms took steps towards consolidation through mergers and acquisitions to exploit economies of scale, further concentrating the economic base of the region. Capital investment to employment ratios were the lowest of all UK regions.[65]

The economic malaise of the region was then exacerbated because it bore the brunt of the cost-cutting measures of the large firms upon which the regions were dependent. British Leyland/Austin Rover, for example, had a supply chain (though the firms were not exclusive suppliers of Leyland) of 4,000 local firms that collectively employed over 30% of the population in the West Midlands.[66] When the demand facing these firms collapsed and no new markets opened for their goods or related ones, these firms too went under. Between 1981 and 1985 approximately 11,000 firms were liquidated in the West Midlands, employment levels fell by 16%, unemployment rose by 9%, and 360,000 jobs were lost.[67]

The region has retained its manufacturing roots, though it continues to adjust. The current regional economic development plan sets the context: "Today, the region again faces the

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[64] Ibid., p97; Bull, P., "The Changing Geography of Manufacturing Activity," in Johnston, R. and Gardiner, V., *The Changing Geography of the United Kingdom*, London: Institute of British Geographers, 1991, p214-5.
[65] Marshall and Mawson, 1987, p101.
[66] Ibid., p99.
[67] Ibid., p121.

need for economic restructuring and reinvention, continuing a process that has been underway for at least 40 years."[68] Even today the region's growth is hampered by a relative skills deficiency – both on supply and demand sides of the equation.[69] Output per head is still only 89% of the national average. The employment rate is lower than the national average and the region is also less productive than its compatriots.[70] The region's population grew by only 0.7% in the decade up to 2001.[71] The West Midlands still leads UK regions in manufacturing employment as a share of total regional employment (15% in 2007 – down from 21% in 2001).

Data from the mid 1990s shows that innovative activity continues to be dominated by large firms, especially activity that brings a new product to the market.[72] Mole and Worrell (2001) attribute this to the dominance in the region of mature and vertically integrated industries. Whether the lack innovation in the SME sector is due to the maturity of the industry or its vertical integration (or the combination) is difficult to disaggregate and deserves further attention, but either would fit into the explanatory framework of this paper.

Theory implies that mature industries *will* face cost-competition and that mature industries *will* reduce employment levels over time. This is exactly happened in the West Midlands. The large firms had the resources to reinvent themselves, albeit at a smaller scale and with many productive sites relocated elsewhere. Unfortunately, other employment opportunities did not exist because of both the sheer number of unemployed and also because demand for and consequently returns to mass-production manufacturing skills (what the West Midlands economy was based on) were declining. The region was ill-prepared for a transition to either a service

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[68] "Connecting to Success: West Midlands Economic Strategy," Advantage West Midlands and West Midlands Regional Assembly, 2007.
[69] Ibid., p27.
[70] Eurostat: Portraits of a Region: West Midlands.
[71] Ibid.
[72] Mole, Kevin and Worrall, Les, "Innovation, Business Performance and Regional Competitiveness in the West Midlands," *European Business Review*, Vol. 13, Iss. 6, 2001, p359.

economy or a flexible and specialized manufacturing economy. Union presence was strong too, preventing wages from adjusting (though they are sticky even without unions influence) and reducing the attractiveness of the region to cost-conscious firms. In the Birmingham conurbation alone live over two million people, however, and the regional economy has since reshaped itself and rebounded. Its large population (it is the second largest market in the UK), its position at the center of the UK road and rail networks, and its proximity to larger UK and European markets surely hastened its recovery.

The *Ruhrgebiet* (Ruhr Area)

The Ruhr area has undergone a remarkable transformation in the last fifty years. The agglomeration economy originally grew around a fortuitous natural resource endowment of both coal and iron ore and was reinforced by forward and backward linkages among these and related industries. Its comparative advantage was iron clad (pun intended) and reinforced by the very transportation cost considerations that Krugman (1991) predicts leads to the agglomeration of certain economic activities.[73] The transportation of coal, iron ore, steel, and all downstream products is expensive. Since both coal and iron ore are necessary inputs into the steelmaking process, their geological clustering in the Ruhr naturally led to the geographic clustering of the steel industry. Producers relying on steel as an input faced the incentive to locate there too in order to minimize their own costs. The fact that the Ruhr was closest to (indeed at the center of) Europe's largest market only bolstered the regional advantage of the Ruhr.

The Ruhr evolved into a classic Marshellian industrial district, and the engine of the post-war *Wirtschaftswunder*. Referring to the Ruhr, Becattini explains:

> "The conditions of population density, presence of infrastructure, industrial atmosphere, which are both the source and the result, the cause and the effect of that part

[73] Krugman, 1990.

> of returns which cannot be explained either by internal economies of scale or by R & D, apply to the industrial district. It is this extra element of productivity which made the… Ruhr…stand out against the rest."[74]

The Ruhr area in its heyday enjoyed a stock of highly developed and highly specialized assets, both tangible and intangible. The infrastructure was attuned to the needs of heavy industry (iron and steel were the primary products, though the mining of ore and coal were related). The workforce was highly specialized and strongly unionized but as differentiated as the local firms in which they were employed, which covered every link in the supply chain. Firms were linked tightly and networks ran deep. Suppliers and their customers relied on strong relationships to reduce transaction costs. Local industry enjoyed political clout and a supportive institutional environment.[75]

Shortly after reconstruction began the regional economy took off. Already by 1950 the Ruhr accounted for 13% of German GDP but only 8% of the population.[76] The industry's Marshellian organization worked well throughout the 1950s and 1960s; the region grew and thrived. Demand was stable and growing, which fostered even closer links among firms with long-term orientations. Firms did not compete in the open market per se, because long-standing relationships with business partners were more profitable at the time. Business was conducted with greater ease and compatibility of supplies was ensured. Innovation was more of a joint venture than an individual firm imperative because a firm's customers were established and their preferences known.[77]

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[74] Becattini, G., "Sectors and/or districts: some remarks on the conceptual foundations of industrial economics," in *Small Firms in Industrial Districts in Italy*, London: Routledge, 1989, p132.
[75] Berndt, Christian, "Divisions of Labor, Power Asymmetries and Place Dependence: The Restructuring of Industrial *Mittelstand* Firms in the Ruhr Area," ESRC Centre for Business Research, University of Cambridge, Working Paper No. 58, 1997.
[76] Grabher, 1993, p257.
[77] Ibid.

There were vulnerabilities underlying this closely knit regional system of production. The Ruhr industries in question were very much organized along the lines of the 'German Model,' which emphasized strong ties, relied on close, cooperative and institutionalized labor relations, and rewarded quality, stability, and long-term investments in relationships and individual specialization.[78] Berndt identifies power asymmetries in these inter-firm ties and relationships which rendered certain producers wholly dependent on and reactive to the demand of long-established, larger enterprises.[79]

These power asymmetries also manifested themselves as informational asymmetries: suppliers to the larger, externally linked firms experienced the market *indirectly* through the firms downstream. Market signals were *relayed* to them, then interpreted through cognitive lenses attuned to (and possibly only perceiving) expected long-term stability. Any deviations were perceived as temporary and reconciled against the anticipated, stable long-term outlook. Power asymmetries were also used to transmit cost pressures progressively further upstream, though rationalization occured at all links in the supply chain.[80]

As the post-war boom petered out, demand slowed because the income elasticity of demand for iron and steel, it is estimated, halved and fell sharply below one.[81] Lower cost competition from abroad also threatened the Ruhr iron and steel complex not just at home but in international markets as well. Between 1977 and 1986 employment in the iron and steel industry fell by over 23% and over 100,000 workers lost their jobs in the first half of the 1980s.[82] At its peak, the industry employed 580,000 workers; today it employs 119,000.[83] Into the late 1980s

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[78] Berndt, 1998, p335-336. See also: Berndt, 1997.
[79] Ibid., p334.
[80] Ibid., p344, 345.
[81] Schlieper, A., *150 Jahre Ruhrgebiet – Ein Kapitel deutscher Wirtschaftsgechichte*, Duesseldorf: Schwann, 1986, p 178.
[82] Grabher, 1993, p256.
[83] Eurostat: Portrait of a Region: Duesseldorf

unemployment was approximately 8% higher than the national average and 9 weeks longer in duration. Absolute levels of steel production had already declined by 1982 and machine building output had stagnated already in 1977, losing market share to other *domestic* competitors.[84]

A supply-side analysis of the Ruhr's decline illuminates the ambivalent nature of certain aspects of industrial districts. Grabher's term "rigid specialization" captures the means by which assets derived by an industrial location can turn into liabilities. The industry founded upon specialization and strong linkages among firms is susceptible to rigidity in the face of a changing market environment.

Crucial in the Ruhr to why productive resources were not redeployed readily elsewhere was the fact that many assets were not *redeployable*. Small and medium firms (in Germany, the *Mittelstand*), with few and in some cases only a single long-term, trusted customer will develop asset specificity.[85] Their assets (capital, mostly physical but human also applies) were specialized to serve a certain firm with a certain product on certain long-standing and mutually agreed upon terms. The physical assets of such a firm are quickly rendered useless once the relevant market disappears. The fixed stock of capital in a time of transition, then, falls. Labor is rendered less productive as a consequence, threatening output and income.

The major Ruhr firms, once they recognized the nature of their new environment, did attempt to reinvent themselves without abandoning their base. The "coal, iron and steel" technological trajectory was still firmly in place, but the business models and modus operandi of regional industry had to be revamped. The strategy embraced by most firms was to utilize the specialized assets they possessed to begin higher value-added production in more niche markets, a strategy that has worked rather well to this day for firms like Thyssen-Krupp.[86] Many medium-

[84] Grabher, 1993, Figure 12.1.
[85] Carlton & Perloff, *Modern Industrial Organization*, 4th Ed., New York: Pearson, 2005, p409.
[86] Grabher, 1993, p267.

sized firms leveraged their existing networks and relationships with larger firms to themselves internationalize and diversify successfully, 'piggybacking' their way to diversification of demand, recovery, and success.[87] Note that restructuring was necessary (for example, the aforementioned merger) and hardly painless, especially for smaller firms with less capital at their disposal.

The Ruhr has recovered from its slump as a reinvented economic entity. It has done so not by abandoning its core but by adapting to a new economic environment. Many firms have (re) established themselves as worldbeaters and the Ruhr steel industry is competitive and profitable, flexible and in tune with the market and its niches. Links within regional industry are still strong, but less rigid, more market based, and oriented globally. For example, eight out of eleven *Mittelstand* firms analyzed by Berndt in the iron and steel industry indicated that at least 40% of their output was still sold locally in 1995.[88] The region has successfully diversified and spawned new, modern industries *related to the core industry*, as the evolutionary model predicts. A telling indicator of a modernized Ruhr lies in education: Before 1965 the region was home to zero universities; by 1995 there were six, complemented by six polytechnics, four Max Planck and two Frauenhofer Institute centers, making it one of the densest milieus for higher education in Europe.[89]

An innovative environmental technology sector has emerged too, capitalizing on the region's experience with negative externalities, its specialized knowledge about the production processes of heavy and dirty industries, and on a new and unique market opportunity offered by politics (EU climate directives and Kyoto emissions protocols, for example) and changing

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[87] Berndt, 1998.
[88] Ibid., p338.
[89] Hudson, R., "Institutional Change, Cultural Transformation, and Economic Regeneration. Myths and Realitites from Europe's Old Industrial Areas," in Amin, A. and Thrift, N., (eds), *Globalization, Institutions and Regional Development in Europe*, Oxford: Oxford University Press, 1994, p201.

consumer preferences. The Ruhr is then an exemplary example of a region and a collection of industries that has successfully restructured *from within* in the face of a dramatically changing environment and a reshaped competitive landscape.

Statistical Analysis:

Background

The original goal here was to present a statistical analysis that tested whether the dominance of a single sector in a region is related to slow growth and innovation outside of that dominant sector. The implication of this would be that regional specialization in one industry precludes the emergence of another. Regional economies dominated by mature industries are then locked into relative decline since those industries naturally rationalize production as time progresses (increase the capital to labor ratio and take steps to exhaust and enhance economies of scale). This is an extension of the hypothesis that a region will be more susceptible to prolonged decline if there is a large and mature industrial presence in the region, because mature industries are presumably less innovative and foster a less innovative and dynamic culture, for the reasons expressed above.

A negative and significant relationship between the share of a dominant industry in regional output and employment and growth in output and employment in other, unrelated sectors would indicate a lack of economic diversity and entrenched dependence on that dominant sector. Note that no mention has been made of growth *within* that dominant industry. This is because we are interested in how undiversified regions fare in the face of both Schumpeterian challenges to core industries and a comparatively stagnant, maturing industrial base. A lack of diversification will be a liability if the core industry is hit by some exogenous and adverse shock, as standard diversification theory suggests, or even as the industry matures, mechanizes, and

rationalizes.[90] Without growth in other sectors, redundant workers will be unable to find gainful employment and local income will fall. We expect that the ease of successful transition into other, new and growing sectors is positively related to diversification/heterogeneity in the long run.[91]

The Nature of the Data

Unfortunately, establishing what makes a mature industry mature involves an element of subjectivity. It turns out, however, that I did not have to make this arbitrary distinction because a complete set of relevant data was unobtainable. The U.S. government appears quite adept at parrying off any attempt to find meaningful data at relevant microeconomic spatial levels. Metropolitan Statistical Area (MSA) level data is the most appropriate for my analysis, which defines a region along economic, not political boundaries.[92] Cities are too small, especially considering the spatial organization of business and industry since the 1950s (referring to the rise of the suburbs). Counties are an improvement but still too small because labor markets, obviously an integral part of any regional system of production, cross country lines. States are much too large for, after this analysis, I hope obvious reasons. In retrospect though, the Census Bureau's County Business Pattern data may have been more complete and therefore useful, though it is painfully disaggregated.

The second problem I encountered early on was finding a metric for the economic/ industrial diversification of a region that measures the share of the largest sector at the 3- or 4-digit NAICS level in MSA GDP and employment, or better yet, some sort of specialization index at the MSA level. Unfortunately I was unable to find any such convenient metric and the

[90] A study by Trendle (2006) suggests that the evidence on the contribution of diversification to economic stability is inconclusive at best, however.
[91] Bathelt, 2001, agrees.
[92] "Final Report and Recommendations From the Metropolitan Area Standards Review Committee to the Office of Management and Budget Concerning Changes to the Standards for Defining Metropolitan Areas," Executive Office of the President, Office of Management and Budget, 2000: http://www.whitehouse.gov/omb/inforeg/metro2000.pdf

regional data beyond the 2-digit NAICS level is kept almost exclusively confidential. Therefore, I was forced to construct a simple (some might say – and I would agree – crude) measure of specialization (or dominance of a sector) by finding the share of manufacturing output and employment in MSA total.[93]

Thirdly, establishing the effect of sectoral dependence on innovation is a challenge since innovation is notoriously difficult to measure and its effects on regional welfare are even more so. Patent activity is the most widely used metric, but the link between patenting and local welfare improvements is tenuous at best. Productivity growth would probably be the most ideal proxy but is available for industries, not MSAs.[94] Regional GDP growth is used as a satisfactory proxy since it captures and aggregates the market performance of a region's firms, presumably incorporating innovation.

The fourth foundational flaw of my statistical analysis is that regional GDP ignores the regional distribution of income and is therefore an imperfect proxy for the well-being of a locality. Even worse, income from innovations that increase output and profitability may accrue to distant shareholders instead of local residents. Median wages or wage growth, perhaps indexed to the national average or inflation, would be the best metric for regional prosperity. Unfortunately, median earnings by metropolitan statistical area (MSA) only come out with the census every ten years, and MSA data only began being collected with the 2000 Census.[95] Average wage growth is used instead.

The final problem is that the relevant time frame is actually quite long. When arguing that history matters, it makes good sense to include history in a dataset. That the data presented

[93] Data is from the Bureau of Economic Analysis, Regional Indicators.
[94] Available from the Bureau of Labor Statistics.
[95] "Final Report and Recommendations From the Metropolitan Area Standards Review Committee to the Office of Management and Budget Concerning Changes to the Standards for Defining Metropolitan Areas," Executive Office of the President, Office of Management and Budget, 2000: http://www.whitehouse.gov/omb/inforeg/metro2000.pdf.

here spans only five years is a serious shortcoming. Archived data going back beyond 2000 was not available to the public by the Bureau of Economic Analysis (BEA), the primary source of data for this paper. But it is plausible that the industrial base of a region does not change drastically more in ten years than it does in five, so it was worth continuing the study, in my opinion, nevertheless. A longer time span would have required a time series analysis anyway, the complexity of which is beyond the scope of this paper. And if, as hypothesized, the industrial base of one period influences the evolution of the industrial base in the next, its influence should be just as strong, if not stronger, in the short term as in the long.

Set-up

The statistical analysis is comprised of two parts: a linear regression and a correlation. Three independent variables were identified for three different regressions: the share of manufacturing in regional GDP in 2001 (manusha~2001); the share of mining, natural resource extraction and manufacturing in regional GDP in 2001 (miningm~2001); and the share of manufacturing employment of total employment in 2000. The dependent variables regressed against all three were: the growth rate regional GDP from 2001-2005 (growt~200105); the growth rate of output in the IT sector (itgrowth); the financial sector (financegrow~h); professional and technical services (proftechse~h); management (mgmtgrowth); computer manufacturing (compmanugr~h); the 2005 unemployment rate (unemp2005); the rate of population change (popch~200105); and average wage growth (avgwagegro~h). The correlation was taken for each independent variable.

The results were disappointing but expected because of the poor quality of the data, the short time period, and the acknowledgement that many varied economic forces, both endogenous and exogenous, are at work in any one locale. Any relationships uncovered were expected to be

subtle rather than definitive. Given the limitations, the aim was to see what comes out of the data, not to use the data to confirm conclusively any hypothesis. Keeping this in mind, the regression results below do offer some interesting information.[96]

[96] Please see the appendix for the complete data set.

Data

```
. regress growthrate200105 manushare2001 miningmanushare2001 manuemp2000
```

Source	SS	df	MS		
Model	1180.30016	3	393.433387	Number of obs	236
Residual	18357.1574	232	79.1256786	F(3, 232)	4.97
				Prob > F	0.0023
Total	19537.4576	235	83.1381174	R-squared	0.0604
				Adj R-squared	0.0483
				Root MSE	8.8953

growt~200105	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
manusha~2001	15.76708	17.24916	0.91	0.362	-18.21794	49.7521
miningm~2001	-13.48776	11.26955	-1.20	0.233	-35.69149	8.715972
manuemp2000	-.3552186	.1902108	-1.87	0.063	-.7299798	.0195426
_cons	17.89267	1.457687	12.27	0.000	15.02068	20.76467

```
. regress itgrowth manushare2001 miningmanushare2001 manuemp2000
```

Source	SS	df	MS		
Model	16252.5264	3	5417.50879	Number of obs	192
Residual	280544.164	188	1492.25619	F(3, 188)	3.63
				Prob > F	0.0140
Total	296796.691	191	1553.90938	R-squared	0.0548
				Adj R-squared	0.0397
				Root MSE	38.63

itgrowth	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
manusha~2001	-18.90736	83.62206	-0.23	0.821	-183.8655	146.0508
miningm~2001	80.12373	51.48103	1.56	0.121	-21.43097	181.6784
manuemp2000	-1.714128	.9577835	-1.79	0.075	-3.603512	.1752555
_cons	52.67707	6.920292	7.61	0.000	39.02567	66.32847

```
. regress financegrowth manushare2001 miningmanushare2001 manuemp2000
```

Source	SS	df	MS		
Model	5825.21446	3	1941.73815	Number of obs	214
Residual	62038.0706	210	295.419384	F(3, 210)	6.57
				Prob > F	0.0003
Total	67863.285	213	318.606972	R-squared	0.0858
				Adj R-squared	0.0728
				Root MSE	17.188

financegro~h	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
manusha~2001	-4.389932	34.99081	-0.13	0.900	-73.36818	64.58831
miningm~2001	-1.277043	21.95252	-0.06	0.954	-44.5526	41.99851
manuemp2000	-.6536433	.3961356	-1.65	0.100	-1.434555	.1272686
_cons	21.52939	2.918091	7.38	0.000	15.77688	27.28189

```
. regress proftechservicesgrowth manushare2001 miningmanushare2001 manuemp2000
```

Source	SS	df	MS		
Model	5342.54992	3	1780.84997	Number of obs	152
Residual	65749.3263	148	444.252205	F(3, 148)	4.01
				Prob > F	0.0089
Total	71091.8762	151	470.807127	R-squared	0.0751
				Adj R-squared	0.0564
				Root MSE	21.077

proftechse~h	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
manusha~2001	-6.896986	51.57242	-0.13	0.894	-108.8104	95.01643
miningm~2001	13.95902	28.67524	0.49	0.627	-42.70675	70.6248
manuemp2000	-.8476366	.6131138	-1.38	0.169	-2.059225	.3639513
_cons	33.41487	4.139248	8.07	0.000	25.23521	41.59453

```
. regress mgmtgrowth manushare2001 miningmanushare2001 manuemp2000
```

Source	SS	df	MS		
Model	4734.69507	3	1578.23169	Number of obs	132
Residual	849935.788	128	6640.12334	F(3, 128)	0.24
				Prob > F	0.8699
Total	854670.483	131	6524.20216	R-squared	0.0055
				Adj R-squared	-0.0178
				Root MSE	81.487

mgmtgrowth	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
manusha~2001	102.33	215.2477	0.48	0.635	-323.5743	528.2342
miningm~2001	35.99681	119.7716	0.30	0.764	-200.9918	272.9854
manuemp2000	-1.539065	2.496762	-0.62	0.539	-6.479334	3.401204
_cons	26.97691	16.93853	1.59	0.114	-6.538858	60.49269

```
. regress compmanugrowth manushare2001 miningmanushare2001 manuemp2000
```

Source	SS	df	MS		
Model	164061.242	3	54687.0805	Number of obs	96
Residual	6358760.08	92	69116.9574	F(3, 92)	0.79
				Prob > F	0.5018
Total	6522821.32	95	68661.2771	R-squared	0.0252
				Adj R-squared	-0.0066
				Root MSE	262.9

compmanugr~h	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
manusha~2001	1123.967	797.0452	1.41	0.162	-459.0334	2706.968
miningm~2001	-133.091	401.4259	-0.33	0.741	-930.3576	664.1756
manuemp2000	-11.77006	10.06066	-1.17	0.245	-31.75139	8.211278
_cons	118.1114	69.39087	1.70	0.092	-19.70485	255.9277

```
. regress unemp2005 manushare2001 miningmanushare2001 manuemp2000
```

Source	SS	df	MS		
Model	67.1227712	3	22.3742571	Number of obs	236
Residual	525.753507	232	2.26617891	F(3, 232)	9.87
				Prob > F	0.0000
Total	592.876278	235	2.52287778	R-squared	0.1132
				Adj R-squared	0.1017
				Root MSE	1.5054

unemp2005	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
manusha~2001	-6.600994	2.91915	-2.26	0.025	-12.35243	-.849562
miningm~2001	9.188557	1.907194	4.82	0.000	5.430924	12.94619
manuemp2000	.0147609	.0321902	0.46	0.647	-.0486615	.0781834
_cons	4.357076	.2466906	17.66	0.000	3.871036	4.843116

```
regress avgwagegrowth manushare2001 miningmanushare2001 manuemp2000
```

Source	SS	df	MS		
Model	.05630457	3	.01876819	Number of obs =	236
				F(3, 232) =	16.98
Residual	.256407004	232	.001105203	Prob > F =	0.0000
				R-squared =	0.1801
				Adj R-squared =	0.1694
Total	.312711575	235	.001330688	Root MSE =	.03324

avgwagegro~h	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
manusha~2001	-.1332383	.0644659	-2.07	0.040	-.2602518	-.0062249
miningm~2001	.0169333	.0421181	0.40	0.688	-.0660495	.0999162
manuemp2000	-.000598	.0007109	-0.84	0.401	-.0019986	.0008026
_cons	.1680502	.0054479	30.85	0.000	.1573166	.1787838

```
. regress popchange200105 manushare2001 miningmanushare2001 manuemp2000
```

Source	SS	df	MS		
Model	.109275025	3	.036425008	Number of obs =	235
				F(3, 231) =	13.56
Residual	.620660169	231	.002686841	Prob > F =	0.0000
				R-squared =	0.1497
				Adj R-squared =	0.1387
Total	.729935194	234	.003119381	Root MSE =	.05183

popch~200105	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
manusha~2001	-.1632639	.1005285	-1.62	0.106	-.3613339	.0348062
miningm~2001	.0120742	.0656821	0.18	0.854	-.1173383	.1414866
manuemp2000	-.001016	.0011088	-0.92	0.360	-.0032007	.0011686
_cons	.0899437	.0084996	10.58	0.000	.073197	.1066904

```
. save "F:\Regression 2.dta"
file F:\Regression 2.dta saved

. corr  manushare2001 growthrate200105 itgrowth financegrowth proftechservicesgrowth mgmtgrowth compmanugrowth unemp2005
>  popchange200105 avgwagegrowth
(obs=92)
```

	man~2001	g~200105	itgrowth	financ~h	profte~h	mgmtgr~h	compma~h	une~2005	p~200105	avgwag~h
manusha~2001	1.0000									
growt~200105	-0.3359	1.0000								
itgrowth	-0.2690	0.4374	1.0000							
financegro~h	-0.2867	0.6041	0.3920	1.0000						
proftechse~h	-0.3233	0.5342	0.4059	0.3488	1.0000					
mgmtgrowth	0.0619	0.1095	0.1156	0.0607	0.0635	1.0000				
compmanugr~h	0.0580	0.0415	0.0590	0.0919	-0.0887	-0.0870	1.0000			
unemp2005	-0.0208	-0.0338	0.0720	-0.1245	-0.0493	-0.0391	-0.0006	1.0000		
popch~200105	-0.3772	0.6750	0.3967	0.5063	0.4470	0.1343	-0.0004	0.0196	1.0000	
avgwagegro~h	-0.4348	0.6899	0.4731	0.4632	0.4439	-0.0530	0.0045	-0.0044	0.4873	1.0000

```
. corr  miningmanushare2001 growthrate200105 itgrowth financegrowth proftechservicesgrowth mgmtgrowth compmanugrowth une
> mp2005 popchange200105 avgwagegrowth
(obs=85)
```

	min~2001	g~200105	itgrowth	financ~h	profte~h	mgmtgr~h	compma~h	une~2005	p~200105	avgwag~h
miningm~2001	1.0000									
growt~200105	-0.3577	1.0000								
itgrowth	-0.1475	0.4284	1.0000							
financegro~h	-0.2745	0.6045	0.3790	1.0000						
proftechse~h	-0.1722	0.5541	0.4331	0.2891	1.0000					
mgmtgrowth	-0.0503	0.0981	0.1697	0.1388	0.0935	1.0000				
compmanugr~h	0.0271	0.0337	0.0510	0.0771	-0.1245	-0.1106	1.0000			
unemp2005	0.2192	-0.0283	0.0690	-0.1249	-0.0316	-0.0155	0.0023	1.0000		
popch~200105	-0.2982	0.6794	0.3834	0.4775	0.4336	0.2203	-0.0156	0.0162	1.0000	
avgwagegro~h	-0.2727	0.7028	0.4644	0.4561	0.5075	0.0120	-0.0002	-0.0165	0.4753	1.0000

```
. corr  manuemp2000 growthrate200105 itgrowth financegrowth proftechservicesgrowth mgmtgrowth compmanugrowth unemp2005 p
> opchange200105 avgwagegrowth
(obs=78)
```

	man~2000	g~200105	itgrowth	financ~h	profte~h	mgmtgr~h	compma~h	une~2005	p~200105	avgwag~h
manuemp2000	1.0000									
growt~200105	-0.3033	1.0000								
itgrowth	-0.3052	0.4732	1.0000							
financegro~h	-0.3344	0.5483	0.4635	1.0000						
proftechse~h	-0.3827	0.5440	0.4406	0.2956	1.0000					
mgmtgrowth	0.0802	0.0768	0.1283	0.0525	0.0594	1.0000				
compmanugr~h	0.0502	0.0432	0.0523	0.1172	-0.0823	-0.0782	1.0000			
unemp2005	0.0184	-0.0033	0.0844	-0.0332	-0.0133	-0.0416	0.0153	1.0000		
popch~200105	-0.4482	0.6790	0.4260	0.4871	0.4755	0.1614	-0.0265	0.0655	1.0000	
avgwagegro~h	-0.4294	0.6972	0.5109	0.4653	0.4799	-0.1038	0.0307	-0.0189	0.5345	1.0000

Discussion

Only three statistically significant relationships at the ninety-five percent confidence interval were established, one at ninety-nine percent, and three more were significant at ninety percent. Tellingly, the *highest* R-squared value that came out of the nine regressions was 0.1801, for average wage growth. The explanatory power of my independent variables is negligible. The strongest correlation was found between average wage growth and GDP growth, falling between 0.6899 and 0.7028, depending on the data set used. There were very few observations that went into the correlation analysis by the time incomplete data sets (due to confidentiality of just one variable for any MSA) were thrown out.[97]

The reader should remember that approximately one third of the dataset for this regression was kept confidential. A sample selection bias cannot be ruled out – it would be unsurprising if those MSAs that fared the worst or those dominated by a single firm or sector kept their data confidential. The more diverse a region's economic base, the harder it is to disaggregate the data and attribute shares to local producers or industries. This is presumably why data at the NAICS 3 and 4 digit level was almost universally unavailable and why the broader "manufacturing" sector designation had to be used here.

There are huge differences disguised then within this "manufacturing sector" variable. It ignores entirely the industrial organization in a region and the diversity of the manufacturing base. But a corollary argument of this paper is that there are common elements to and inherent characteristics of industrial regions that explain their rather pervasive decline. Manufacturing share of regional GDP should capture this, so my data analysis will continue with some pretense of worth and issuing the caveat that a large yet diverse manufacturing sector could still be an engine of innovation, dynamism and growth.

[97] Because so much of the data for the 365 MSAs was kept confidential, all values for any given MSA were thrown out of the data set, leaving only 78, 85 and 92 complete observations for the correlations, respectively.

The share of mining and manufacturing in regional GDP in 2001 apparently explains the unemployment level in 2005 with over ninety-nine percent confidence. The share of manufacturing alone does so with over ninety-five percent confidence. Disturbingly and confoundingly though, manufacturing has a negative coefficient while mining and manufacturing has a positive coefficient. Remember that both are significant. Also confounding the results is the fact that the share of manufacturing employment in 2000 has nothing to do with later unemployment. I double-checked the data sets for input flaws at any step and found nothing. I will reiterate that time series data would have been more useful.

This trend holds true for seven of the nine regressions. I am especially surprised because the share of mining in comparison to that of manufacturing was relatively much smaller for most observations. That it changed the results so completely and so significantly does not make sense. I encourage the reader to look at the data set to confirm. One possible explanation is that the value of mining sector output, which includes natural resource extraction, fluctuates with commodity prices. This would imply that the gross product of these industries bears little relationship to other indicators. But the most valuable commodities are concentrated geographically – if market prices dramatically skewed the values, this would reveal itself as outliers or larger standard deviations.

The only other significant relationship uncovered linked the average growth rate of wages from 2001 to 2005 to the share of manufacturing in regional GDP in 2001. The coefficient is negative, as expected. This indicates that wages grew slower in regions with a larger manufacturing base at the start. In other words, the returns to labor increased at a slower rate in these regions, implying that labor's product is relatively less valuable here. Although not conclusive, this evidence suggests that the local workforce may be ill-suited for high-paying, high-skilled jobs, or, from a supply-side perspective, that demand for skilled labor is low and

innovative, value-added production is not taking place. Either way, the results show that a large manufacturing sector has a negative relative impact on welfare (measured by wages).

Unknown are the sectors in which wages are growing, and which sectors are growing themselves. Nevertheless, low wage growth means low productivity growth (in theory, at least) and low growth in value added per unit of labor. Growth in high-paying service (or any other) jobs would be reflected in average wage growth, since wages would presumably rise. The opposite is true for low-paying jobs. Growth in both, away from average wage jobs, would not be discernable.

Another problem with growth rates is that they disregard absolute levels of whatever is being measured. Here, no account is taken of how high a region's wages are to begin with, or whether a large manufacturing sector is related to higher or lower wages broadly. Since this paper is concerned with dynamic effects, however, this is not a serious shortcoming.

If we sacrifice significance and broaden the confidence interval to ninety percent for the sake of discerning trends and influence, not for establishing causality, three more relationships appear. First, the share of manufacturing employment in a region in 2000 seems to negatively influence regional GDP growth in later periods. This finding fits with the prediction that a dominant manufacturing sector is not conducive to longer term growth not only in that sector, but in all sectors. Growth, after all, depends on innovation, the capacity for which we claim here the dominance of manufacturing hinders. If it were possible to disaggregate mature from young manufacturing industries, this relationship would likely be much stronger. Still, this result provides evidence that an industrial labor force is ill-suited for innovation and growth.

Adding more evidence to support the conjecture that an industrial labor force is ill-suited for innovation is our second result in which low growth in the information and technology sector can be explained in part by the share of local employment in manufacturing. This holds true for financial sector growth as well. Direct causality is not established, but it is reasonable to suggest

that a dominant manufacturing sector exerts some negative influence over growth in other sectors and the local economy as a whole.

Finally, population change appears to be negatively related to the share of manufacturing in regional GDP as well. As time progresses and manufacturing industries mature and require less labor to produce any given level of output, we would expect to see fewer new jobs and stagnant wages in the region, since "sticky" wages do not adjust downwards to ensure full regional employment. Labor that is mobile and responsive to wage differentials between regions would move from the region and avoid moving to the region, as this result attests.

The most surprising finding for me was the total lack of a discernible relationship between the share of manufacturing employment in 2000 and the unemployment rate in 2005, though the correlation coefficient is expectedly positive. Either unemployment in the manufacturing sector is as a rule low, or, as I would guess, much unemployment is long term and leads to workers exiting the labor force. It seems implausible that unemployment is not a manufacturing sector (mature or not) problem. A measure of employment growth might have painted a more complete picture.

I had debated including computer manufacturing growth as a proxy for the emergence of a high-tech, comparatively "new" manufacturing industry because of endogeneity problems, since this NAICS 3-digit subsector is included in the 2-digit manufacturing sector data. No relationships proved significant however, and the R-squared value of 0.0252 was the lowest of any regression. Were I to repeat the regression though, I would be sure to subtract the share computer manufacturing in regional GDP and employment from regional totals first before regressing computer manufacturing growth on the independent variables.

The regression analysis intimates that the manufacturing sector's influence on growth in other sectors and therefore growth prospects outside of the manufacturing sector is limited and unpredictable. As mentioned before, the fact that I was unable to isolate mature industries – or

any industries for that matter – limited the relevance of the regression from the very beginning. Nevertheless, the sheer lack of causality or even correlation uncovered by the data is surprising.

The correlations do not offer any real conclusive results either.[98] The coefficient between the share of manufacturing in 2001 and average wage growth is -0.4348, the highest value of that set. This can be interpreted to mean that the preponderance of manufacturing in a region and the incidence of lower wage growth tend to coincide, but the direction of causality cannot be determined, and the relationship is not definitive (coincidence cannot be ruled out). Some weak support for the contention that manufacturing depresses regional *growth* is offered here.[99] The virtually nonexistent relationship between the relative size of the manufacturing sector and unemployment appears here too. Add mining to the equation and all correlations disappear.

The highest correlation (0.7028) was between growth and average wage growth (two of our dependent variables). This can be interpreted in two ways. One, this could reflect that growth in value of output is being transferred back to workers and is indeed improving local welfare. The other interpretation is that the relatively weak correlation by statistical standards points to gross inequities in the system, where workers do not enjoy the full fruits of their labor. No judgment on this will be passed here, but the finding is provocative. The next strongest correlation was between another set of dependent variables, regional GDP growth and population growth (0.6794), which should be self-explanatory.

The employment share of manufacturing is somewhat correlated with lower population growth (-0.4482) and lower average wage growth (-0.4294). Encouragingly, the signs of the coefficients are all in the predicted direction. All three independent variables are negatively but insignificantly correlated with regional GDP growth, IT sector growth, financial sector growth, professional and technical services growth, population growth, and average wage growth. The

[98] Only the first column in the correlation data set is relevant.
[99] It should be noted though that U.S. manufacturing *output* is still growing, and the U.S. is still the world's largest manufacturer. Output data does **not** reflect regional welfare though because it does not reflect employment and wage conditions. Unfortunately, it is output data that is the best collected and easiest to work with.

hypothesis of this paper is then, while far from unequivocally confirmed, not rejected by the correlation analysis. We are unable to determine whether the explanatory factors identified in other sections of this paper are indeed the forces at work behind these results though.

The statistical analysis here provided no conclusive results, but did allude to some relationships among variables that were worth mentioning. I hope that interested parties are intrigued by these preliminary results, which highlight the need for an advanced statistical analysis. Any further study should use time series data from a longer period – ideally, MSA data would extend back from the 1950s, when many of the regions "in decline" today were thriving, and into the 1980s at least, to observe regional development over the cycle. It would be interesting to see if there is an optimal level of diversification for a region in the long run – too much could be just as detrimental as too little (or ineffectual) since specialization and tacit knowledge are still sources of competitive advantage. Still, diversification is a good proxy for ideas in the air, which is, after all, where innovation begins. The inclusion of some other variables like entrepreneurship or culture would also augment any analysis.

Concluding Thoughts

All industries will encounter at the very least cost competition as they mature, and in all likelihood will be threatened by an innovation that attacks the product around which that industry is organized at its most basic elements. Firms and the factors of production which they employ have the ability to restructure, retrain, or reinvent themselves and be put towards productive use again. So how firms, factors and actors react is a key determinant of the extent of economic dislocation suffered by either industrial maturation or innovation (interestingly, two opposites with similar long-run implications). Systems of production – related firms and factors – localize and cluster in space, so their fate becomes a "regional" fate along deeps channels of interdependencies. How adaptive and resilient these regional systems of production are – which has a lot to do with the transferability and transformability of the regional factors of production:

land, labor and capital – will determine how a region fares *as the capitalist engine continues ahead normally*.

Innate characteristics of "regional systems of production" are not easily observable or quantifiable, unfortunately. Nor is the force identified earlier and attributed with being one of the primary causes of regional decline: stability, ironically. Stability encourages the institutionalization of the status quo. Routinization becomes ingrained and regional "fitness" in the evolutionary sense suffers the longer the market conditions stay the same. This is especially applicable to mature industries, which have already passed through the competitive phase of the product cycle and expect no entry. Complement this maturing industrial base undergoing a gradual but constant rationalization process with a maturing workforce, little entrepreneurial experience and specialized but untransferable knowledge and you have yourself a recipe for economic hardship in the face of change.

It is important to remember that the firms remaining in mature industries *are* the ones that can compete on costs. They survived the competitive struggle and are stronger for it. They know competitive discipline and they know how to react to it. These are the firms that wheedled the industry into its mature state and organization. Their business models have worked and been successful for so long that they are deservedly unchallenged. It is reasonable and rational to believe that if a business model has worked in the past then it should work in the future. This orientation spills over to related firms and workers too. Is not such an industrial orientation though, in the long run, irreconcilable with an economic system that subsists off change?

What explains the decline of old industrial regions then? Not external forces like low cost competition from abroad, but rather the very specialization of the factors of production which made that region and resident industries successful in the first place. In a way, their decline is linked to their longevity. The longer their habits were left fundamentally unchallenged, and the longer they continued to derive success from them, the harder those habits

are to break. So the very organizations, divisions of labor within and among firms, routines, cognitions and heuristics that served an industry and its dependents in space so well period become ingrained and institutionalized, thus leaving the industry ill-prepared for the coming of the grim reaper of obsolescence. All else equal, industry maturity alone, if the industry is dominant in the region, will cause regional economic decline. The simple reason is that fewer workers will be needed to produce the same output as the industry matures, and the limited transferability of traditional skills into the modern sector ensures lasting unemployment and stagnant wages. An industry rendered fundamentally inferior to a new, insurgent technology will also effect regional decline, if the regional system of production is unable to reinvent itself.

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Appendix 1

Knowledge Networks in Rochester, New York from Safford, 2004.

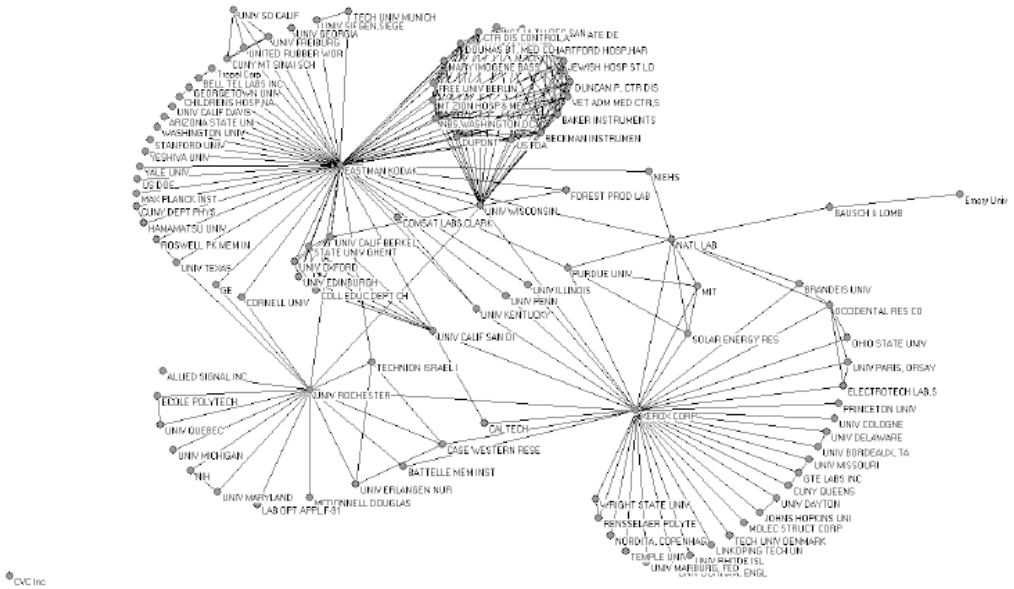

Figure 3.b Rochester's Knowledge Network 1980-1982

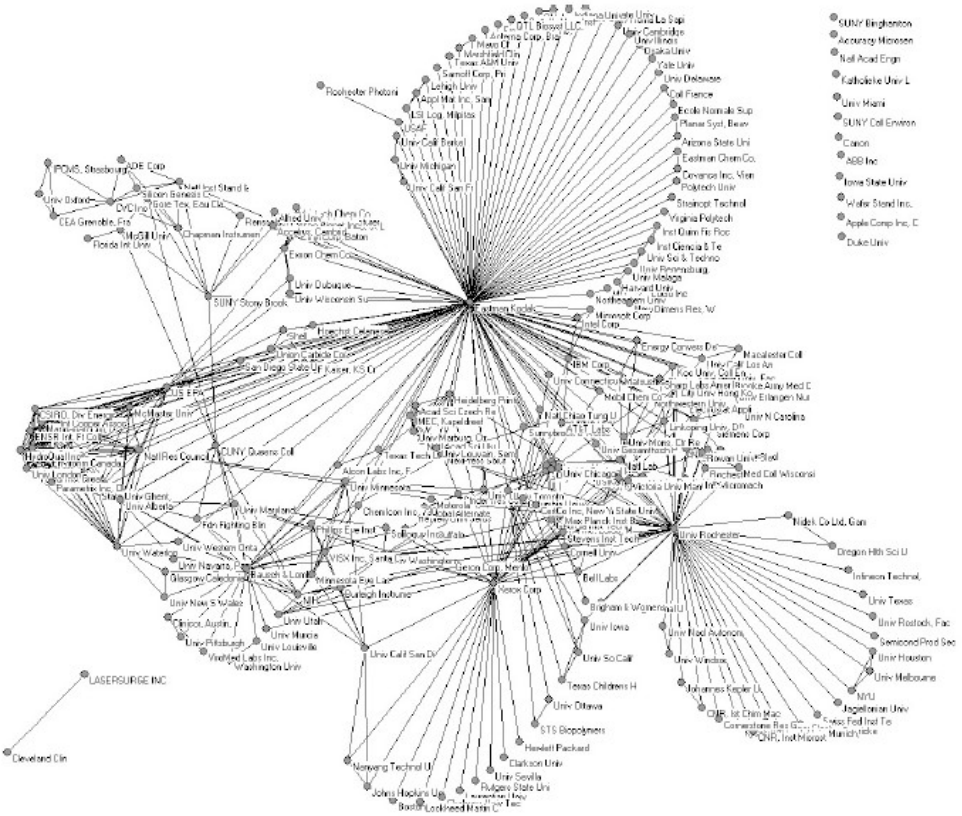

Figure 3.d Rochester's Knowledge Network 2000-2002

Appendix 2:
Forms and Sources of Regional Lock-in from Martin and Sunley, 2006.

Source	Features
Natural resource based	Region's development path shaped by dependence on a particular raw material (e.g. coal, oil, forestry products, etc.), and the technical possibilities this provides for related and derived industries
Sunk costs of local assets and infrastructures	Durability ('quasi-irreversibilty') of a region's capital equipment, especially in heavy industries, and its physical infrastructures, such as urban built form, transport system and the like, which remain in use, and shape economic development possibilities, because fixed costs are already sunk' while variable costs are lower than total costs of replacement
Local external economies of industrial specialization	Local industrial districts and clusters of specialized economic activity characterized by Marshallian-type dynamic externalities and untraded interdependencies—common pool of specialist skilled labour, dedicated suppliers and intermediaries, local knowledge spillovers and local co-ordination effects in terms of business mechanisms, such as networks of co-operation, business practice conventions, etc., all of which create a high degree of local economic 'interrelatedness'
Regional technological 'lock-in'	Development of a distinctive specialized regional technological regime or innovation system through processes of local collective learning, mimetic and isomorphic behaviour, dedicated technology and research organizations, interfirm division of labour and other forms of technical interrelatedness
Economies of agglomeration	Generalized self-reinforcing development based on various agglomeration externalities, such as a diverse labour pool, large market, thick networks of input–output relations, suppliers, services and information. Wide scope for various specialist functions and activities
Region-specific institutions, social forms and cultural traditions	Development of locally specific economic and regulatory institutions, social capital, social infrastructures and traditions, all which embed economic activity into local trajectory
Interregional linkages and interdependencies	Development paths in a region may be shaped by those in other regions, though intraindustry and interindustry linkages and dependencies; reliance on financial institutions elsewhere; and influence exerted by economic and regulatory policies pursued in other regions and at national level (or even beyond). Regional development paths co-evolve in complex ways

Appendix 3:

The Profit Cycle from Markusen, 1985.

Table 3.1
Business behavior across the profit cycle

Profit cycle stage	Experimentation	Innovation	Competition	Maturity	Decline
Output, cost, price, profits, investment					
Output (physical)					
Level	Low	Moderate	Moderate/high	Moderate/high	Low
Growth	Slow to rapid+	Rapid++	Moderate+ to moderate−	Slow+ to rapid+	Rapid−
Price (real)					
Level	High	Moderate	Low	Low to moderate	Low
Growth	Rapid−	Moderate−	Moderate−	Moderate+ to moderate−	Stable to slow
Unit cost	High	Moderate	Low	Moderate to low	Moderate
Profitability	Low	High	Moderate	Low to moderate+	Low
Investment in new capacity	Low	High	Moderate	Moderate to negligible	Disinvestment
Production features					
Capital/labor ratio	Low	Moderate	High	High	High to moderate
Employment					
Level	Low	Moderate	High	Moderate to high	Moderate
Growth	Rapid +	Rapid ++	Slow + to slow −	Moderate −	Rapid −
Occupational composition					
Engineering/ technical (%)	High	High	Moderate	Low/ moderate	Low
Managerial (%)	Low	Moderate	High	Moderate	Low
Production (%)	Low	Moderate	High	High	High
Subcontracting	High	Moderate	Low	Moderate	Moderate to high
Advertising, Sales	Low	Moderate	High	High to moderate	Low
Industry Structure					
Entry	Low	High	Moderate	Low	Low
Concentration	High	Moderate	Low	Moderate	High
Size of firm	Low	Moderate	Moderate to high	High	High
Vertical integration	None	Modest	Extensive	Extensive	Moderate
Modal class of ownership	Partner/ proprietor	Corporate: Single plant	Corporate: Multiplant	Corporate/ conglomerate	Corporate/ conglomerate + small firm