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# Table of Contents

Estimating the Economic Impact of Universities  
*M. Carroll & B. Smith*  
1

Human Capital in Japanese Manufacturing  
*R. Kalafsky*  
13

Time Paths of Uneven Development in Japan  
*S. Banasick & R. Hanham*  
27

Manuscript Reviewers  
46

Guidelines for Contributors
ESTIMATING THE ECONOMIC IMPACT OF UNIVERSITIES:  
THE CASE OF BOWLING GREEN STATE UNIVERSITY

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Abstract

Because of the changing financial climate facing public higher education, university administrators are seeking concrete economic justifications for their budget requests from state legislatures. Consequently economic impact studies, which provide such information, are increasingly on the “radar scope” of university administrators. The purpose of this paper is to describe the results of a recent economic impact study of Bowling Green State University, Ohio. The most widely cited finding of the study was that for every dollar Bowling Green State University received in state support it returned a conservative estimate of $8 in economic activity to Ohio’s economy. In addition, the advantages to geography and geographers of being involved in such studies are addressed.

INTRODUCTION

Higher education institutions in the United States are in an era of increasing financial pressures (Zumeta 2003). As Alexander (2000 p. 411) observed: “Governmental authorities are no longer as receptive to the traditional self-regulatory processes that have dominated university development for centuries.” A new economic motivation is driving states to redefine relationships by pressuring institutions to become more accountable, more efficient, and more productive in the use of publicly generated resources.” Maximizing economic returns is increasingly important to state legislators who must balance requests for higher education funding against a plethora of other financial needs, such as prisons, Medicaid, K-12 education, and the like (Zumeta 2003). In addition, universities are expected to become an engine of economic preparing an increasing percentage of the population to be productive members of the high tech workforce (Alexander 2000).

Ohio is not immune to such trends. In 2003, the Governor of Ohio formed the Commission on Higher Education and the Economy (CHEE) to address three
issues: “delivering results for public investments”, “making Ohio competitive in the knowledge economy” and “promoting access and creating opportunities for all students.” (Governor’s Commission on Higher Education and the Economy 2004 p. 3). While the CHEE report asserted that higher education significantly contributes to the state’s economic vitality, it relied on documentation from studies in other states because: “The State of Ohio has not conducted a full-scale analysis of higher education’s contributions to the state’s economic vitality and to the prosperity of the communities served by these institutions.” (Governor’s Commission on Higher Education and the Economy 2004 pp. 11-12). Within that political context, Bowling Green State University (BGSU) commissioned an economic impact study of the University.

The purpose of this paper is to describe the methodology and results of a university impact study, specifically BGSU. Because these studies are on the “radar scope” of university administrators looking for economic justifications for their budget requests (Brown and Heaney 1997), there are benefits to becoming involved in such endeavors. Those advantages that pertain to geography and geographers will be addressed.

METHODOLOGY
The region of analysis selected was the State of Ohio, mainly because BGSU is state-supported. The audience for this study was intended to be state legislators who make decisions about BGSU’s funding in the state budget. Other impact studies have included the institution’s impact on the local community (Blackwell et al. 2002; Booth and Jarrett 1976), but that regional delineation was not relevant in this research due to the audience being addressed.

The 2002 audited financial reports of the University were the bases of the analysis, including university expenditures on items such as purchases of tangible goods and related services, staff payroll, capital improvements, physical plant and inventory. In addition, revenues, such as interest income, grants and appropriations, gifts, and sales of auxiliary goods, were included. In contrast to other university impact studies, all the revenue and expenditure transactions were reconciled and any non-cash transactions, such as depreciation, accruals, etc., were eliminated. These non-cash transactions are bookkeeping transactions only and therefore have no impact on the local economy.

The BGSU study employed an input/output model designed by the IMPLAN Group to make the primary economic forecasts (MIG
Input\output methodology allows the examination of forward and backward linkages that are present in any regional economy. The model measures the total annual economic activity that results from inter- and intra-industry transactions. The model breaks the economy into approximately 500 separate sectors with each sector representing an individual industry. It then uses a sectoring scheme developed by the IMPLAN Group (MIG Inc. 2004). The model is approximately a 500 by 500 matrix that shows all transactions between the individual sectors. The entries in the matrix are based on the dollar amount that each industry sells to (and purchases from) other industries in the Ohio economy. It measures the amount of final consumption by the residents of the region, as well as how much each industry exports from the area. The model uses data collected at the county level, which are obtained from the IMPLAN Group (MIG Inc. 2004) and the BEA (U.S. Department of Commerce 2003).

Input\output models estimate economic impacts by taking advantage of the relatively stable patterns in the flow of goods and services within the economy (Leontief 1986). Predictions can be made about an industry’s total economic impact by examining the purchasing patterns of the individual sectors. The BEA collects extensive data on these regional trade flows and reports their findings annually (U.S. Department of Commerce 2003).

This study used IMPLAN’s Type III multipliers, which include the direct, indirect, and the induced effects (MIG Inc. 2004). The direct impact includes the purchases of resources (labor, goods, and services) as the University fulfills its academic mission. The indirect impact occurs through business-to-business purchases resulting from the university’s interactions with its Ohio suppliers. Finally, the induced impact reflects the change in household demand as those employees of the University and BGSU suppliers’ employees earn dollars for consumer spending. Therefore, the total impact to the economy is the summation of the direct, indirect and induced components. The indirect and the induced portions are commonly known as the multiplier, which shows how the initial (direct) expenditures get multiplied through the economy. Calculating the multipliers based on the supplier relationships and employee consumption patterns are much more accurate than simple multiplier tables used in some studies (Stewart et al. 1989).

Some of the problems associated with other impact studies were not pertinent in this case. For example, Blackwell et al. (2002) were concerned with the impact
on the local urban area and therefore argued that one must incorporate the import substitution impact of students who would have attended an out-of-town institution had they not gone to the local university. According to BGSU’s Admissions Office, most students not opting for BGSU attend another Ohio institution so this impact is negligible since the region of interest is the state.

Another impact included by some researchers is the enhancement of the region’s technological base resulting from firms locating nearby to facilitate tech transfer from the institutions research (Blackwell et al. 2002). Because BGSU is largely an undergraduate institution located in a predominately agricultural area, tech transfer was not considered.

One thorny issue is the role of human capital in university economic impacts. Bluestone (1993), among others, argued that projects should take into account the fact that universities add to the skill base of the region and their graduates earn higher incomes than they would without that education, and therefore contribute more to the economy. Measurement of this impact is problematic and controversial (Blackwell et al. 2002). We concur with the view that inclusion of a measure of human capital impact will substantially overestimate the impacts and “... conservative assumptions and methods should be used to promote objectivity in the research process (Brown and Heaney 1997 p. 237). A conservative approach is particularly desirable since some have criticized methodologies that may inflate the impacts (Beck et al. 1995; Potter 2003). Consequently no estimates of the contribution of BGSU to the formation of human capital in the state were included. Instead we are just measuring the impact of the economic activities of BGSU.

RESULTS
The economic impact of the University was attributed to four types of expenditures. In order of size of impact, they are: capital improvements and operating expenditures, employee spending, student spending, and visitor spending. The size of each are briefly described (Table 1).

**Capital Improvement and Operation Spending**
Combined capital improvements and operation spending was calculated from the University’s audited financial statements. To avoid double counting, payroll amounts were deleted since the impact of employee spending is described later in this report. Also non-cash transactions such as accruals, and depreciation were eliminated, as they have impact on the economic community. After making the necessary adjustments, BGSU spent $179.4
million directly on capital improvements and operations in 2002. This initial spending in turn generated an additional $52.7 million indirectly through the University’s purchase of labor and raw materials from local sources. The induced component, $89.9 million, was generated as the employees of suppliers spent the wages earned from University contracts. The total economic impact is the summation of the direct, indirect and induced effects. In this case, the University’s total impact from operations and capital improvements is $321.9 million.

From an employment perspective, BGSU created 5,472 full-time jobs as a result of their operations and capital improvement activities. Of the 5,472 jobs created, 3,667 were the result of direct university construction and operation activities, 715 resulted from the business-to-business, or indirect, activity, and 1,090 resulted from suppliers’ employees’ spending.

**Employee Spending Impact**
The second largest impacts were derived from BGSU employee spending. BGSU paid $142.0 million in gross salaries (excluding benefits) in 2002. To determine possible employee spending, it is first necessary to subtract the amount of taxes and other deductions from gross pay. Following the Bureau of Labor Statistics (BLS) guidelines for our region, it was assumed that, on average, 85% of the gross pay, or disposable income, was available for consumption (U.S. Department of Labor 2003). The 85% may appear high but it is assumed that state and local taxes are spent in the Ohio economy and therefore were added back. Therefore, it was assumed that the portion of University salaries available for consumption was $120.7 million. This was then allocated into spending categories (food, housing, healthcare, etc.) based on the BLS Consumer Expenditure Survey. This survey estimates the typical household spending patterns for our region for middle-income ($35,000 to $50,000 annual income) consumers. It was assumed that the bulk of the employee consumption spending (food, clothing, and transportation) was in Ohio, which is consistent with BLS research on local consumption spending. The direct spending of $120.7 million generated an indirect impact of $24.3 million and an induced impact of $22.6 million. Thus the total impact of employee spending was $167.6 million in the Ohio economy. This level of spending supported 1,439 jobs in Ohio.

**Student Spending Impact**
Student spending was estimated for three distinct categories. Undergraduate students who reside in on-campus facilities were the first group. This category has the lowest economic impact as the bulk of their spending occurs at
University facilities, which was included in the university operations estimates. The second category of student spending is undergraduate students residing in off-campus housing. This impact is significantly higher as the living expenses are often expended at local rental agencies and businesses. The last category of student spending is graduate student spending. Spending from graduate students tends to be higher than undergraduate spending. This is traditionally due to higher stipends for graduate students and from additional family income of a locally employed spouse.

Table 2 shows the number of students per category and the annual budget amounts for each group. BGSU has very few graduate students in on-campus facilities so all graduate students were considered to be off-campus. The budget estimates are based on University figures.

Similar to employee spending, the direct amount was allocated into spending categories based on the BLS Consumer expenditure Survey for households in the local region making under $15,000 per year. Again it was assumed that the bulk of the spending occurred in Ohio.

Direct spending of $136.5 million generated $28.2 million in indirect activity and $26.2 million in induced spending. Thus, the total impact in Ohio of BGSU student spending was $190.9 million. This level of consumption in turn generated 1,636 Ohio jobs.

Visitor Impact Spending
Estimating visitor spending in these studies is always difficult. One method is to simply use some estimated percentages of the university impact, but this is not always accurate and does not capture any unique student or university activities. Another method is to use surveys at a sample of University events, but cost considerations precluded the survey approach. Furthermore, given the regional nature of BGSU and the fact that the state is the service area for this study, the number of out-of-state visitors for each event would be small. Another method for estimating visitor spending in a regional university is to base it on the number of visitors per student and faculty member (Appleseed 2003; Bay Area Economics 2002). The number of students and faculty provides a good foundation and measuring personal visits from out of town friends and family is a good proxy for all visitor categories. The faculty number includes professional visitors who may attend conferences presented by faculty from BGSU.

It is estimated that undergraduate students have 5.95 overnight visitors annually; graduate students have 3.12, and faculty have 4.32, with each
**Table 1.** BGSU’S ECONOMIC IMPACT ON OHIO (Millions of dollars)

<table>
<thead>
<tr>
<th>Expenditure</th>
<th>Direct</th>
<th>Indirect</th>
<th>Induced</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>University Spending</td>
<td>$179.4</td>
<td>$52.7</td>
<td>$89.9</td>
<td>$321.9</td>
</tr>
<tr>
<td>Employee Spending</td>
<td>120.7</td>
<td>24.3</td>
<td>22.6</td>
<td>167.6</td>
</tr>
<tr>
<td>Student Spending</td>
<td>136.5</td>
<td>28.2</td>
<td>26.2</td>
<td>190.9</td>
</tr>
<tr>
<td>Visitor Spending</td>
<td>14.5</td>
<td>3.9</td>
<td>5.9</td>
<td>24.4</td>
</tr>
<tr>
<td>Total</td>
<td>$451.1</td>
<td>$109.2</td>
<td>$144.6</td>
<td>$704.9</td>
</tr>
</tbody>
</table>

**Table 2.** STUDENT SPENDING

<table>
<thead>
<tr>
<th></th>
<th>Students</th>
<th>Annual Spending per Student</th>
<th>Total Spending (millions of dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undergrad on-campus</td>
<td>6,835</td>
<td>$2,550</td>
<td>$17.4</td>
</tr>
<tr>
<td>Undergrad off-campus</td>
<td>10,382</td>
<td>$8,050</td>
<td>83.6</td>
</tr>
<tr>
<td>Off-campus graduate</td>
<td>3,142</td>
<td>$11,300</td>
<td>35.5</td>
</tr>
<tr>
<td>Total</td>
<td>20,359</td>
<td></td>
<td>$36.5</td>
</tr>
</tbody>
</table>
person spending approximately $125 per visit (Carroll et al. 2004). The graduate student and faculty numbers are lower than the undergraduates because graduate student and faculty often stay as guests in their residences. Based on the 2002 student enrollments and the numbers shown above, the estimates of direct visitor spending is shown, it is estimated that $14.5 million of direct spending by visitors generated an additional $3.9 million in indirect impacts, $5.9 million in induced impacts for at total of $24.4 in economic activity. This economic activity supports 1,636 Ohio jobs with the bulk of the jobs being in Wood County.

**Fiscal Impact**
In 2002, BGSU received $84.6 million in state appropriations. During that time period, the BGSU economic activity generated $85.9 million in tax revenues. The total economic impact of BGSU on Ohio’s economy was $704 million. Therefore, for every dollar BGSU receives in state support, it generates more than $8 in economic activity. This is not to say that BGSU has a multiplier of eight. What it does mean is that BGSU takes the state appropriation, couples it with tuition and grant revenues, and produces the $704 million dollar impact. The overall multiplier, generated from this study, is a very conservative 1.56. This number is derived by dividing the total impact by the direct effect.

**DISCUSSION**
As noted by various researchers, direct comparisons of the results of this study with other similar studies are problematic due to variations in the methodology (Beck et al. 1995). Nonetheless it is worthy of note that the impact of BGSU ($8 generated for each dollar from the state) is less than reported in some other studies. For example, a Michigan study reported that for each dollar spent on Michigan universities, the state of Michigan gets $26 back and a study of New Jersey community colleges reported that the state benefited by $18 for each dollar spent on the colleges (Potter 2003 p. A26). Finally Pittsburgh State University concluded that $18.20 was returned for every state taxpayer dollar appropriated to Pittsburgh State (President’s Economic Impact Assessment Task Force 2002 p.5). In general, the BGSU estimate is low, in part due to the conservative assumptions that were made. Considering that economic impact studies have been criticized for being too broad and self-serving (Potter 2003; Brown and Heaney 1997), a conservative approach seemed prudent.
While university administrators may find economic impact studies to be useful, that does not mean that they can correctly interpret all the analysis. For example, one BGSU administrator thought the analysis would identify efficiencies, or the lack thereof, in university offices, which obviously...
is not necessarily true. Consequently, simply generating a written technical report is not sufficient. At BGSU, the report was orally presented to numerous senior administrative committees with contextual remarks for clarification. One of those groups was the Board of Trustees, which is BGSU’s governing body appointed by the Governor of Ohio. Many trustees are from the business community. Comparisons of state spending on BGSU with state and local incentives to manufacturing companies resonated well with many of them. For example, Ohio appropriations were less than $10,000 per BGSU employee in 2002. In contrast, local newspapers reported that Ohio and local governments spent $250,000 per job to land a centrifuge plant (Rulon 2004 p. 3) and $57,142 per job to attract an auto plant (McKinnon 1999 p.10). Obviously these comparisons must be carefully crafted and explained, but nevertheless these data provided a meaningful perspective for the business representatives.

Because senior administrators look to economic impact studies to provide economic justification in their lobbying for state resources, it is beneficial for faculty to participate in these studies. In this context, geographers often fret about the status of the discipline, both nationally and within institutions. The following statements by Bierly and Gatrell (2004 p. 337) are one example: “Given the continuing evolution of their discipline, geographers are compelled to periodically assess the overall condition of its institutions. Are the number of geography departments, programs, and faculty positions growing or shrinking? How has the scope of geography (or the number of geographies) changed in recent years? Historically, geographers have assumed the worst. The anecdotal evidence geographers share with one another at national meetings and in AAG newsletter columns has generally not been positive with respect to the health of geography, geography programs, and/or the shifting disciplinary identities of programs and geographers.” Various geographers have suggested methods by which geographers and geography can increase their visibility. For example, Harman (2003) contended that geographers’ research agendas must address important human issues. In addition, Harmon (2003 p.420) argued: “If, as individuals, we create valuable products, then our discipline will be valued in the aggregate.” While Harman was primarily addressing a larger scale than simply one university, his ideas make sense in terms of helping geographers compete for increasingly scarce resources within their home institutions. In today’s funding climate for higher education, many senior administrators would view
economic impact analyses as a valuable product.

CONCLUSIONS
State tax dollars to support higher education are becoming scarcer in many states, including Ohio, and senior administrators in universities are seeking information to buttress their funding requests. Economic impact studies are one source of such information.

From the viewpoint of BGSU’s leadership, the most significant outcome of this analysis was that BGSU received $84.6 million in state appropriations in 2002, but the total economic impact of BGSU on Ohio’s economy was $704 million. For every dollar BGSU received in state support, it generated more than $8 in economic activity. This figure for BGSU is low in comparison to other university impact studies, largely because of the conservative strategy adopted. In particular, no estimates of the contribution of BGSU to the formation of human capital in the state were included. Although this is an important benefit of higher education, there is no accepted method of measurement, and its inclusion can result in inflated multipliers.

Since senior administrators are looking to economic impact studies to provide economic justification in their lobbying for state resources, it is beneficial for faculty to participate in these studies. Because many geographers are knowledgeable of this technique, economic impact analyses of this nature may provide a venue for “catching the eye” of the upper echelon, which may prove valuable in the internal competition for scarce resources.

REFERENCES


Bluestone, B. 1993 UMass/Boston: An Economic Impact Analysis. Boston, MA: John W. McCormack Institute of Public Affairs, the University of Massachusetts.


*Carroll and Smith* 11


HUMAN CAPITAL IN JAPANESE MANUFACTURING: EVIDENCE AND PRACTICES FROM A KEY CAPITAL GOODS SECTOR

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Abstract

Japan's metalworking machinery industry maintains its dominance across international markets in terms of both production and innovation. Much of this success can be attributed to firm-level and industry-wide practices, many of which concentrate on the importance of the workforce. A set of interviews across the industry confirms that a number of unique practices play a role in the industry's competitiveness. However, several demographic trends could lead to a human capital shortage in a sector that demands a highly skilled workforce.

Introduction

Japan's metalworking machinery sector has long been one of its most successful durable goods industries. While in most industrialized economies this sector's production has declined or moved offshore, many Japanese manufacturers continue to thrive and are considered to be among the world's best, leading in total output and exports (Gardner, 2005). A central factor in the success of these producers has been related to the workforce. Across the machine tool industry and other capital goods sectors, Japanese firms have integrated workers at all levels of the corporate hierarchy into the manufacturing process, which has contributed to continued innovation and productivity (Forrant and Flynn, 1999). This paper provides a brief examination of the role of human capital in the operations of Japanese metalworking equipment manufacturers across a number of facets, including producer-level strategies and corporate culture. It is informed by a series of onsite interviews within the metalworking machinery sector and related support organizations, which reveal unique firm-level practices and suggest that human capital remains a central component of the industry’s continued dominance. Before further discussion of the interviews, a research context for this study and a brief background of the industry are in order.

Research Context

When examining a national industry and comparing its manufacturers against
competitors from other countries, it is important to consider the often divergent institutional settings in which manufacturing develops. Much of the most recent research confirms that in order to understand a firm or an industry, one must take into account a holistic view of the environment in which the economic activities take place (Redding, 2005). The contrasting business and economic systems of different countries provide wholly different environments for industry (Boyer, 2003). Even within market-based economies, there are vastly different degrees of government involvement in private sector activity (Boyer, 1990; Amable, 2003). Moreover, there are wide variations in institutions and the relationships between a range of economic actors (Whitley, 1999). This becomes apparent when looking at large manufacturing states such as Japan, Germany, and the US, in aspects ranging from plant-level labor relations to government intervention in the economy. Japan’s rapid rise as an economic power is attributed in most corners to a distinctly unique institutional environment. Overall, the Japanese economy has been seen as a mix of free-market policies and active government intervention that has changed as that country’s economy has developed (Sakakibara, 1993). Until the last decade, it must be noted that various levels of the Japanese government were very active in directing and advising the private sector.

In order to understand the dynamics of an industry and the firms within it, one must also be aware of the culture of the firm, including internal relationships within the organization (Schoenberger, 1997). The organizational cultures within a firm or industry are also informed by national cultures which also must also be taken into consideration. A useful example of this is seen in research by Hofstede (1980), who found that national culture plays a role in company dynamics with respect to measures such as individualism and views on time. In related work, Trompenaars and Hampden-Turner (1998) determined that culture is pivotal to comprehending norms within business operations. Culture extends to all facets of the company, as work by Gertler (2004) demonstrated that culture is indeed integral to the successful implementation of advanced technologies for manufacturers.

BACKGROUND
The metalworking machinery industry includes the production of metal forming and metal cutting equipment\(^1\), in addition to assorted support industries that make the innumerable parts and

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\(^1\) Within Japan, metal cutting equipment is often viewed as the machine tool sector. Metal forming equipment is often categorized separately.
accessories that are involved in developing machines that shape metal. It is a broad category, encompassing products as diverse as industrial presses, grinders, and lathes that are used throughout the secondary sector. Accordingly, the products of this industry form the basis for most other manufacturing, especially in key durable goods industries such as aircraft, household appliances, and motor vehicles and increasingly, its products play a pivotal production role in leading edge markets such as surgical equipment, replacement body parts, and semiconductors. The metalworking machinery industry is remarkably small in absolute numbers, comprising far less than one-percent on total national employment and value-added. Still, given its fundamental role in the abovementioned industries, the sector is the recipient a great deal of attention, both from others in manufacturing and within policy circles.

Given the above description, it is understandable that the metalworking equipment industry was viewed as a fundamental element of Japan’s post-war reconstruction (see Sarathy, 1989). During the early years of the rebuilding process, capital goods producers such as the one described in this paper had access to various forms of government assistance. Some of this assistance came in the form of lower import duties (for early reverse engineering) and research assistance (Tsuji and Ishikawa, 1995; Tsuji, 2000). In many ways, this initial government support and intervention provided a foundation from which the industry could transform into an international competitor. A related, perhaps more critical aim was to assist Japanese manufacturing at-large to become more competitive as well.

There is little doubt that investment in research and new technologies enabled this industry to become a recognized force in a relatively short amount of time (Kotha and Nair, 1995). By the 1970s, Japan’s machine tool industry and related sectors ranked among the world’s leaders, in terms of both production and innovation. A number of industry-level strategies also enable this rapid rise. One pivotal approach was the early and wide-ranging adoption of CNC (computer numerically controlled) technologies, which provided the industry with a distinct advantage on international markets (Tsurata, 1988). Additionally, Japan’s manufacturers developed products that were highly advanced and of superior quality, but were also affordable to both large firms and smaller metalworking operations (Tsuji, et al., 1999). Overall, Japan’s early success in metalworking machinery production did enjoy many forms of government intervention, yet much of its later
success actually occurred in spite of government involvement and was a direct result of firm-level strategies such as the abovementioned CNC integration and continual attention to innovation.

The bursting of the “bubble economy” in early 1990s and the prolonged domestic economic slump negatively impacted internal demand for new machine tools (see Okamoto, 1994). However, due to the utility and technological advancements of Japanese machine tools, the domestic slump was counterbalanced by the industry’s success on international markets. During this challenging period, the industry managed to maintain high production levels and even increased world market share. The next section begins to details some of the strategies that have enabled the industry to maintain its leadership edge.

**Human Capital: Importance and Practices**

The remainder of this paper discusses findings from interviews from within the industry. Onsite visits and conversations were conducted in 2003 and 2005 with 41 representatives working in and related to Japan’s metalworking machinery sector. The interviews took place largely within the Tokyo metropolitan region and in Aichi Prefecture, the location of many metalworking firms and manufacturing giants such as Toyota (see Figure 1). This group included metalworking machinery firms; component makers; affiliated trade groups, and manufacturing organizations. The trade groups work closely with machinery producers and are often managed or staffed by current and former workers from within the industry.

The corporate interview is a useful means to examining the evolving operations of business organizations. Schoenberger (1991) illustrated that this method is particularly valuable for looking at group dynamics and likewise, Yeung (1995) demonstrated that in international business studies, the corporate interview yields particular richness in examining the continually changing dynamics of firms and offers a degree of flexibility in firm-level research. Differences in national culture often provide obstacles to conventional survey methods, hindering attempts to ascertain interactions both within and between firms. In general, the interview is seen as an important tool in international business analyses. In terms of this paper, these interviews were largely exploratory and form the basis for a more in-depth study of the industry.

It should be mentioned at the outset that many of the strategies and concepts described in this could apply to Japanese manufacturing at large. This is
Figure 1. Central Japan and Aichi prefecture

Source: Map created by author; data from UNEP/GRID Spatial Data Clearinghouse
understandable given the industry’s centrality to most manufacturing processes – one interviewee referred to the machine tool sector as, “...the mother of all manufacturing.” While there could be understandable bias in the statement, this sentiment has nonetheless been shared by others in involved in manufacturing in locations outside of Japan (Hogan, 2004) and by researchers as well (Graham, 1993; Finegold, et al., 1994). The onsite conversations provided numerous insights on a series of connections between the metalworking machinery producers and customers across the spectrum of durable good production.

The interviews revealed that relationships within these metalworking organizations are often imbedded in institutions that in many ways are unique to Japan. Until the past decade, the Japanese workforce has been noted for its relative stability. Accordingly, one of the principal components of the success metalworking machinery firms across Japan is the relatively small turnover rate for most producers. Large Japanese manufacturing companies have traditionally been reluctant to layoff workers, a practice that was mentioned throughout the interviews. In fact, one equipment firm representative revealed that many companies across this industry have long viewed employment stability as more important that shareholder value. This has undeniably been a factor in the success of Japanese machine tool manufacturers. By contrast in North America, high worker turnover has often complicated the process of integrating new manufacturing technologies (Gertler, 1995). Beyond this longstanding principle, most interviewees provided a pragmatic reason for maintaining workforce stability: machinery technologies have become so advanced it is important to have a workforce that is familiar with highly technical processes and products. Given the quality levels expected by the users of this equipment, every firm representative emphasized that employees must feel that they have a vested interest in not only the company but also in the customer. This is linked to related messages that were seen on signs posted in two of the factories that were visited. Another finding which illustrates this was seen in one of the largest and most successful machine tool manufacturers, where workers at every level of the corporation carry a wallet-sized card that reminds them of their commitment to quality and the customer. The concept of workforce stability is quite important in Japan and confirms what has been seen in the literature regarding the integration and use of advanced production equipment (e.g. Gertler, 1993; Gertler, 1995).

A related structural aspect of Japanese machine tool success
regards the current composition of the workforce. The interviews suggested that much of the current success within the Japanese metalworking industry stems from the rebuilding process in the country at large. During that period, a large number of university students studied engineering or one of the physical sciences. In the 1960s well through the 1980s, it was possible for graduate at any level to obtain a position in the manufacturing sector. As will be discussed in the next section, this is expected to change, due to demographic changes and overall transitions in Japanese career preferences. In the meantime, this large body of engineers and scientists has enabled the continued innovation at many firms.

Many interviewees discussed another strategic reason that, in their opinions, explains some of the industry’s success. There is a prevailing belief within the industry that Japan capital goods manufacturers have been much less protected and/or assisted by government intervention than other sectors such as banking or retailing. Essentially, most manufacturing firms were left to fend for themselves on world markets. In the case of metalworking equipment production, this suited these firms quite well. After initial government assistance that was discussed in the previous section of this paper, it has been largely a series of firm-level or industry-wide initiatives that have allowed the Japanese machine tool industry to continue to thrive. While the lack of policy-based support is a common lament throughout most industrialized countries, every metalworking industry representative admitted that government help was far less than desired. At the same time, it has prompted the industry to independently seek new markets and product lines.

Another point that is often overlooked in explaining the industry’s continued success is the fact that within Japan, manufacturing in general is still viewed as a good profession, which helps to attract workers to the metalworking sector. According to six of the interviewees, much of the blame for the economic stagnation and collapse of the bubble economy has been laid at the feet of the financial industry, specifically banking and real estate. Manufacturing is seen as the economic sector that kept a modicum of stability in Japan’s economy through the past decade. Given their importance, visibility, and success, machine tool and related metalworking machinery manufacturers are accordingly viewed as more stable employers and therefore attract some of the better employees. This is especially the case in manufacturing-intensive regions such as Aichi Prefecture. Within the secondary sector at-large, the first employment choices are the
obvious manufacturing giants such as Toyota and Canon. Across the industry detailed in this paper, leading machine tool firms are extremely attractive to younger workers, as world-leading toolmakers such as Mori Seiki and Okuma often have the first selection of new graduates.

There is also an interesting regional aspect to the labor supply matter that emerged from the interviews and is worth noting. Within the Aichi prefecture, there is of course competition between the numerous metalworking and myriad manufacturing firms for skilled employees. Some of the workforce advantages stem from the demographic changes in Japan, which will be discussed further in the next section. Family sizes have become much smaller, with many families having only one child. What helps many Aichi-based employers is that there is a large sense of obligation to look after one’s parents that is still prevalent in the region. Many of these children prefer to stay in the Aichi region in order to be near one’s parents. This works to the advantage of many of the machinery companies, as they have access to a comparatively stable regional workforce. In turn, this also helps the more prestigious toolmaking firms, as again, they are the first choices among potential job applicants.

Linked to this generally favorable impression of manufacturing is the concept of monotsukuri. A rough translation means ‘making things’, but it is a broader idea, actually extending to hands-on creation. To the generation who came of age during Japan’s rebuilding process, actually ‘building something’ is quite important. This is easily understandable, given the tasks of this industry’s firms and products. Also, given the failings of Japan’s service sector and the general view of the machinery industry in Japan, the importance placed upon the concept of monotsukuri is plainly evident. While discussing this idea, one firm representative also discussed the concept of gijyutsu gino no densho. Even the interviewees admitted that this was difficult to describe, but the best estimation is some combination of technical skill and innovation that is passed to the next generation within a firm or industry. It is viewed as an obligation to relay these skills to the next generation of manufacturing workers. In this sense, the manufacturing is viewed as not only a skill, but also as an art. A very important part of this is that within these companies, the worker is viewed (in the words of one company representative), “…not as a simple person.” Rather, he or she is viewed as an integral part of the company.

The term meister was used continually throughout the interviews with company representatives. This originates with the German process of a manufacturing worker who is a
master of his or her craft or process, and has been widely adopted by Japanese firms. Within many of the metalworking equipment firms, this is a goal that many production-level employees are supposed to work toward. At one Japanese machine tool maker, the board of meisters has been expanded several times and the title is seen as an important goal within the company. This is firmly embedded in the belief of manufacturing as both a trade and as an art. The similarities between Japan and Germany with respect to the national economies and in particular, manufacturing, are striking. Incidentally, these two countries consistently rank first and second in world machine tool production.

Within individual companies, this industry, and manufacturing in general, a number of important practices have helped Japanese toolmakers to remain among the best internationally. An important part of the manufacturing process is the concept of genba-shugi or field-oriented management. A representative (and retired engineer) from one industrial organization stated that perhaps the best way to describe this concept in English as “site-ism”. This would appear to be a fitting translation, as an emphasis is placed on being onsite in order to learn the process. In many firms, it is a policy that all engineers get into the field to actually observe what is occurring on the factory floor. The belief is that this will enable engineers to understand what occurs on the production line and throughout the company. Beyond this, many companies and organizations described this process as a critical part of office personnel understanding the importance of the role of the plant floor worker to the success of the organization. Within most machinery firms, this is a commonly-used process.

One the largest Japanese machine tool producers that was visited during the interview process explained a program in which every employee must work on the production side of operations. A firm representative confirmed that these trainees actually assemble machines that are bound for customers, which emphasizes the importance of the task. This is just one example of the internal training programs that most large machinery producers use. As was mentioned in many interviews, such programs provide an enduring respect for the production workers and moreover, it helps employees to understand the entire manufacturing process for that particular product. As one company representative explained, the end result is that an engineer will not design a product that is difficult to assemble.

Without a doubt, the process of kaizen (constant improvement) is essential to the success of Japanese manufacturing. The other concepts
previously mentioned tie into the kaizen process. Given the work circles and the resulting cooperation between different parts of the corporate hierarchy, the process of constant improvement is enabled. Kaizen was fully implemented through all of the factories that were visited. In many ways, it is not an exception; rather it is standard practice across most Japanese manufacturers. Given the abovementioned practices that place all workers on the factory floor at one point, it is understandable that this contributes to the kaizen process. Incidentally, an interviewee mentioned that a kaizen program was implemented at his employer’s US branch plant, with less than satisfactory results until an individual cash reward was offered for improvement suggestions. This example illustrates that even within the same corporation, national culture often plays a pivotal role. It should be mentioned that all metalworking companies that were interviewed have internal activities that emphasize quality and improvements in productivity.

TRANSITIONS AND CHALLENGES
Japanese metalworking machinery manufacturers obviously place an emphasis on human capital and have in place a number of strategies for workforce development. At the same time, there are a number of impending challenges for manufacturers. Observers have noted for some time that Japan must address major structural challenges in order to continue as a major industrial power (Yamamura, 2003). Keeping this in mind, it is worth exploring what competitive issues that the industry is now facing. The interviews revealed several looming issues that could challenge the industry and its leading position. These are not problems rooted within the industry itself, but the result of larger structural changes within Japan.

The first, perhaps most critical problem is largely demographic. An ageing population and the shrinking workforce provide a formidable challenge to machine tool producers. Since the industry is so heavily dependent upon innovation to maintain its edge against international rivals, it has become important to continue to find skilled workers. Given that the working-age (and overall) population is shrinking, it remains to be seen if the manufacturers of this advanced equipment can continue to recruit and retain the workers that are so pivotal to their success. Almost everybody who was interviewed agreed that although the labor shortage is not a critical problem now, it certainly will be within the next 10-15 years given Japan’s demographic trends. In a proactive approach, some metalworking firms are now extending employment for older workers beyond the traditional
retirement age in order to at least temporarily hold off potential labor shortages.

Some firms are already starting to see shortages in certain engineering functions and in production positions. While there is no trouble recruiting mechanical or manufacturing engineers, it is often difficult to recruit software engineers that can assist with the increased automation or the proprietary computer controllers of some firms. According to company representatives, prospective recruits are instead attracted to a more ‘glamorous’ firm, such as Fanuc (an industrial robotics and controls producer) or to actual software firms. This shortage, while small, is important as engineers form the technological future for the industry.

Additionally, the shrinking labor force problem is already beginning to impact the smaller machinery firms and the parts manufacturers. A representative from a parts-makers trade group admitted that it has now become extremely difficult to recruit workers to smaller and medium sized enterprises (SMEs). Some of this stems from obvious financial attractions and relative stability found at the larger firms. Yet some of this also stems from yet another geographical angle – many of the SMEs in the parts industry are located in largely rural prefectures which are not necessarily attractive to younger workers, despite the familial obligations that were discussed earlier.

Given the attractions of other industries, such as information technologies and telecommunications, it remains to be seen whether machinery manufacturers can indeed maintain their attractiveness to younger members of the workforce. This was a concern voiced in all but a few interviews, not only in metalworking equipment production but in conversations with companies in many types of manufacturing. Beyond the demographic trends that presage a shrinking labor force for metalworking manufacturers, the interviewees acknowledged the slow generational change with respect to the perception of manufacturing. In almost every conversation and onsite visit, the dilemma of the “3K” problem arose. The 3Ks stand for kitsui (difficult), kitanai (dirty), and kiken (dangerous). These are labeled as the general perceptions of manufacturing. These labels often have been applied to occupations such as construction, but now many see these as applying to manufacturing, even in sectors as advanced and as relatively ‘clean’ as the metalworking industry. In order to address this perception issue, many firms now take part in programs that introduce high school students to the secondary sector, in order to show them what modern manufacturing actually looks like.
There is a general consensus within the industry that younger people are not attracted to manufacturing due to the perceived characteristics mentioned above. Additionally, much to the lament of many of the interviewed manufacturers, information technologies are a big attraction to younger workers. Interestingly, the ‘Livedoor’ situation was raised during six interviews as a disturbing situation (an upstart internet company that attempted to purchase an established Japanese broadcaster). While far outside the realm of metalworking or manufacturing, this situation is largely emblematic of changes in Japan’s economy in the opinion of some interviewees. This was viewed as generally indicative of ‘the next generation’ avoiding manufacturing as a vocation, symbolic of declining emphasis on manufacturing, and avoiding employment at established firms.

A final competitive challenge to note is the evolving nature of the firm in Japan. As discussed earlier, there was a large sense of obligation to employees. Several individuals admitted that this is changing, as short-term returns become increasingly important and the overall economy changes. The shorter-term view is becoming increasingly prevalent, as profits become increasingly important to investors. Moreover, the traditional networks of companies are dissolving and individual firms are expected to be financially viable. This alone has compelled many firms to think of profitability perhaps at the expense on long-term labor force stability.

**CONCLUSION**

The interviews suggest that machinery firms across Japan view workers as an integral part of firm-level and industry-wide success. Much of this is maintained via a number of concepts or practices that are grounded in Japanese organizational culture, such as relatively low turnover rates. Many of these policies place an emphasis on the importance of production workers to the firm’s success and they have undoubtedly contributed to the industry’s unparalleled achievements on world markets. It would be difficult to directly apply these systems within another work environment, given numerous cultural and organizational differences.

Demographic changes are threatening the relative stability of Japanese manufacturing and at its core, the machinery industry. The central challenge for firms in the next several decades will be to recruit new workers at all levels from a steadily shrinking workforce. Moreover, changing perceptions of manufacturing could shrink this workforce further, as has happened in many advanced economies. Given that consumers of these capital goods demand increasingly high-end equipment, this pressing human capital issue
is one of the largest challenges for the industry.

REFERENCES


TIME PATHS OF UNEVEN INDUSTRIAL DEVELOPMENT
IN JAPAN

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Abstract

This paper examines the uneven spatial development of manufacturing in Japan from 1990 to 2001, a period of prolonged economic stagnation and crisis. The paper analyzes the annual change in employment in forty-six Japanese prefectures for twenty-one manufacturing industries. The goal of the research is to investigate whether there is a link between economic crisis and the changing spatial differentiation of the industrial landscape, specifically as it pertains to employment. Time paths of uneven development for each industry are constructed using the standard deviation of employment change among prefectures for each year. Most industries became more spatially differentiated over time as the economic crisis in Japan worsened. Furthermore, spikes in the time paths tend to correspond to the onset of crisis generating events, such as the bursting of the bubble economy in 1990-91 and the Asian financial crisis of 1997-98. In the final stage of the research a time series regression examines the relationship between the changing spatial differentiation of employment and changes in the uneven development of manufacturing output and productivity. The results show that changes in the uneven development of most industries is most strongly shaped by changes in the spatial pattern of productivity.

INTRODUCTION

The Japanese economy has been chronically stagnant since the bursting of the financial bubble in 1990-91 (Itoh, 2005). The average annual percentage change in Japanese GDP between 1990 and 2000 was 1.3%, a very low rate of growth by Japanese standards. GDP grew by an annual rate of 4.6 percent in the 1980s, 5.2 percent in the 1970s and 10.2 percent in the 1960s (Brenner, 2002). The growth rate since 2000 has averaged less than two percent (Itoh, 2005). The economic crisis
has been particularly severe in manufacturing, which has suffered from considerable overproduction and the lowest rate of profit since the end of the Second World War. The net profit rate in manufacturing in the 1990s was less than twenty percent, which compares to approximately thirty percent in the 1980s, thirty-five percent in the 1970s and forty percent in the 1960s (Brenner, 2002).

As a result of the crisis, there has been widespread deindustrialization, large-scale shifts in investment capital from less profitable industrial sectors to more profitable ones, and shifts in capital out of manufacturing altogether. At the same time, there have been major geographic movements in production from less profitable regions in the country to more profitable ones, and an acceleration of outward foreign direct investment, particularly in Asia.

One consequence of the economic crisis in manufacturing has been massive job loss. Table 1 shows that 2,306,609 manufacturing jobs were lost in Japan between 1990 and 2001, a decline of 20 percent. Employment fell in all but one of the twenty-one, two-digit level manufacturing industries during this period. The biggest losses were in textiles/apparel (-593,094),

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<th>Sector</th>
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<td>Food Processing</td>
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<td>Beverages</td>
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Note: 1. Calculations by authors using Census of Manufactures.

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electrical machinery (-487,925),
general machinery (-198,606),
fabricated metals (-147,493),
iron/steel (-113,994),
ceramics/stone/clay (-110,754),
lumber/wood (-100,975) and
transportation equipment (-96,464). Proportionately, declines were most severe in
textiles/apparel (-53.5%), leather (-47.3%), lumber/wood (-40.0%),
precision instruments (-34.1%), iron/steel (-33.7%), furniture (-32.7%), rubber (-26.1%) and electrical machinery (-25.2%). The only industry that grew during this time was food processing, where employment rose by 5.9 percent.

The loss of manufacturing jobs since 1990 has occurred throughout the country. For example, every prefecture in Japan had fewer people employed in manufacturing in 2001 than they did in 1990. However, the decline in employment has been very uneven. The highest rates of decline between 1990 and 2001 were in four regions of the country. Two regions surround the long established industrial cities of Tokyo and Osaka, the third region comprises a cluster of less industrialized prefectures in the northern periphery of the country and the fourth region consists of a cluster of less industrialized prefectures in the southwestern periphery of the country. Lower rates of decline occurred in the center of the country, comprising a number of less industrialized prefectures as well as some established industrial prefectures such as Aichi, where Toyota is located. Lower rates of decline also occurred in the extreme northern and western peripheral regions of the country.

Previous research on the regional decline of manufacturing employment in Japan since 1990 has shown that there are a number of well-established, general reasons for the decline of manufacturing employment in regions throughout the country, foremost among them being the rising value of the Yen, increasing competition and the shift in production overseas. In addition, however, this research has also shown that local or regional context plays an important role in shaping employment trends in particular places. Togashi (2003), for example, found that industrial restructuring in the general machinery and electrical machinery industries affected regional employment in several, and sometimes seemingly contradictory, ways. Many regions lost jobs due to falling demand and plant closures, but others lost them because of technology-driven productivity improvements and the shift to higher value-added production.

Such uneven development of the space-economy is an integral component of capitalist dynamics. Smith (1990) and Harvey (1982) argue that the devaluation of capital which accompanies economic crises creates the economic and spatial conditions for future capital accumulation. Furthermore, economic crises are place-specific. The spatial impact of economic crises is uneven, either because the hardest hit industries are spatially concentrated or the outcome of competition for economic survival.
among firms is localized. As a consequence, the spatial landscape during and immediately after an economic crisis tends to be highly differentiated. In the period of expansion that follows, circulating capital in the search for accumulation opportunities begins to equalize these spatio-economic differences, until the onset of the next crisis and the differentiation process begins anew (e.g. Smith and Dennis, 1987).

This paper examines the uneven spatial development of manufacturing in Japan from 1990 to 2001. Specifically, the paper analyzes the change in employment in forty-six Japanese prefectures for each of the twenty-one manufacturing industries listed in Table 1 for every year during this period. The primary goal of the research is to investigate whether there is a link between economic crisis and the spatial differentiation of the industrial landscape, specifically as it pertains to employment. The research uses a multivariate shift-share model to estimate a contextual measure of employment change in each prefecture, together with estimates of the degree to which this change can be attributed to changes in output and productivity. The research then constructs time paths of uneven development for each industry using the standard deviation of the employment change among prefectures for each year. The time paths are used examine the trajectory of uneven development over time and to investigate the impact of economic crises on the spatial differentiation of employment change. Finally, the research uses time series regression to examine the relationship between the time path of the uneven development of industry specific employment and the uneven development of industry specific output and productivity.

The paper is organized as follows. The second section discusses the economic forces which triggered the loss of manufacturing employment in Japan since 1990. The third section discusses the methods and data used in the analysis. The fourth section describes the time paths of uneven development for each industry. The fifth section presents the results of the regression analysis relating the time path of employment to the time paths of output and productivity. The sixth section offers some conclusions.

DEINDUSTRIALIZATION IN JAPAN
The economic stagnation of the 1990s is strongly linked to Japan’s so-called bubble economy of the late 1980s. Japanese manufacturers shifted to an export-led growth strategy to escape the crises of the 1970s and early 1980s, but the strength of
the strategy was dramatically curtailed in the mid-1980s as trade frictions with the US and European countries increased (Tsuru, 1993). The US and the other G-5 countries reacted to the success of the Japanese export strategy by pressuring Japan in 1985 to raise the value of the yen, an agreement known as the Plaza Accord (Leysmon, 1994; Brenner, 2002). The revaluation of the yen sharply reduced economic growth in Japan, and in response the Japanese authorities cut interest rates in half and began to encourage bank lending to real estate companies and brokerages so as to inflate land prices and increase consumer spending (Brenner, 2002). An unintentional consequence of these policies, however, was the formation of bubbles in the real-estate and stock markets, eventually pushing stock prices and urban land prices for the six largest metropolitan areas to record highs (Wright, 2002; Kerr, 2002).

When the Japanese government eventually attempted to slow the expansion of the twin bubbles by raising interest rates, it triggered a sudden price collapse. Since overvalued land had been used as collateral for extensive borrowing during the bubble period, the fall of land prices also contributed to the emergence of a banking crisis (Werner, 2003). The collapse depressed consumption and investment after 1990 and pushed the economy into a thirty-two month recession (Oizumi, 1994; Brenner, 2002).

In addition to the formation of the bubble economy, the yen revaluation of the mid-1980s also contributed to a sharp increase in Japanese outward foreign direct investment (FDI) in manufacturing, particularly in Asia (UNCTAD, 2001; Farrell et al., 2004). The problem was compounded as small-sized subcontractors followed larger Japanese firms into Asia (Adachi, 1996; Hatch, 2001). With labor intensive manufacturing increasingly moving overseas, domestic investment turned to higher value-added production in high-tech industries, often located in peripheral regions (Kiyonari, 1993; Banasick, 1999).

By 1995, Japan’s stagnant economy had caused sufficient concern within the Clinton administration in the US, which was already shaken by the collapse of the Mexican peso, to reverse the weak dollar (strong yen) policy instituted in 1985 (Brenner, 2002). The weakening of the yen combined with several extensive stimulus packages instituted by the Japanese government contributed to the emergence of an economic upswing, but it was soon cut short by the 1997-1998 Asian financial crisis and the Japanese government’s decision to increase the consumption (sales) tax (Brenner, 2002). The post 1997
economic crisis was even deeper than that of the early 1990s. Japan’s GDP fell below one percent for the rest of the decade, the bankruptcy rate for Japanese corporations soared (Gao, 2001) and unemployment rates began to climb to levels not seen since the end of the Second World War, particularly in the northern and southwestern peripheral regions (Economic Planning Agency, 2001).

METHODS AND DATA
This research is carried out in three stages. The first stage uses the multivariate shift-share model developed by Rigby (1992; Rigby and Anderson, 1993) to estimate the employment ‘regional effect’ (also known in the shift-share literature as the ‘competitive’ or ‘differential’ effect) for every year between 1990 and 2001 for twenty-one manufacturing industries. The estimates were calculated for forty-six prefectures in Japan (Figure 1). Okinawa was excluded from the analysis because of the small size of its manufacturing sector. The regional effect provides a measure of employment change in a given prefecture that is due to factors specific to that prefecture, after having filtered out the effect of the change in national employment and the effect of the prefecture’s industrial mix on prefectural employment (Loveridge and Selting, 1998). Although not traditionally conceptualized in this way in the shift-share literature, we argue that the employment regional effect measures the impact of regional context (in this case, prefecture-specific context) on changes in prefectural employment, and as such offers a more conceptually focused measure of employment change than the raw employment change. In addition, a distinguishing feature of Rigby’s multivariate model, compared to the more common univariate shift-share model, is that it also provides an estimate of the impact of prefecture-specific changes in both manufacturing output and productivity on prefectural employment. These estimates add multivariate, quantitative detail to the prefecture-specific processes involved in shaping prefectural employment change. The shift-share model was estimated using Barff and Knight’s (1988) dynamic procedure and Haynes and Dinc’s (1997; 2001) modification which highlights labor’s contribution to productivity. Haynes and Dinc (1997; 2001) have argued that Rigby’s model does not distinguish between the contribution of capital and labor to changes in productivity. They propose a modification to the model which isolates labor’s contribution (capital’s contribution is relegated to a residual effect in the model). This is accomplished by discounting the estimated productivity effect in Rigby’s model by labor’s share of value added.
second stage of the research constructs time paths of the uneven development of manufacturing employment. This
is accomplished by calculating and plotting the standard deviation of the employment regional effect among prefectures in each industry in each year between 1990 and 2000. These time paths are used to determine whether the spatial development of each industry became either more differentiated over time or whether there was a tendency towards equalization. The time paths are also used to draw conclusions about the impact of economic crisis in general and major crisis-inducing events in particular on the uneven development of each industry. Three events in particular are of interest in this period: the collapse of the bubble economy in 1990-91, the revaluation of the Yen in 1995 and the Asian financial crisis of 1997-98.

The third stage of the research analyzes the relationship between the uneven development of manufacturing employment and the uneven development of manufacturing output and productivity from 1990 to 2001. This is accomplished by estimating a time-series multiple regression model for each industry in which the standard deviation of the shift-share regional effect among prefectures is the dependent variable and the standard deviations of the output and productivity determinants of employment from the multivariate shift-share model are the explanatory variables. The model is as follows:

\[ \text{EMPStDev} = a + b_1 \text{OUTStDev} + b_2 \text{PRODStDev} + e, \quad (1) \]

where EMPStDev is the standard deviation of the shift-share regional effect among prefectures for a given industry in a given year, OUTStDev is the standard deviation of the shift-share output coefficient among prefectures for a given industry in a given year, PRODStDev is the standard deviation of the shift-share productivity coefficient among prefectures for a given industry in a given year, \( a, b_1 \) and \( b_2 \) are parameters to be estimated and \( e \) is the error term. Equation (1) was estimated separately for each industry. Given the possibility of time series autocorrelation, the model was estimated by generalized least squares with a one year lag structure.

The data required for the analysis are annual employment, output (measured by value added) and productivity (measured by value added per worker, discounted by the wage share of value added) in twenty-one manufacturing industries for each prefecture. These data were obtained from the annual Census of Manufactures for all firms with four or more employees (Ministry of Economy Trade and Industry, various years). Value added and wage data were converted to constant 1995 yen values using

\[ \text{Banasick and Hanham} \]
national-level, industry-specific deflators (Economic and Social Research Institute, 2005). Core and peripheral prefectures were identified using the prefectural share of national manufacturing employment for 1990.

THE SHIFT-SHARE REGIONAL EFFECT
The shift-share regional effect aggregated over the period 1990-2001 is shown in Figure 2. There are two clusters of prefectures with positive regional effects. The first cluster centers on the Aichi prefecture in the core and several other peripheral prefectures surrounding it. The second cluster includes four peripheral prefectures located close to Tokyo that have been destination sites for much of the production that has left the core prefectures (Whittaker, 1999; Oda, 1997a; 1997b). Three prefectures in the northern periphery and three in the southern periphery also had positive regional effects.

![Figure 2.](image-url)
Four of the seven core prefectures had negative regional effects during the study period, including the Tokyo and Osaka metropolitan prefectures. Both prefectures had developed major clusters of industrial production during the postwar period, but recent increases in production costs had contributed to an intensification of restructuring processes. The southern periphery stands out for the large cluster of prefectures that performed poorly in terms of the regional effect.

TIME PATHS OF UNEVEN DEVELOPMENT
In this section we examine the time paths of uneven development for each industry. This is accomplished by plotting the standard deviation of the employment regional effect among prefectures for each industry annually between 1990 and 2001. The results are shown in Figures 3-6. The time paths can be classified into four groups depending on initial conditions and the trajectory of the standard deviation over time. In the first group the initial level of unevenness is relatively low and there is a dominant tendency for the standard deviation of the regional effect to increase over time (Figure 3). The majority of industries in this grouping are light manufacturing industries experiencing considerable decline (textiles/apparel, printing/publishing, furniture, and lumber/wood), with two additional industries focused on materials manufacturing (chemicals and pulp/paper), and one leading industry centered on assembly/fabrication (electrical machinery).

Figure 3.
Figure 4.
Figure 5.
For the second group the initial level of unevenness is relatively high throughout the period compared to the industries in the first group (Figure 4). The standard deviation of the regional effect increases rapidly for petroleum, but tends to fluctuate for the other industries. Two of these industries are the materials based iron/steel and non-ferrous metals. The fourth industry, general machinery, is a leading sector that focuses on assembly/fabrication.

The spatial pattern of employment change for the first group became more uneven during the prolonged economic downturn that occurred from 1990 to 2001, which corroborates Smith and Dennis’ (1987) claim that economic crisis generates a more differentiated landscape. In addition, the time path for most of the industries in the first two groups is broken up by sudden changes in the trajectory of the standard deviation over time. An examination of the time paths reveals that these sudden changes are more often than not associated either with the onset of economic crisis or with events that precipitated growth in the space-economy. For example, there was a sustained rise in the standard deviation for most of the industries in these two groups beginning in 1991-92, following the bursting of the bubble economy and the onset of a three year recession. There was also a
The third group of industries also has relatively high levels of unevenness initially, but their time paths are dominated by a singular spike in their uneven development (Figure 5). The trend in the remaining years tends to be modestly rising. This group is comprised of two leading industries based on fabrication/assembly - precision instruments (1996-97) and transportation equipment (2000-2001) – and two minor industries centered on light manufacturing - rubber products (1994-95) and leather/fur products (1997-98). These surges may result from partial crises which are localized by either prefecture or sector (Harvey, 1982; Smith, 1990). For example, within the transportation equipment industry there has been considerable spatial variation in performance. Some major auto manufacturers such as Toyota and Honda have remained profitable even during the crisis, and prefectures such as Aichi and Shizuoka where many of their large assembly plants are located have had relatively strong economic performance, while Mazda, headquartered in Hiroshima prefecture, struggled throughout the 1990s and eventually looked to Ford Motors for assistance in restructuring some aspects of production (Fujimoto, 1999; Lincoln and Gerlach, 2005).

The fourth group of industries begin with relatively low levels of unevenness and demonstrate time paths of development which trend towards both equalization and differentiation over the study period (Figure 6). This group consisted of four industries focused on light manufacturing (food processing, beverages, fabricated metals, and ceramics/stone/clay), and two industries centered on materials manufacturing (miscellaneous and plastics). Generally the level of unevenness was higher and the fluctuations larger for the materials manufacturing industries. The time paths for food processing and ceramic/stone/clay are relatively less volatile and contain a more complex combination of brief, rather than sustained, equalization and differentiation trends.
REGRESSION ANALYSIS
In this section we analyze the relationship between the uneven development of manufacturing employment and the uneven development of manufacturing output and productivity from 1990 to 2001 by means of the time-series multiple regression model specified in equation (1). The goal of this analysis is to determine the degree to which the uneven development of industrial employment between 1990 and 2001 was shaped by the uneven development of industrial output and the uneven development of industrial productivity. The regression model relates the standard deviation in the regional effect over time to the standard deviations of output and productivity over time.

The explained variance and parameter estimates for equation (1) are shown in Table 2 for each industry. Only parameters significant at the 0.05 level are shown in the table. Given the fact that there are only seven degrees of freedom, these results must be viewed with some caution. However, the fact remains that the explained variance is very high in most industries and the majority of parameters are significant, which is a testament to the strength of the relationship in most cases. In only five industries is neither the standard deviation of output nor the standard deviation of productivity significantly related to the standard deviation of the regional effect. Four of these are light manufacturing industries (textiles/apparel, lumber/wood, printing/publishing, ceramics/stone/clay), and only one is based in materials manufacturing (non-ferrous metals).

The standard deviation of productivity is the most consistently significant variable in the model, and its relationship with the standard deviation of the regional effect is always positive. The relationship holds for fourteen industries. There is considerable variation in the strength of the relationship, varying from 1.784 for rubber to 0.339 for petroleum products. It is important to clarify the meaning of this relationship. It signifies that changes in the unevenness of the pattern of employment change over time correspond to changes in the unevenness of the pattern of change in productivity. When productivity changes in an industry become more (less) spatially differentiated, the result is an increase (decrease) in the spatial differentiation of employment change. In other words, the uneven development of employment is positively linked to the uneven development of productivity over time.

When the productivity parameter is approximately equal to one, this indicates that changes in the uneven development of productivity over time are
matched by the same amount of change in the uneven development of employment. This is the case for the transportation equipment, iron/steel, chemicals and pulp/paper industries. When the parameter is more than one, this indicates that changes in the uneven development of productivity generate a greater amount of change in the uneven development of employment. This is the case for rubber, furniture and miscellaneous. When the parameter is less than one, changes in the uneven development of productivity generate a smaller amount of change in the uneven development of employment. This is the case in beverages, electrical machinery, food processing, fabricated metals, general machinery, plastics, and petroleum. Finally, there is no significant link between the uneven development of employment and productivity in textiles/apparel, lumber/wood, printing/publishing, leather, ceramics/stone/clay, non-ferrous metals and precision instruments.

The standard deviation of output is significantly related to the standard deviation of the regional effect for twelve industries. The relationship is negative in nine industries, which indicates that when changes in output become more (less) spatially differentiated, changes in employment become less (more) spatially differentiated. In other words, the uneven development of employment is inversely linked to the uneven development of output over time. This inverse relation holds, in order of magnitude, for furniture, miscellaneous, chemicals, transportation equipment, pulp/paper, iron/steel, beverages, electrical machinery and general machinery. The relationship between the uneven development of employment and output is positive in three industries, which indicates that when changes in output become more (less) spatially differentiated, changes in employment also become more (less) spatially differentiated. This positive relation holds for leather, petroleum and precision instruments. There is no significant link at all between the uneven development of output and employment in food processing, textiles/apparel, lumber/wood, printing/publishing, plastics, rubber, ceramics/stone/clay, non-ferrous metals and fabricated metals.

CONCLUSIONS
This research has shown that manufacturing industries developed very unevenly in Japan from 1990 to 2001, a period of prolonged economic stagnation and crisis. The spatial pattern of employment change became more differentiated and uneven in most industries as the economic crisis intensified over time. The pattern of development also responded to major economic events, both crisis- and growth-inducing. The
bursting of the financial bubble in 1990-91 and the Asian financial crisis of 1997-98 both triggered an increase in the spatial differentiation of the development of many industries, and the mild economic recovery sparked by the devaluation of the Yen in 1995 triggered a trend, albeit brief, toward equalization in several industries.

The regression analysis showed that the change in the uneven development of most industries over time was positively associated with the uneven development of productivity and negatively associated with the uneven development of output. In other words, changes in the spatial pattern of employment became more (less) differentiated when productivity became more (less) differentiated. However, changes in the spatial pattern of employment became more (less) differentiated when output became more (less) uniform. What this suggests is that the spatially varied landscape of employment change which occurs during economic crisis is shaped by a spatially varied pattern of changes in productivity and a more spatially uniform pattern of changes (presumably falling) in output.

Despite the general findings outlined above, it is also clear that there are substantial variations in the results. Time paths of uneven development, the impact of economic crisis on these time paths and the extent to which they are shaped by the uneven development of productivity and output all vary among industries. Some of these differences, for example, may be due to the degree to which an industry is capital or labor intensive, others to the degree to which an industry is export dependent. Further research must examine these differences in greater depth.

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