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EDITORIAL: ECONOMIC DECLINE AND THE RELEVANCE OF INDUSTRIAL GEOGRAPHY

The current economic downturn presents a challenge for industrial geographers, a trying time that has multiple dimensions. First, as members of society, we cannot help but be impacted by the economic circumstances that for many of us are without parallel in our lifetimes. The lives of millions of people are being affected by bankruptcy, foreclosure, and job loss, and for many there may be little realistic hope of recovery, at least in the near future. The depth of the crisis has permeated society in recent months to such an extent that a candidate for the U.S. presidency who ran in 2008 on a foundational theme of "hope" finds himself in 2009, following his election as president, infusing his speeches with words of warning against economic calamity. Even in an academic setting, many of us have seen salary freezes, cutbacks, and uncertainty at our institutions. On multiple levels, the pain of recession is a real and growing part of our lives.

Yet, related to the nature of the teaching and research we do in our field, our role as industrial geographers extends beyond experiencing recession to a second level of involvement. Given our interests in economic geography, our work links to a proactive world of *examining* the functioning of our economic system and *communicating* the nature of the forces that shape this fundamentally geographic system to our colleagues, students, and broader community. It is empowering on many levels to think of the possibilities for contribution that are ours because of what we study.

However, as always, there are things we can seek to do better. Two observations, one from each of the aforementioned areas of examination and communication, provide some insight into the possibilities for positive change.

1. Our research can be even more relevant to the broad range of problems now faced by society. It is clear that one area of need in current economic planning and policy-making relates to a basic understanding of the factors that contribute to economic decay, so that these conditions may be addressed. Although an exceedingly well-established body of research deals with the geography of business decline (Massey and Meegan 1982; Clark and Wrigley 1997; Essletzbichler 2004), important gaps exist in that literature. Business decline research in geography has historically focused on job loss and plant closure, and has been characterized by an overwhelming orientation toward the study of manufacturing. It is clear that losses in these traditional areas of concern remain important in the current recession, but it is also clear that the economic problems we now face go well beyond the manufacturing sector and job losses alone. Recent geographic research related, for example, to the unfolding real estate crisis, and weaknesses in finance

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and services (Crump et al. 2008; Aalbers 2009), is an essential complement to the historic focal points of business decline studies in our discipline. Other "blind spots", or research weaknesses rooted in our disciplinary traditions, certainly exist in geography. Geographers who display the flexibility necessary to diversify their research agendas to encompass current issues provide a real service to geography and society. For the sake of relevance and ultimately the survival of our field, we must be willing to go beyond the research boundaries of the past so that we can address the full spectrum of themes that are most important for our future.

2. We need more industrial geographers willing and able to engage a broader audience. Diverse research agendas are important, but they are not enough. Although a small number of economic geographers (Richard Florida being a classic case) and non-geographers with spatial interests (Paul Krugman being another timely example) have carved out public reputations related to expertise in our field, it is difficult to escape the conclusion that public debate and policy formation could use a higher awareness of the basic principles on display in any economic geography class. Krugman's colleagues in economics have grasped this point, to the benefit of their discipline; we ought to learn from their example. Industrial geographers need to be more active in translating the fundamentals of economic geography into a language and format that is relevant to the needs of policy-makers and the public at large.

Industrial geographers have always had messages worth sharing outside of our immediate, professional circles. For the good of society and the growth of our field, it is important that we engage in a continuous assessment of the research that we do, how well this work meets societal needs, and how we might best position our analysis for effective dissemination beyond our profession. As a journal with an empirical and applied orientation, *The Industrial Geographer* aims to contribute to this process.

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IMPORTING CHANGE: CANADIAN COMPETITION AND THE U.S. FLORICULTURE INDUSTRY

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ABSTRACT

During the last century American agriculture has undergone a massive transformation from an industry dominated by a large number of small family-owned farms to an industry characterized by a fewer larger scale, heavily-capitalized enterprises. In this paper, we analyze the shifting geography of production with respect to the U.S. floriculture industry. The ongoing transformation of the floriculture industry is being driven by two interrelated phenomena. One is growing Canadian imports, particularly from Ontario. Canadian producers benefit from a fortuitous location with respect to major American markets, operate on a larger scale, enjoy a more favorable institutional setting, and until recently, profited from a favorable exchange rate. Another transformative process has been increasing sales of floricultural products by mass merchandisers in the U.S. The "big box" stores favor large scale operations, including Canadian exporters, due to larger scale demand and more complex sales agreements. As a result of these transformative changes, the U.S. floriculture industry will likely move to a dual market structure, consisting of large scale producers, who can supply the "big boxes" and compete effectively with foreign imports, and another segment of small scale producers who will have to carve out local markets based on higher quality customer service and/or being responsive to specialized consumer demands.

Key words: floriculture, Canadian imports, United States, mass merchandisers, global value chains

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INTRODUCTION

During the last century American agriculture has undergone a massive transformation both in terms of scope and scale. It has shifted from being a cottage industry dominated by a large number of small family-owned farms to an industry dominated by a fewer larger scale and more heavily capitalized commercial enterprises (Hart 2003). This consolidation of agricultural production has been driven and facilitated by a number of interrelated factors. These include the evolution of supply chain production models, economies of scale, state intervention in agriculture, and advances in genetic engineering technology, as well as the broader forces of technological change that have transformed nearly all global production systems (Barkema & Cook 1993; Drabenstott 1998, Page 1996; Woods 2005). As this paper demonstrates, the evolution of supply chains in agriculture and the scaling up of production has been driven by both upstream and downstream forces. Agriculture (including floriculture), however, is unique insofar as the re-scaling of retail activities vis-à-vis the expansion of "big box" stores has reconfigured customer expectations in the area of crop/plant quality and product standardization.

The purpose of this research is to document the changes that are occurring in the U.S. floriculture industry. In particular, we focus on the growth in Canadian imports and the reasons driving and implications of this growth. In particular we explore the increasing role of "big box" stores in the sale of floriculture products. Most of the data for the study comes from secondary sources. However, we also use the results of field work done in Ontario in the summer of 2007.

Rural areas and agriculture have undergone substantial change (Evans *et al.* 2002; Lyson and Geisler 1992). Farm operators are continuously responding to various economic, political, and social stimuli, such as globalization and social modernization (Holloway and Ilbery 1997). Many refer to such adjustments as restructuring. However, Woods (2005) believes that the term "restructuring" has been applied too loosely. Also Hoggart and Paniagua (2001) argued that the concept of restructuring is in danger of being trivialized through its misapplication. This research on the greenhouse industry is not an analysis of restructuring. Instead this paper more narrowly focuses on the impacts of foreign trade as well as changes in the retail environment.

CHAINS, LINKS, AND SCALE

Until recent years, the global value chain of floriculture largely conformed to the market governance type described by Gereffi *et al.* (2005). That is, most small growers sold to local markets, including through their own retail operations. The complexity of transactions was low, the capability of suppliers was high, and the power symmetry and degree of coordination were low. With the advent of the "big box" stores and their evolving market power, the situation is changing. The industry is experiencing a shift to the captive governance type. The complexity of transactions is increasing, transactions are increasingly codified, and the degree of coordination is increasing, with an asymmetric power distribution favoring buyers over suppliers (Murray 2007). This shift has been accelerated by the growth in Canadian imports which are in part oriented towards the "big boxes".

Such changes are not unique to the U.S. Hughes (2000) demonstrated how the UK retailers were able to drive changes in the supply chain of Kenyan cut flower producers. Also Matthee, *et al.* (2006) analyzed the challenges to floriculture producers in the

Republic of South Africa resulting from larger numbers of international producers and an increasingly competitive global market.

In concert, these "change" forces have over time contributed to significant change across the agricultural sector. Yet, change has not occurred in a temporally, or spatially even, fashion. For example, the poultry industry production system was reconfigured in the 1960s while the pork industry has only more recently, in the 1990s, changed its structure (Drabenstott 1998). In the case of floriculture, the sector's transformation would best be described as evolving. More importantly though, as we argue in this paper, one of the primary drivers in the transformation of the floriculture industry has been, and continues to be, the growth, expansion, and altered dynamics associated with Canadian imports.

In an attempt to chart the shifting geography of production associated with the industry, we examine the growing imports of Canadian floriculture products into the U.S. After reviewing the pertinent economic characteristics of the U.S. industry, the Canadian trading patterns are described. In addition, the reasons for the growth in Canadian imports and their impact on the U.S. industry are analyzed.

INDUSTRY CONTEXT

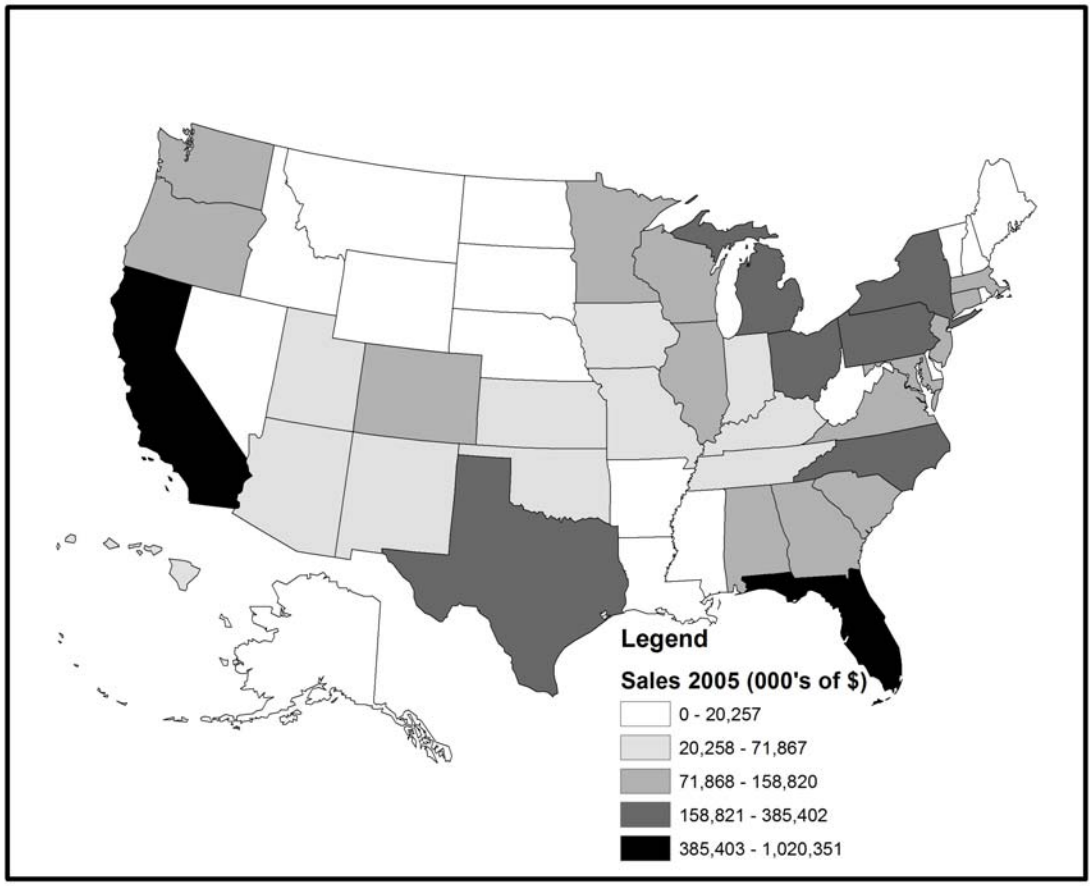
The U.S. floriculture industry comprises establishments primarily engaged in growing a variety of floriculture products such as bedding plants, cut flowers, hanging baskets, and house plants. Floriculture is the largest component of the greenhouses and nurseries industry, accounting for 74.6% of total establishments and 74.8% of the area under cultivation in 2002 (U.S. Department of Agriculture 2002).

The greenhouse industry is a major agricultural sector in the U.S generating almost $16.9 billion of market value of production in 2006 (U.S. Department of Agriculture 2007). To measure the importance of greenhouses and nurseries, Hart (2003) used a different yardstick. He computed the gross value per acre of a variety of farm outputs. The average gross value of nurseries and greenhouses was $8,864 per acre in comparison to $3,489 per acre for the second highest crop - tobacco (Hart 2003 p. 242).

U.S. floriculture production is widespread. The 2002 Census of Agriculture reports 78.1% of counties as having at least one floricultural operation. While floriculture production is geographically dispersed in the U.S., most production occurs in a few states. The leading production states in 2005 sales volume were California, Florida, Texas, and Michigan, which collectively produced 49.3% of the U.S. total (Figure 1; all values are in US dollars unless otherwise specified).

Traditionally greenhouses have been viewed as being associated with urban areas. In part, the urban orientation of greenhouses underscores the industry's high value/productivity per acre, historically intensive production regime, and the continued relevancy of basic economic rent models for agricultural production. In empirical terms, greenhouses continue to reside at the urban-rural fringe, and as Hart (1991 p. 48) observed, "greenhouses are the last rural use that remains in an urbanizing county, because apparently they can cohabit more or less comfortably with built-up areas." Production of highly perishable products explains the historical need to be in close geographic proximity to urban markets. This pattern continues today with approximately 63.2% of the floricultural operations being located in Metropolitan Statistical Areas (U.S. Department of Agriculture 2002).

Figure 1. Floriculture Production in Volume of Sales, 2005

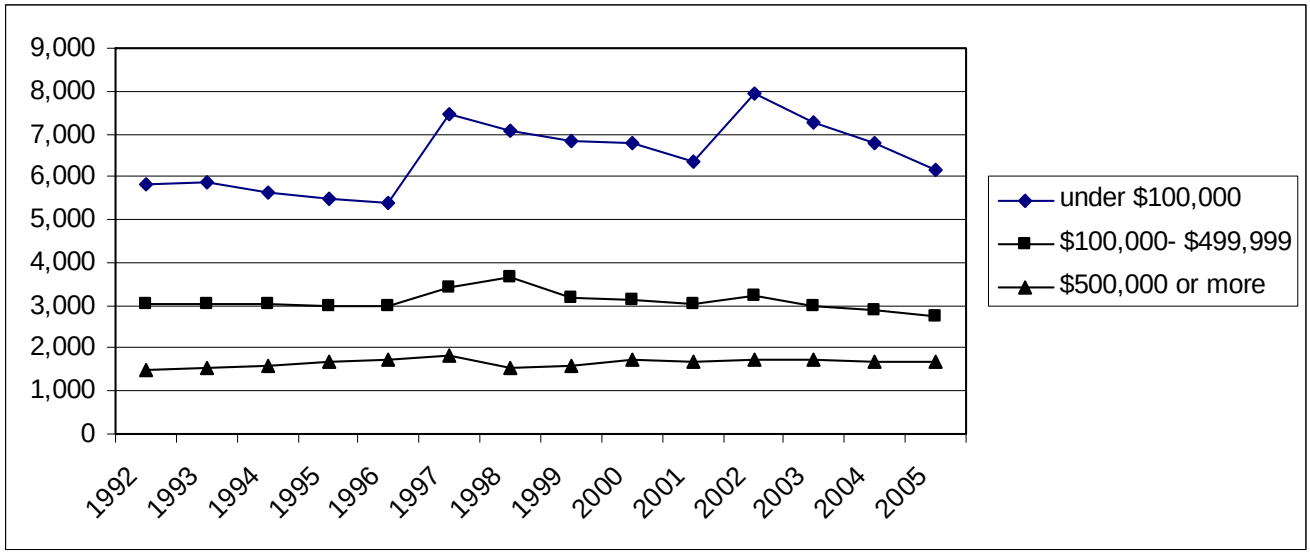


Source: *U.S. Department of Agriculture 2007*

The U.S. floriculture industry has been characterized by fluctuations in the number of greenhouse businesses (hereafter referred to as "growers") (Figure 2). In recent years the number of growers fluctuated between a low of 10,070 in 1996 to a high of 12,916 in 2002. Much of the grower fluctuation is attributable to the coming and going of small growers, i.e. those selling less than $100,000 per year. In contrast, the number of growers selling over $100,000, particularly those selling over $500,000, has been more consistent. Growers on the lower end of production scale are more likely candidates to exit and enter the industry than large scale production growers.

Fluctuations in the numbers of growers, especially small growers, are attributable to various phenomena. For example, Gale (2003) characterized floriculture operations as one of a group of farms which he termed "hobby farms", i.e., small, part-time farms located on the urban fringe. The number of such farms fluctuates widely year to year since their operators do not have a strong commitment to farming. Hart (2003) identified another cause of turnover in the industry, at least in the case of the northeastern U.S. According to Hart, the urban orientation results in owners selling their land for urban development and then using the profits to move to another, larger site farther out from the urban area.

Figure 2. Number of Floriculture Growers by Size of Operation, 1992 to 2005



Source: *U.S. Department of Agriculture 2007*

Klingaman and Robbins (2004) noted that the failure rate of start-up greenhouses is very high, with close to 80% not staying in business five years.

The financial stability of smaller growers is also more precarious. The productivity of smaller growers, when measured by sales per acre, is substantially lower than larger growers, and has been decreasing over time. For example, in terms of prices adjusted for inflation, growers producing less than $100,000 in sales per year sold $42,913 per acre in 1993 as compared to $85,384 for those operations selling over $100,000 per year (U.S Department of Agriculture 2007). By 2005, the smaller growers' sales per acre had declined by 26.9% to $31,361 per acre. In contrast, the larger growers' sales per acre had increased by 13.0% to $96,481 per acre (U.S. Department of Agriculture 2007).

These changes in the supply side of the U.S. floriculture industry have occurred while the consumption of floriculture products has been increasing. Between 1992 and 2005, per household consumption of floriculture products increased, in real terms, by 25.7%, from $44 to $55 (U.S. Department of Agriculture 2007). Furthermore, the United States was the second largest market in the world for floriculture in 2002, following Germany, and is approximately six times larger than the Canadian market (Agriculture and Agri-Food Canada 2004). These market characteristics make the United States a very attractive target for exporters of floriculture produce from other countries, including Canada.

FLORICULTURE IMPORTS

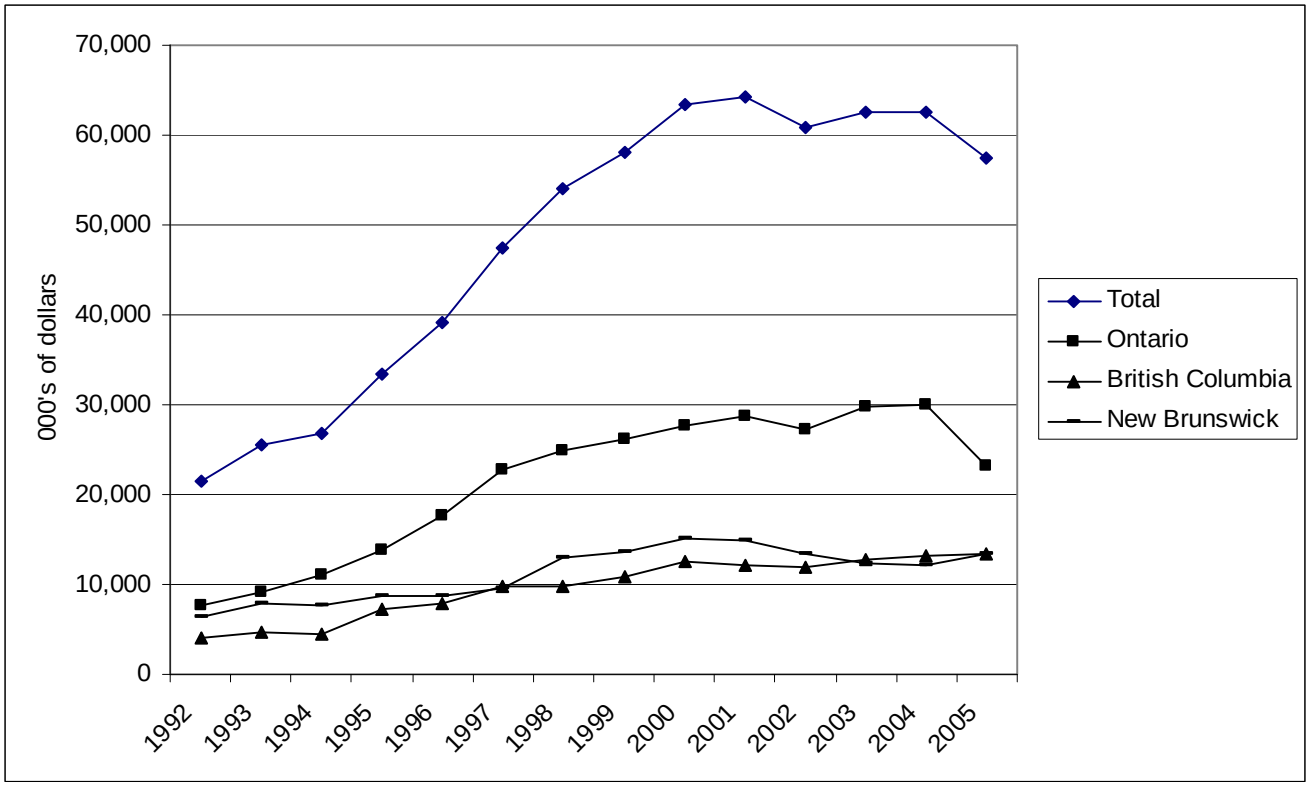
Prior to the 1970s, floriculture products tended to be produced for a domestic market or a nation's immediate neighbors (Matthee *et al.* 2006). With the advent of reliable and frequent air transport, as well as distribution facilities, the industry has become more global in nature. U.S. floriculture imports increased in real terms by 84.1% between 1992 and 2005 to reach

$1.4 billion (U.S. Department of Agriculture 2007). In terms of imports, the floriculture industry is composed of two primary segments - - cut flowers and nursery stock. In 2005, $709 million of cut flowers were imported along with $678 million of nursery stock (U.S. Department of Agriculture 2007).

The origin of imports for cut flowers and nursery stock differs somewhat (U.S. Department of Agriculture 2007). In 2005, the major sources of cut flowers were Columbia, Ecuador, and the Netherlands, with each contributing 59.0%, 18.2%, and 9.1% of the total respectively. In the case of nursery stock, the major countries of origin were Canada, the Netherlands, and Costa Rica, with each accounting for 42.2%, 27.3%, and 5.3% of the total respectively.

In terms of imports of nursery stock, one of the notable trends has been the comparatively recent growth in imports to the U.S. from Canada. Between 1992 and 2005, Canadian imports of floricultural products, primarily nursery stock, increased by approximately 166% to reach $57.9 million. The main provinces involved in exporting floriculture products to the U.S. in 2005 were Ontario (40.6% of the total), New Brunswick, (23.3%) and British Columbia (23.2%). Of these provinces, Ontario has the steepest growth trajectory (Figure 3). The decline in both total imports and Ontario

Figure 3. Origin of Floricultural Imports to the U.S. from Canada



Source: *Industry Canada, Strategis.*

imports between 2004 and 2005 is primarily attributable to changes in currency exchange rates.

The expansion of the Canadian imports not only occurred in volume, but also in terms of their spatial footprint within the U.S. (Figures 4 and 5). In 1992, four states accounted for 65% of Canadian floriculture imports. New York was the leading importer (23.2% of Canadian imports), followed by Massachusetts (16.6%), Washington (16.1%) and New Jersey (9.1%).

Beyond these four states, the import of Canadian floriculture products was relatively small.

By 2005 the there was a considerable expansion in the geography of Canadian floriculture imports into the United States. Six states accounted for over 65% of the Canadian imports in 2005. In order of importance these were New York (16.5%), Washington (13.7%), Massachusetts (13.4%), Michigan (9.4%), Maine (6.8%), and New Jersey (5.8%). A comparison of the 1992 and 2005 maps shows the spatial expansion of Canadian floriculture imports into the Midwest, South, and Far West.

To better understand the spatial distribution of imports by state, regression analysis was used in a gravity model-type formulation to assess the relative importance of U.S. market size and production characteristics, as well as distance (see Roy & Thill 2004). To measure production, the number of large growers in each state was used. Market size was measured by the number of households. Distance was the mileage from a state's centroid to the Canadian border (Tables 1 and 2). As is conventional in gravity models, the equation was estimated in log-linear form (Helmers & Pasteels 2005).

The model is expressed as:

$$\ln I = \beta + \beta \ln D + \beta \ln G + \beta \ln H + e$$

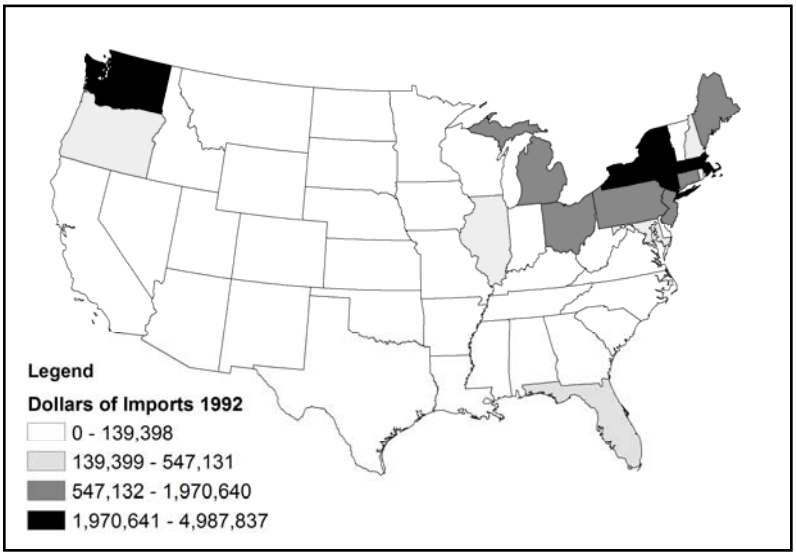
Where

I = total Canadian Imports
D = distance from U.S.-Canada border
G = total producers or growers
H = total households
e = error term

The R-square values were significant at the 0.05 level in both years, being 0.79 in 2005 and 0.76 in 1992. In 1992, the only significant independent variable was distance, whereas distance and the number of households were both significant in 2005. This would suggest that the geography of Canadian imports were driven more by market size in 2005 than they were in 1992.[1] In 1992, the correlation coefficient between growers and households was 0.89 and 0.83 in 2005. Given the tendency of floriculture operations to be located in metropolitan areas, this result is not surprising. What is notable is the fact that the simple correlation between the number of growers and imports was positive and significant in both years, being 0.49 in 1992 and 0.41 in 2005. This suggests that the Canadian imports are penetrating the major producing states in the U.S. Moreover, the coefficient of distance diminished between 1992 (-2.64) and 2005 (-1.40). It is apparent that distance was less of a barrier to Canadian imports in 2005 than had been the case in 1992.

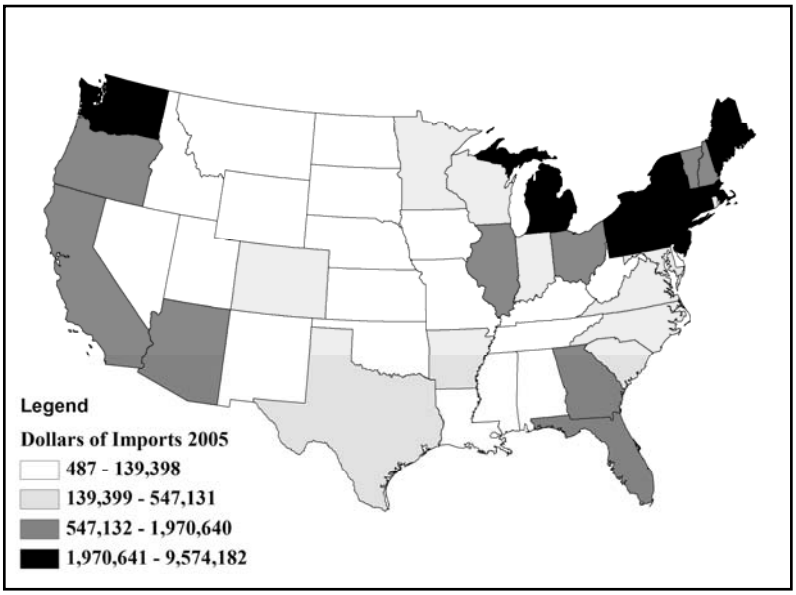
[1] A variance inflation factor (VIF) was calculated for each variable in the estimated equations. The obtained VIF values are well below the critical levels of 10 which *may* suggest the existence of multicollinearity and/or the potential for poorly estimated equations.

Figure 4. Destinations of Imports from Canada, 1992



Source: *Industry Canada, Strategis.*

Figure 5. Destinations of Imports from Canada, 2005



Source: *Industry Canada, Strategis.*

REASONS FOR GROWTH IN U.S. IMPORTS OF CANADIAN PRODUCTS

The Canadian ability to compete in the U.S. is attributable to a number of factors. A key geographic advantage of the Canadian floriculture industry is its proximity to the U.S. market, particularly the Ontario segment of the industry, which produces over 50% of the Canadian total (Brown & Murphy 2003). Approximately 50% of the U.S. urban population is within an 8 hour drive from Ontario (Reid & Lindquist 2005). Viewed from a different perspective, Ontario is the third largest producer of floriculture products in North America in terms of value of production behind California and Florida (Brown & Murphy 2003).

The average floriculture operation in Ontario is approximately 32,100 square feet (Brown & Murphy 2003). However, the average size of operation is much larger in those areas located closest to the U.S. For example, the average size in Essex County, which borders Detroit, Michigan, is 87,457 square feet. In the Niagara Municipality, which borders Buffalo, the average operation is 71,300 square feet (Reid & Lindquist 2005). These sizes compare quite favorably with the average size of many operations in the U.S. For example, in Ohio in 2002, the average size of greenhouse was 29,000 square feet (U.S. Department of Agriculture 2002). This differential size provides Canadian producers with a significant cost advantage. Schumacher and Marsh (2003) found that there were substantial scale economies in floriculture. As growers increase their scale of operations and automate, they will experience a cost advantage over smaller producers.

The large concentration of growers (and wholesale distributors) in southern Ontario

has allowed individual growers to specialize in particular product lines. A product line from a particular grower is shipped to distributors who combine it with product lines from other growers. In this way Canadian growers are able to supply a full line of floriculture products to "big box" stores in the United States. Product line specialization has been a key competitive strategy for Canadian growers as it has allowed them to achieve significant economies of scale (Brown 2007).

Table 1. Model Results

Variable	1992	2005
Constant	5.36 2.11	2.83 1.33
Distance	-2.64 -5.39	-1.40 -5.62
Total Growers	0.39 1.16	0.08 1.11
Households	1.59 1.92	0.95 2.79
R-square	0.76	0.79

Given their larger size of operations, one trend favoring Canadian floriculture is that an increasing percentage of sales of floricultural products are made by mass merchandisers, home centers, and other "big box" stores. In fact, White *et al.* (2002) noted that the expansion of the larger growers in Canada is linked to the expansion of the chain stores in the U.S.

As shown in Table 2, home centers and mass merchandisers are the primary retail outlets for lawn and garden customers in 2004. Anecdotal evidence substantiates the role of home centers and mass merchandisers in the growth of this industry. For example, mass merchandisers accounted for 44% of lawn and garden sales in 2004 as compared to 30% in 1999. Home centers share grew form 36% in 1996 to 50% in 2004 (Hinson & Navajos 2004). Also, a 2001 Green Industry survey in Ohio found that between 1996 and 2001 wholesale sales, some of which go to large retail outlets, grew at an annual rate of 32.8% while retail garden center sales declined at an annual rate of 1.2% over the same period (Gao *et* al, 2002 p. 6).

Table 2. Lawn and Garden Retail Customers, 2004

Retail Outlet	Customers (Millions)
Home Center	42
Mass Merchandiser	36
Independent Garden Center	34
Hardware Store	25
Supermarket	16
Feed/Seed Store	11
Mail Order	7

Source: *National Gardening Association 2004*

The demand for floriculture products has been transformed from being primarily oriented to elite classes to mass consumption (Lee 2000), which in part has been stimulated by and benefited mass merchandisers in the US. Growth in the "big box" retail sectors creates substantial demand in the floriculture industry. For example, Sanford (2005) estimated that for every new Home Depot that opens, the growth in demand creates a need for an additional three hectares of floriculture production. Since the opening of its first store in 1979, Home Depot has expanded to 2042 stores in 2005 (Home Depot). This suggests that "big box" stores, perhaps through advertising and competitive pricing, are increasing demand from current consumers and/or creating new demand by creating new consumers.

Mass merchants privilege large growers for various reasons. The most obvious is that only the larger growers can provide a large volume and varied selection of competitively-priced products (Hinson 2005). To meet that demand, floriculture is becoming

increasingly capital-intensive. Large producers are able to make the necessary capital investments. Moreover the retailers often impose price restraints that reduce profits and profit margins, which smaller growers may not be able to accommodate (Campbell 2004). In addition, the large wholesalers and retailers often impose stringent conditions on the sales agreements with growers, including minimum order specification, bar code stickers, and on-time delivery (Hinson 2005). Some retailers, such as Home Depot and Lowes, use "Pay by Scan" which means the grower is paid for the product only after the consumer has purchased it (Herndon 2006). In general, these stipulations favor larger growers since they can bear the additional costs. Growers selling to mass merchants are, in a sense, facing the same Faustian bargain that Morgan and Murdoch (2000) described for organic farmers selling to supermarkets in the United Kingdom. They will have access to a large market but they give up control over some of their production decisions.

While many American growers supply mass merchandisers, the fact that Canadian producers tend to be operating at a larger scale gives them a potential edge in this growing market. White and Bills (2004) argued that the increase in Canadian imports is linked to the growth of the major chains. Somewhat related to the size issue is a difference in attitudes of the growers in the respective countries. While objective evidence of differential attitudes has not been acquired, there are indications that at least some Canadian growers are more aggressive than their American counterparts. In their profile of the Ontario greenhouse industry, Brown and Murphy (2004) noted the youthfulness of the growers, many of whom are second generation operators of businesses started by immigrants from the Netherlands and Denmark in the 1950s. They are characterized as risk takers, who rapidly adopt new technologies in order to stay competitive in the global marketplace. The Ontario growers operate as an industrial cluster, the Ontario Greenhouse Alliance, with their goal of being a world leader in greenhouse operations (Ontario Greenhouse Alliance 2004). One example of their proactive stance is that they formed a cooperative to purchase natural gas at lower prices in order to cope with rapid increases in natural gas prices, a major expense in the industry (Brown & Murphy 2004). Also, they partner with the Canadian government to obtain research and development support (White *et al.* 2002).

Some characterizations of American growers by industry observers are not as positive. Brumfield and Martin (2006 p. 42) chided growers with the observation that "a typical grower was doing "business as usual" for two generations. This grower invested little profits back into the family business. He was complacent, neglecting peeling paint, broken glass and potholes in the parking lot. His greenhouse looked old and unkempt. He had halfhearted promotions and short hours. The greenhouse layout, lighting, displays and merchandising were virtually unchanged since construction. The signage was poor. He was slow to incorporate new trends and follow customers' changing needs and preferences." In an article aimed at highlighting the increasingly important role of women in making greenhouse purchases, Pohmer (2005 p. 62) observed, "let's us face facts . . . we've been a production-driven, male-dominated industry since time immemorial." U.S. producers with these attitudes will not be competitive in an increasingly buyer-driven industry in which mass merchandisers play a major role in shaping the future of the industry. In essence, the institutional arrangements of growers in Ontario have adjusted more rapidly to the realities of a global supply chain than has been the case in many parts of the U.S. As Maskell (2001 p. 935) pointed

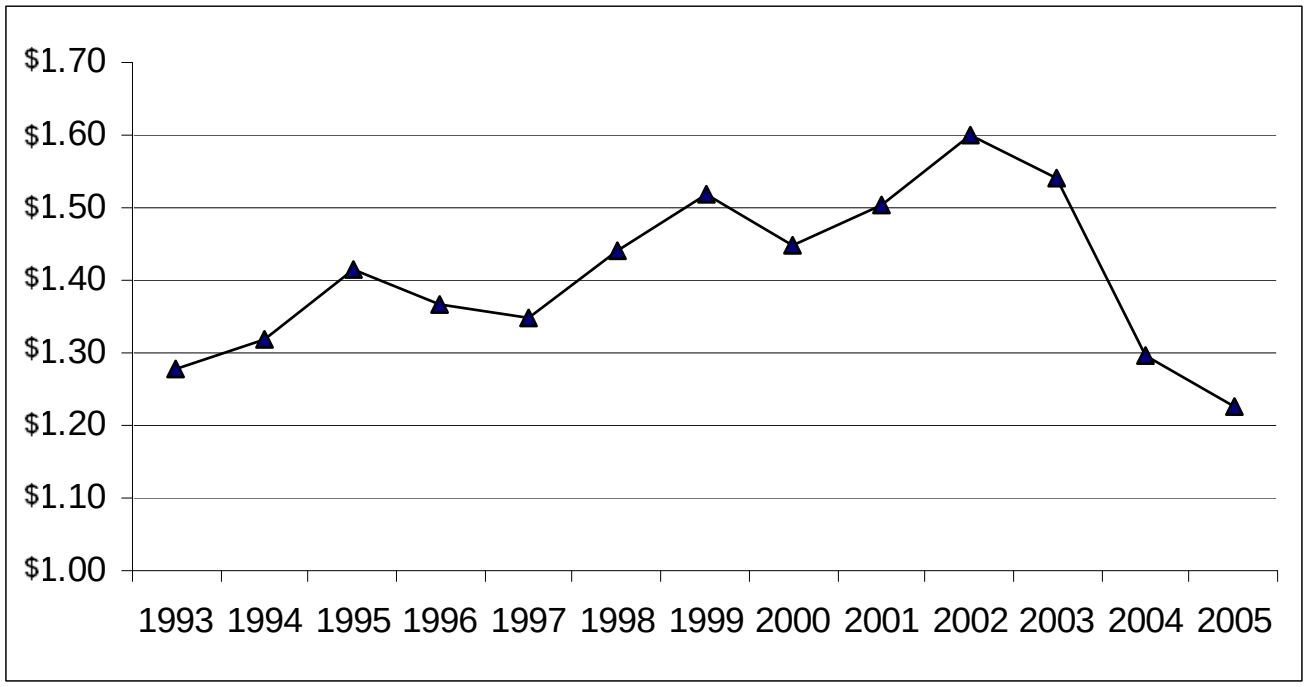
out, institutional change is important because institutions assist firms in meeting the challenges or opportunities caused by changes in the outside world.

Another advantage for the Canadian producers has been a favorable exchange rate, which has kept the price of their products relatively low in the U.S. market (Figure 6).

For most of the study period, the U.S. dollar has been stronger than the Canadian dollar. In most years between 1992 and 2002, the U.S. dollar gained strength. However, it has declined in value since 2002, diminishing the price advantage of Canadian imports. The strengthening of the Canadian dollar since 2002 has been one reason for the slowing of the growth of Canadian floriculture imports (Figure 3) (Ontario Greenhouse Alliance 2006). Indeed, the increase in transaction costs associated with currency exchange rates is often cited as a determinant of cross border trade by individual Ontario growers (Ontario Greenhouse Alliance 2006).

One of the events fostering greater trade between Canada and the U.S. was the implementation of the North American Free Trade Agreement (NAFTA) in 1994. Various researchers have suggested that NAFTA has promoted trade in greenhouse products (White and Bills 2004; LaFary *et al.* 2006). However, the extent to which the rapid growth in floriculture imports is attributable to NAFTA is not clear. The data in Figure 3 suggests a continuous upward trend in imports between 1992 and 2002, with no unusual increase after the inception of NAFTA. In their analysis of the impact of NAFTA on various components of the New York State horticulture industry, White and Bills (2004) suggested that exchange rates and the fortuitous location of Canadian production near major U.S. markets are more influential in fostering trade than is NAFTA. They posited (2004 p. 422) that,

Figure 6. Value of U.S. Dollar Relative to Canadian Dollar, 1993-2005



Source: *Industry Canada, Strategis.*

"the fact that trade is growing so rapidly has to be attributed to the influence of factors other than NAFTA." Moreover, in their analysis of the impact of NAFTA on agricultural trade between the U.S., Canada, and Mexico, Zahniser and Link (2002) argued that factors such as population growth and exchange rates have a much greater impact on the growth in agricultural trade than did NAFTA, except in the case of a few commodities (although not floricultural products). Thus, while NAFTA no doubt has contributed to the growth in floriculture imports, it alone does not explain the rapid increase between 1992 and 2004.

In more recent years, other border issues have assumed a greater role in impacting trade, especially those changes which have accompanied the U.S.'s growing concern with homeland security. Since much of the floricultural products are trucked into the U.S., the slowdown in border crossings after September 11, 2001 has been a challenge for the Canadian exporters (Ontario Greenhouse Alliance 2006). Starting in the fall of 2004, changes in the inspection of cut flower imports also affected the flow of Canadian imports (Brown & Murphy 2004). Such problems are particularly acute given the fragility and perishability of the product with the result that slow-downs in the supply chain can generate sizeable losses. A study by MacPherson (2008), on the topic of border delays, is potentially insightful. Analyzing the impact of the U.S. Bio-terrorism Act upon Canadian food exports to the United States, MacPherson found that there was a greater likelihood of border delays if the exported product was perishable and if the exporter was a smaller company. The extent to which MacPherson's findings are applicable to Canadian floriculture products will require more research.

Finally, the geography of Canadian growers themselves is becoming more complex as growers are increasingly acquiring facilities in the United States. Based on interviews with Ontario growers in the summer of 2007, an increasing number of entrepreneurs are taking advantage of currency rates to purchase U.S. production facilities. In addition to the currency issue, Canadian direct investment also yields transportation and logistical benefits in a post-9/11 security environment.[2] As a result of new Canadian investment in the U.S. industry, the production practices of Canadian growers will continue to alter U.S. production systems. Indeed, the experiences of previous industries—most notably the automobile industry (see Reid 1995)—suggest that targeted foreign direct investment promotes structural change in production systems.

TRADE FUTURES

The future of Canadian floriculture exports to the United States depends upon a number of factors. These have already been highlighted in this paper. Currency fluctuations will be an important influence. According to one study, the critical value at which Canadian floriculture exports to the United States are likely to be severely compromised is $U.S1. to $C1.25 (Ontario Horticultural Crops Research and Services Committee 2003). This critical threshold was surpassed on 20 October 2004 and the exchange rate has remained above that level through at the time of writing (November 2008), with the exception of a brief four day period in October 2008 (Bank of Canada 2008). Going forward it is difficult to predict

[2] Interviews were performed during the summer of 2007. Project researchers met with a variety of southwest Ontario greenhouse growers with production facilities in both the U.S. and Canada. The objective of the interviews was to identify the scale and scope of production as well as the export activities and practices (and attitudes) associated with product export.

the future of exchange rates. They will be dependent upon a number of macro economic factors including central bank policies, relative trade balances, and global commodity markets such as petroleum.

The extent to which border delays, currently being experienced by Canadian exporters, will be a salient issue in the future is also subject to uncertainty. Much will depend upon how the regulatory environment evolves. Regardless of that environment there is strong evidence that Canadian exporters who approach the challenge of border delays in an aggressive and proactive fashion are less likely to experience disruptive border stoppages. For example, Canadian exporters of perishable products who invest in understanding the compliance environment (e.g. attending compliance seminars, conducing compliance research) are less likely to experience border delays than those not investing in such activities (McPherson 2008).

In other industries unfavorable terms of trade has resulted in foreign direct investment (FDI) as a strategy for accessing foreign markets. The extent to which the Canadian floriculture industry might respond in this fashion is uncertain. FDI as a strategic response only makes sense when there is some certainty that unfavorable terms of trade are going to exist for a prolonged period of time. Furthermore, FDI requires capital. In Canada, the cost of entry into the industry is prohibitive. A new, state-of-the-art greenhouse can cost upwards $C200 per square meter (Brown 2007). As a result, gradual expansion of existing greenhouse structures is the path chosen by the majority of Canadian greenhouse operations. Investment in the U.S would also result in the geographic dispersion of Canadian production capacity. Currently, the Canadians enjoy some significant competitive advantages from the economies of scale that are the result of much of their industry being geographically concentrated in southern Ontario. Together, these factors make it unlikely that there will be significant Canadian investment in U.S. production facilities in the foreseeable future.

CONCLUSIONS

The dynamics of the floriculture industry and the global value chain are impacting the geography of floriculture production. The value chain is shifting from the market type governance described by Gereffi *et al.* (2005) to the captive governance type. One major force in this change is the increasing sales of floricultural products by mass merchandisers. The "big box" stores privilege large scale production over smaller growers. The large scale operations not only realize economies of scale but also they can better respond to the mass merchandisers' more complex sales agreements, such as minimum order specification, bar codes, on-time delivery, and pay-by-scan.

Closely linked to the growth of "big box" sales is increasing imports from Canada, especially Ontario. Between 1992 and 2005, Canadian imports grew both in volume and spatial extent. Much of the Canadian imports are directed toward the U.S. mass merchandisers. Canadian producers experience the benefits of a fortuitous location with respect to major American markets, larger scale operations, and until recently, a favorable exchange rate. Moreover, the Ontario producers, at least, operate within a more favorable institutional environment, including an active industrial cluster, aggressive entrepreneurs, and government research and development. A less favorable exchange rate and post-9/11 security issues have dampened the rate of growth in Canadian imports. One response to these trade barriers has been greater Canadian direct investment in U.S.

production facilities. Based on the experience of other industries, the targeted direct foreign investment can be expected to promote further structural changes in the production system.

Because of changes in its operational environment, the U.S. floriculture industry will likely move to a dual market structure. One component will be the large scale producers who can meet the demands of the mass merchandisers and compete effectively with foreign imports. The other segment will be small scale producers who will have to carve out local markets based on greater service. Small growers may generate a local market building on Lee's (2000) concept of the geography of regard. He suggests growers build social relations with consumers who share their specialized interest in particular floriculture products. Following Lee's (2000 p. 138) logic, producers may be able to "identify spaces of production *within* the market but *outside* the norms of capitalist evaluation and that these spaces are sustained by the mutual interest and support generated by knowledgeable participants on both sides of the market."

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OUTSOURCING, EXTERNAL COLLABORATION, AND INNOVATION AMONG U.S. FIRMS IN THE BIOPHARMACEUTICAL INDUSTRY

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ABSTRACT

This paper examines the outsourcing patterns of U.S. firms in the biopharmaceutical industry. Data from an exploratory survey of 86 companies suggest that the outsourcing of strategic activities such as applied research and formulary development has started to decline among firms of all sizes, though noncore activities such as manufacturing and clinical trials continue to be outsourced at an accelerating pace. The data suggest that there is no correlation between outsourcing and innovation performance, but that external collaboration supports innovation in positive ways. The results also show that medium-sized firms tend to manage their external partners more efficiently than smaller or larger firms – especially with respect to innovation-oriented collaboration. Medium-sized companies are found to be the most innovative in terms of patents and new product introductions, despite lower levels of research-intensity than those observed for smaller and larger firms. The paper concludes with a brief discussion of the implications of the survey findings for technology analysis and strategic management.

Key words: biopharmaceutical industry, external collaboration, innovation, outsourcing, firm size.

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Introduction

Much of the recent literature on the innovation performance of the biopharmaceutical sector has focused on large firms or multinational corporations (e.g., Boasson et al., 2005; Lane and Probert, 2007; Tapon and Thong, 1999). This is a logical focus because major drug companies have long dominated biopharmaceutical activity in terms of employment, output, and research spending (for a recent overview, see Mittra, 2007). According to Booth and Zemmel (2004), however, large firms have recently been losing their share of new compounds in development to smaller pharmaceutical companies and specialized biotechnology players. Many of these small and medium-sized enterprises (SMEs) are positioned at the front end of product cycles that require enormous levels of research and development (R&D), as well as cutting-edge human capital. These SMEs must exhibit technological or research leadership in order to survive, as few small companies have the financial resources to withstand lengthy periods of innovation dormancy. Although the organization of the discovery function is well documented for large firms, this is not the case for SMEs operating in niche markets (often very high risk). A central goal of this paper is to compare SMEs with their larger counterparts across key dimensions of the product development process, including internal R&D, external collaboration, and outsourcing. A further goal is to compare the characteristics of exporters versus nonexporters. Foreign markets are often required to recoup earlier investments in new drug formulations, rendering an exporter versus nonexporter comparison potentially instructive.

Our interest in the SME component of the biopharmaceutical sector stems from three factors. First, SMEs have recently been capturing a growing share of the market for new drugs (Booth and Zemmel, 2004). Many of these firms operate in specialized markets where the distinction between pharmaceutical activity and biotechnology is blurred (hence our use of the term *biopharmaceuticals*). Second, the imperative to develop external sources of innovation support is arguably stronger for SMEs than for larger firms, if only because SMEs contain limited in-house resources for drug discovery. Third, R&D productivity in the biopharmaceutical industry has been falling steadily since the 1970s (Buxton and Easton, 2003). If SMEs are to survive or grow, then they will presumably need to generate better R&D returns than their larger counterparts.

Set against this backdrop, three interlinked questions are addressed in the empirical sections which follow. First, are innovation or export-participation rates sensitive to firm size? Second, do firms of different sizes exhibit different approaches toward external collaboration or outsourcing? And third, to what extent does location within an established biopharmaceutical cluster make a difference to firm-level innovation performance? Data for the inquiry come from a sample of 86 companies that participated in an exploratory survey in the winter of 2006. Supplementary data come from follow-up telephone interviews with a sub-sample of 20 respondents.

Our paper is organized as follows. The next section provides a research context for the study, along with an overview of current theoretical perspectives with regard to outsourcing and external collaboration. Next, we describe the survey methodology, and give a synopsis of the main characteristics of the sample. We then examine the sources of external innovation support for the survey firms and assess the contribution of these linkages to the product development process. Following this section, we describe the geography of these external linkages by type and review the role of cluster membership in supporting company

growth. The paper concludes with a brief discussion of the implications of the survey results for the strategic management of the innovation function.

From the outset, however, it should be conceded that we are not attempting to contribute to ongoing theoretical debates regarding the motives behind outsourcing or external collaboration (see Howells et al., 2008). Instead, our focus is empirical, exploratory, and descriptive. Even so, some of our findings will be of interest to R&D managers and/or students of industrial organization. In particular, we find that R&D outsourcing is no longer as popular as it once was – regardless of firm size.

Research Context

For firms operating in the life-sciences domain, including large companies, external linkages to tap specialized knowledge have become increasingly common in recent years (Howells et al., 2008; Lane and Probert, 2007). Although outsourcing to achieve cost-containment has been taking place for several decades, recent evidence suggests that many firms now outsource to access new knowledge, expertise, or technology (Lewin and Peeters, 2006). According to Yasuda (2005), the resource-based theory of external linkage development explains much of the recent outsourcing behavior of high-technology firms – notably in terms of collaborator selection. In knowledge-based sectors such as biopharmaceuticals, however, the role of firm size in the outsourcing decision has not been systematically explored. Intuitively, for example, one might expect SMEs to outsource a larger proportion of their *innovation budgets* than larger firms – if only because the latter sometimes invest billions of dollars per year on in-house R&D. This said, there is a paucity of empirical evidence to confirm or reject this suspicion.

From an economic perspective, outsourcing entails a *cost-driven* switch from internal to external input supply – and thus reflects an efficiency imperative. When a biopharmaceutical company outsources R&D, for example, the goal is typically to capitalize on the superior efficiency of external vendors with respect to specialized aspects of the drug development process – leaving in-house personnel to focus on more critical segments of the R&D function (e.g., exploratory research on promising compounds). External collaboration is also cost-driven, but only in the sense that individual collaborators do not possess the internal resources to work entirely on their own within a specific therapeutic domain. The decision to collaborate is powered by a need to access the human capital resources of complementary firms, some of whom may also be competitors (see Rothaermel and Boeker, 2008). It is important to differentiate between these two strategies from the outset, as outsourcing is driven primarily by the need for cost-containment, whereas collaboration is more strongly motivated by the need to access knowledge that cannot be readily generated via in-house investment.

For both *outsourcing* and *collaboration,* however, a source of ongoing and protracted debate concerns the question of whether such external linkages need to be forged within geographically restricted areas (e.g.. to promote speedy interaction) -- or whether long-distance relationships can be developed to exploit the best possible sources of innovation support (e.g., internet-assisted). The 'being there' school of thought that surged in the aftermath of Gertler's (1995) work on the machine tool industry now seems to have morphed toward a more hedged position, in that spatial proximity between network participants is now seen as a bonus – but long-distance relationships can work too (especially if distant suppliers or partners rank among the world's best). Although we have no interest in exploring

the 'death of geography' perspective (see Johnson *et* al., 2006), some of our data suggest that the 'being there' effect has not entirely disappeared. Contrary to our initial expectations, however, the proximity factor appears to be of only minor importance to SMEs.

The role of geographically clustered production in promoting innovation has been a topic of similar debate in recent years, with no clear resolution in sight as far as we can tell. The various theoretical arguments are compelling (e.g., Porter, 1998), but the empirical evidence is mixed (see St John and Pouder, 2006). As Watts et al (2006) observed, cluster membership is a useful but insufficient factor in the stimulation of successful innovation among industrial firms. Perhaps paradoxically, we find that large firms in the biopharmaceutical industry are more likely than smaller firms to perceive cluster membership as being important to the drug-development process. This finding has been reinforced by recent empirical evidence from Boasson et al (2007), who noted that larger U.S. biopharmaceutical companies tend to rank the importance of urbanization or agglomeration economies more strongly than their smaller counterparts. We return to this point later in the paper.

Several attributes of the biopharmaceutical industry should be flagged from the outset, as this segment of the U.S. manufacturing sector is unusual in at least three respects. First, many firms in this sector are classified as manufacturers under the North American Industrial Classification System (NAICS), but many do not actually manufacture drugs or anything else. For example, approximately 50 percent of the SMEs in our sample are research laboratories that develop new drug formulations that are then manufactured by larger companies. Second, some of these SMEs allocate as much as 100% of their annual revenues toward applied R&D, which means that operational funding comes from accumulated cash reserves, government grants, or investment injections from larger firms. A third and related point is that some of the most innovative and R&D-intensive firms in this industry sell knowledge rather than products – suggesting a case of NAICS classification error.

This said, several important changes have taken place in the organization of the biopharmaceutical sector since the 1980s (which is when economic geographers first started to explore this industry). First, the industry has become increasingly concentrated from a spatial standpoint – with most firms belonging to clusters of similar firms in related industries (see Rosiello and Orsenigo, 2008). Second, strategic alliances have become critically important to firms in this industry (see Xia and Roper, 2008). Indeed, locational clustering and external partnering are now well recognized as being important factors in overcoming innovation barriers, especially among smaller firms (Aharonson, Baum, and Plunket, 2008; Ebers and Powell, 2007; Greis, Dibner, and Bean, 1995). Since the 1980s, then, the innovation thrust among biopharmaceutical companies has become increasingly conditioned by external linkages (alliances), spatial clustering, and a general trend toward the integration of biotechnology with pharmaceutical activity.

Our study was framed with respect to three general expectations that were distilled from the recent literature, including: (1) external collaborative activity was expected to play a positive role in the innovation performance of the survey firms, most notably SMEs; (2) we anticipated that SMEs would be more prone to outsourcing than larger firms; and (3) location within a biotechnology cluster was envisioned as a competitive asset for all firms (regardless of size). This latter expectation was based on the fact that the

biopharmaceutical industry as a whole has become increasingly dependent on the biotechnology sector for the development of new drug formulations (Rothaermel and Boeker, 2008; Sen, 2007).

Survey Methodology

In a preliminary effort to explore the business characteristics of firms in this industry, self-administered questionnaires were mailed to the Chief Executive Officers (CEOs) or R&D Directors of 390 companies in November 2006. The sampling frame for the project was developed from the database of the North American Biotechnology Directory (May 2006). SMEs were defined as firms with less than 500 employees (small firms were defined as having 1-100 employees, whereas medium-sized firms were allocated to the 101-500 employee class).

From a total sampling base of 862 U.S. based companies, a random sub-sample of 390 companies (45%) was selected for the study and questionnaires were then mailed. Our research budget was limited, in that we could not afford to randomly sample more than 45% of the population. The survey instrument was pre-tested with a pilot study of 20 firms during April and May 2006. The results and feedback from the pilot study were used to design the final survey instrument. A cover letter and 4-page survey instrument was then distributed to the 390 R&D Directors or CEOs in November, 2006. A return postage-paid envelope was included in the survey package. Follow-up telephone calls and faxes were made to the companies during December, 2006. By the end of December, 2006, 60 usable responses were received (yielding an initial response rate of 15.4%). Second requests were mailed in January 2007 to the companies that had not responded. Follow-up telephone calls and faxes were made through the end of January 2007, and 26 additional completed surveys were received (giving a final response rate of 22.0%).

Although response rates of 20% or lower are common in survey research that focuses on business establishments, our 22% participation level was disappointing in light of the potential salience of the study to the target firms. Nevertheless, t-tests comparing early (n = 60) versus late respondents (n = 26) failed to uncover statistically significant differences between the two groups in terms of critical variables such as R&D-intensity, patent counts, levels of R&D outsourcing, and new product introductions. This said, we openly concede that a 22% response rate is insufficient to offer conclusive findings. Instead, our results should be treated as suggestive only.

Our survey instrument included questions which were both quantitative and qualitative in nature. Quantitative measurements of the variables ranged from categorical (yes/no), ordinal (5 point Likert scales) to interval (percent of total revenue, etc). The survey was divided into three sections. The first section solicited information on company ownership type, revenue, employment size, R&D-intensity, export activity, and growth characteristics. The second section asked about innovation and biotech collaboration. The third section asked about outsourcing strategies for research, product development, manufacturing, marketing, and distribution (a copy of the survey instrument can be obtained from the authors upon request).

To determine firm-level innovation performance, several measures were employed. These included the percentage of revenue used toward R&D, patent approvals received, and new product introductions over the past seven years. The study also measured the extent of innovation through collaboration with external partners.

Another critical measure was the extent of outsourcing of R&D and the impact on innovation. The survey instrument also included a section on export activity (e.g., growth rates, target markets, export-intensity levels). Here, our goal was to test for the presence of an inverted-U relationship between export-orientation and firm size. Borrowing from Dunning's (1979) model of foreign market entry (i.e., the eclectic paradigm), we expected the inverted-U to resemble a logistics curve (i.e. modest levels of export-intensity among small firms, high levels among medium-sized firms, and better than modest levels among large firms). Exports are not especially important to large biopharmaceutical firms because such firms tend to serve foreign markets via direct investment (i.e., subsidiary plants abroad). For SMEs, however, export participation often signals early product acceptance at the international level. Within the SME category, then, we expected to find significant organizational and/or performance differences between exporters versus nonexporters.

Export Characteristics of the Survey Firms

Our analysis begins with an overview of the characteristics of exporters versus non-exporters, disaggregated across the three size-classes of firms mentioned earlier (i.e., small, medium, and large). Five sets of statistically significant contrasts are evident from the data shown in Table 1. First, there is a direct relationship between firm size and export propensity (Chi-square = 9.21; p = 0.010). However, ANOVA tests for export-intensity revealed that medium-sized firms are significantly more export-oriented than their larger and smaller counterparts (p = 0.032). On average, medium-sized firms earned around 30% of their 2005 sales from export markets, compared to 25% among larger companies and 15% among smaller firms. Experimental scatterplots (not shown here) suggest that the inverted-U relationship mentioned earlier is in place for this industry. The data also point to a direct relationship between export propensity and company age (ANOVA p = 0.047), as well as between firm size and age (ANOVA p = 0.002). Although these findings are not especially remarkable, they do provide an important empirical context that we rejoin later in the paper.

A second feature of Table 1 is that small firms exhibit significantly higher levels of R&D-intensity than larger firms (ANOVA p = 0.002). This is notably the case among small firms that are export active. The latter allocated an average of 57% of their 2005 sales to R&D, compared to around 20% for larger firms. In terms of R&D productivity, however, it would seem that medium-sized firms enjoy a competitive edge. Over the last 7 years, medium-sized firms introduced an average of 10 patents per annum (74.3 in total) – compared to less than 3 per annum among large firms and slightly more than 3 per annum among small firms. Although the ANOVA p-value falls short of 0.05 in this case (p = 0.081), a crisper picture emerges when innovation is scaled as the percentage of 2005 sales represented by products that were developed and commercialized over the last 7 years. Here, medium-sized firms lead the pack by a considerable margin (ANOVA p = 0.011). Among medium-sized firms in the export class, for example, recently developed products accounted for 18% of 2005 sales – compared to 10% among large companies and 5% among smaller firms (ANOVA p = 0.032). Within the small firm class, moreover, it is noteworthy that exporters enjoy a significant innovation advantage over their nonexporting counterparts.

Table 1. Size of firm by export-involvement, age, R&D-intensity, patent counts, and new product introductions: cross tabulation, ANOVA and t-tests. *

Size of firm		Small	Medium	Large	All
( ) = % of column [ ] = export-intensity					
Exports	**Yes**	23 (46) [15.3]	13 (72) [34.6]	15 (83) [24.5]	51 (59) [26.1]
	No	27 (54)	5 (28)	3 (17)	35 (41)
	Total	50 (100)	18 (100)	18 (100)	86 (100)
Chi-square = 9.21 (p = 0.010): ANOVA p-value for export-intensity = 0.032					
Age (years)					**ANOVA**
	Exporters	19.2	23.6	39.2	0.047*
	Non-exporters	11.4	21.3	36.1	0.054
	All	13.6	23.2	38.7	0.037*
	T-test by column:	0.042*	0.097	0.162	
R&D-intensity (%)					**ANOVA**
	Exporters	57.3	22.3	21.7	0.019*
	Non-exporters	40.1	19.6	26.8	0.039*
	All	50.1	20.8	23.0	0.002*
	T-test by column:	0.058	0.137	0.119	
Patent counts					**ANOVA**
	Exporters	22.8	74.7	16.9	0.081
	Non-exporters	11.7	71.2	15.8	0.075
	All	14.4	74.3	16.7	0.073
	T-test by column:	0.026*	0.192	0.216	
New products					**ANOVA**
	Exporters	4.7	18.2	10.3	0.032*
	Non-exporters	1.8	16.9	9.7	0.047*
	All	2.5	17.1	10.1	0.011*
	T-test by column:	0.042*	0.236	0.269	

* Significant group differences at p = 0.05 or less.

This said, no clear correlations were uncovered between R&D-intensity and either of the two innovation measures. This was the case for the sample as a whole, as well as within each of the three size-classes of firms (i.e., Pearson's r-values were statistically insignificant). Research &Development is obviously an important contributor to innovation; otherwise firms would not allocate such a fat proportion of their operating budgets to this activity. Nevertheless, there is no direct or linear association between innovation and research spending (i.e., innovation returns are unpredictable).

Overall, however, two general conclusions can be drawn from Table 1. First, firms that serve export markets tend to be more innovative than their counterparts that focus solely on domestic customers. This is especially the case for small firms. Second, and perhaps more important, medium-sized firms outperform their smaller and larger counterparts in terms of export-intensity, patent counts, and new product introductions. As a group, the medium-sized firms are the least R&D-intensive – suggesting stronger research productivity relative to larger and smaller firms. Indeed, the superior innovation performance of medium-sized firms surely goes some way toward explaining why so many of the world's biggest pharmaceutical companies have become increasingly interested in acquiring these innovators (Sen, 2007).

Outsourcing

Keeping these findings in mind, Table 2 compares our three size-classes of firms with respect to several dimensions of outsourcing. These dimensions include R&D, formulary development, clinical trials, product development, marketing, distribution, and manufacturing. Respondents were asked to estimate the outsourced proportion of their total budgets for each of these dimensions. The data are for two time periods (1995 and 2005).

For the combined sample, outsourcing levels for 3 of the 7 dimensions increased over the study period. In the case of clinical trials, for instance, outsourcing levels increased from an average of 45.8% in 1995 to 55.9% in 2005 (a 22% increase). Clinical trials have become increasingly expensive, time-consuming, and fraught with legal and regulatory complexities because they involve human subject experimentation and extensive statistical testing. It is no surprise that most biopharmaceutical companies outsource on this dimension as much as possible (to constrain costs), and that the outsourcing trend is systematically upward (especially for SMEs). Data presented elsewhere show that cost-minimization is the key driver in this respect (see Sen, 2007), as few biopharmaceutical companies want to internalize this particular activity. The marketing and distribution dimensions also show upward trends with respect to outsourcing, and again this is primarily cost-driven.

In contrast, scientific or knowledge-based activities that pertain to the discovery or development of new drugs appear to be migrating back toward the in-house domain. In the case of research, for example, outsourcing levels dropped from a 1995 average of 38.7% to a 2005 average of 28.4% (a 26% decrease). Similar declines can be seen for formulary development and product development. At first blush, then, it would seem that outsourcing levels have been falling across knowledge or science-intensive fields, in line with recent evidence reported by Boasson et al (2007) for large U.S. pharmaceutical companies.

With regard to outsourcing patterns by firm size, Table 2 again suggests that medium-sized firms occupy a distinct category. On average, such firms currently outsource less than 10% of their current research spending (the sample mean is 28%). Ten years ago, such firms only outsourced an average of 13% of research spending (the 1995 sample mean was 38%). Both now and in the recent past, then, medium-sized firms stand out as being different from the pack with regard to the outsourcing of knowledge-intensive activities. Although the ANOVA tests are not statistically significant in this regard, the general pattern would seem fairly clear. Specifically, the medium-sized firms are different from the population as a whole.

Table 2. Outsourcing trends by company size.

	Sample Mean %	Firm Size			ANOVA
		Small %	Medium %	Large %	
Research: Current	28.4	35.4	9.3	25.4	.112
10 years ago	38.7	48.1	13.4	31.7	.147
Clinical Trial: Current	55.9	63.0	31.3	56.0	.128
10 years ago	45.8	50.5	29.3	56.0	.458
Formulary Development: Current	49.9	61.8	17.6	55.0	.132
10 years ago	51.4	75.6	6.5	44.0	.033
Product Development: Current	27.5	30.6	14.6	33.8	.345
10 years ago	36.2	47.6	8.8	37.0	.100
Manufacturing/Production: Current	37.6	47.3	9.8	44.0	.032
10 years ago	47.2	65.0	13.2	36.2	.029
Marketing/Sales: Current	41.5	41.5	*	*	-
10 years ago	25.8	30.3	8.7	35.0	.407
Distribution: Current	57.6	73.9	21.2	*	.030
10 years ago	37.2	55.0	16.5	31.3	.391

* There are no firms in that size category reporting data.

As a point of general clarification, it should be noted that all of our 86 outsourcers in 2005 were outsourcers in 1995. Further, the patterns shown in Table 2 were not influenced by clusters of outliers (i.e., skewed distributions). For example, all of our 86 respondents outsourced some of their research spending in both 1995 and 2005 – and all 86 reported a moderate or substantial decrease in their external R&D spending over the study period. The same comments apply to most of the other dimensions listed in Table 2. In short, these trends appear to be systemic.

On this note, Table 3 offers a number of clues regarding the patterns shown in Table 2. Here, firms were asked to estimate their outsourcing-related savings over the study period (aggregated across all of the outsourcing categories).[1] Close to 37% of our respondents stated that outsourcing did not result in cost savings – even though cost-reduction was the strategic driver in the first place. Again, however, medium-sized firms stand out as being different. For example, 54.6% of these firms achieved outsourcing-related cost savings in the range of 6-15% over the study period, compared to 15.4% among large firms and 22.2% among small firms. Though not statistically significant,

[1] The survey instrument asked firms to estimate cost-savings across all of the outsourcing categories, as well as provide an overall estimate for outsourcing as a whole. Unfortunately, estimates for individual categories had too many missing responses to warrant tabulation here. In general, however, the available data suggest that savings have been lowest for knowledge-based activities such as R&D and highest for production (manufacturing), distribution, marketing, and clinical trial activities.

Table 3. Financial Benefits of Outsourcing by Firm Size: Savings Realized.*

Size of Savings	Total Sample %	Size of Firm		
		Small %	Medium %	Large %
None	36.7	33.3	36.4	46.2
1 – 5%	20.0	25.0	9.1	15.4
6 – 10%	21.7	19.4	45.5	7.7
11 – 15%	5.0	2.8	9.1	7.7
16 – 20%	3.3	2.8	-	7.7
>20%	13.3	16.7	-	15.4

* Aggregate estimates for all the main outsourcing categories

there is at least a shade of evidence from Table 3 that medium-sized firms are more adept at managing the outsourcing relationship than larger or smaller firms. More broadly, the fact that over one third of the firms across all three size categories did not achieve cost savings goes some way toward explaining why so many of the outsourcing dimensions listed in Table 2 show a downward trend.

Given the importance of cost reduction as the strategic or tactical driver of the outsourcing thrust, it is no surprise that neither of our two innovation metrics were found to correlate significantly with any of the outsourcing dimensions for 1995 or 2005. We mention this only because outsourcing has been associated with an innovation dampening effect by some scholars (e.g., Dankbar, 2005), or even an innovation retardation effect by others (e.g. Boasson et al, 2007). We find no evidence of an innovation impact in one direction or the other. During the early days of our study, however, we did expect innovation to respond positively to levels of external collaboration (innovation partnerships). Our findings in this regard are presented in the following section.

Table 4. External collaboration and company size.

	Small	Medium	Large	All
Patent Collaboration				
Yes	22 (56%)	8 (53%)	8 (73%)	38 (58%)
No	17 (44%)	7 (47%)	3 (27%)	27 (42%)
Total	*39 (100%)*	*15 (100%)*	*11 (100%)*	*65 (100%)*
Chi-square = 1.152 (p = .562)				
Product Collaboration				
Yes	15 (62%)	11 (73%)	9 (82%)	35 (70%)
No	9 (38%)	4 (27%)	2 (18%)	15 (30%)
Total	*24 (100%)*	*15 (100%)*	*11 (100%)*	*50 (100%)*
Chi-square = 1.454 (p = .483)				

External Collaboration and Innovation

Most of the survey firms (58%) collaborate with external partners regarding patent applications, while 70% collaborate to design, develop, and/or commercialize new products (Table 4). Fully 65% of the survey firms indicated that they collaborate with complementary firms to access specialized expertise. Although the incidence of external collaboration does not vary significantly by firm size, there is a general tendency for collaborators across all size classes to exhibit better innovation performance than non-collaborators (Table 5). Medium-sized firms again outperform their smaller and larger counterparts in both the collaborator and non-collaborator categories, but collaborators exhibit a clear innovation advantage across all size classes. Among small firms, for example, collaborators introduced an average of 4.8 new products over the last 7 years, compared to 1.7 among non-collaborators (t-test p = 0.041).

Table 5. External collaboration by firm size and innovation performance.

		Small	Medium	Large
Product collaboration*	**Yes**	4.8	20.7	10.9
	No	1.7	13.6	7.8
t-test p		0.041	0.048	0.064
Patent collaboration**	**Yes**	22.2	75.6	17.1
	No	11.9	64.2	14.9
t-test p		0.024	0.078	0.073

* Average number of new product introductions over last 7 years
** Average number of patent introductions over the last 7 years

One of our survey questions asked firms to indicate the extent to which location within a cluster of biotechnology companies gave them a competitive advantage in terms of innovation, thus testing for two possible effects (see Table 6). The first effect pertains to Porter's (1990) assertion that rivalry conditions within a cluster of related firms spurs innovation as a result of competition. The second effect pertains to the potential for inter-firm collaboration, which is arguably easier when similar types of firms are located near to each other. Among large firms, 63% indicated that location within a biotechnology cluster conveyed either a very important or critically important competitive advantage. This is in stark contrast to SMEs, where approximately 50% indicated a minor or negligible role for this factor (ANOVA p = 0.030).

Looking at the geographic structure of collaborative activity, 58% of the large firms work primarily with external partners located within the same metropolitan area, compared to 46% among small firms and only 30% among medium-sized companies (Chi-square = 8.32; p = 0.043). At first glance, these findings are surprising. After all, large firms have the financial and management resources to scan globally for appropriate partners. Smaller firms might be expected to have less flexibility in this regard. Yet, in this particular sample, SMEs are more likely to operate with non-local partners than their larger counterparts.

Table 6. Perceived importance of location in a biotechnology cluster.

	Small %	Medium %	Large %	All %
Critically Important	5.7	-	27.3	8.5
Very Important	28.6	15.4	36.4	27.1
Moderate Importance	14.3	30.8	9.1	16.9
Minor Importance	25.7	23.1	27.3	25.4
Not Important	25.7	30.8	-	22.0
ANOVA p = 0.030				

One possible explanation for these patterns is that large firms tend to collaborate with small biotechnology companies and other large firms, thus underscoring the importance of being located within a biopharmaceutical cluster. Medium-sized firms tend to avoid partnering with larger companies, and seem more likely to partner with other medium-sized firms and small biotechnology players. Unfortunately, our data are too sketchy to offer reliable comparisons of the size-structure of external collaborations. Nevertheless, the fact that large firms collaborate mainly with similar types of firms located nearby suggests that these firms are better positioned to access the advantages of a clustered location than SMEs. As reported by Boasson et al. (2007), some of these advantages include knowledge spillovers between firms in related industries, access to skilled workers, and proximity to major research universities with large pharmacology or life sciences departments.

Discussion

Despite the limited size of our sample, it would appear that medium-sized firms enjoy a competitive advantage in terms of export-intensity, patents, new product introductions, innovation-related collaborative activity, and the ability to realize cost savings from outsourcing. Such firms have never outsourced basic or applied research at rates comparable with smaller or larger firms, and few seem to regard location within a biopharmaceutical cluster as being especially important. As a group, medium-sized firms are less likely to collaborate with local partners than their smaller and larger counterparts. The question thus arises: why are these firms different? Although we are not in a position to offer definitive answers, several possibilities spring to mind.

To begin with, there is now an extensive literature on the ability of SMEs to innovate more aggressively than larger firms (e.g., Christopherson and Clark, 2007; Feldman et al, 2005). Popular explanations vary from

the risk-oriented nature of SME managers to their faster decision-making, extensive participation in innovation networks, and their ability to attract young research scientists that want to be part of rapidly growing business ventures (especially those that are positioned at the front end of new product cycles). Small firms that have recently transitioned toward medium-sized status appear to be especially attractive to the industry's youngest and most promising research scientists. At this stage, however, some of the general or stylized facts reported in the recent literature on SME innovation have not been systematically tested for the biopharmaceutical sector. In this regard, we feel obliged to offer two cautionary notes. First, our innovation data do not say anything about the commercial impact or broader societal importance of recent product development activity across our three size-classes of firms. We offered innovation counts *only.* Second, our survey was not structured to probe for size-related differences in subtle aspects of business management or human capital attributes (e.g., incentive structures, hiring policies, risk-tolerance). In short, we have identified size-related differences in NPD activity and other organizational characteristics – but we have been unable to go much further.

This said, an issue of more general interest concerns the trend toward reduced outsourcing on the R&D front. Recall that R&D outsourcing is not typically practiced with a view to capturing superior research findings relative to in-house alternatives. Instead, the goal is more commonly to cut costs. As noted earlier, however, close to one third of the survey firms failed to realize outsourcing-related cost savings over the study period. Not surprisingly, these are the firms that have recently cut their external R&D budgets the most. But failure to achieve cost savings is only part of the story. We interviewed 20 firms by telephone to probe this issue further, and two common themes emerged. First, external research is not always reliable. Several firms noted that they did not fully trust the findings reported by their external vendors, and that much time and effort had to be expended on verification procedures (in-house checking). In all of these cases, flaws were uncovered that needed to be corrected -- sometimes at considerable expense. Second, even in cases where external findings were deemed reliable, such findings were often delivered later than expected – causing unacceptable product development delays. For these reasons, many outsourcers have become increasingly selective in their allocation of external contracts. Our follow-up inquiries suggest that R&D outsourcing peaked in the late 1990s, but has since dropped to a level that more accurately reflects the techno-market competence of the contract R&D supplier-base. In short, the days of >30% R&D outsourcing are probably over.

Most of our survey participants indicated that cost reduction was the primary driver across all of our outsourcing categories, whereas external collaboration was more commonly practiced to access specialized expertise (i.e., new or complementary knowledge). Outsourcing has been a successful business strategy for most firms, especially with regard to clinical trials, marketing, distribution, and manufacturing (for comparable evidence from the UK, see Howells et al., 2008). In strategic areas such as R&D, however, few firms reported significant cost savings over the study period. As noted earlier, all of the R&D outsourcers in 1995 had cut their R&D outsourcing budgets by 2005. From a product development perspective, external collaboration appears to be a successful strategy – notably for medium-sized firms. From a theoretical standpoint, then, our data suggest that the transactions cost perspective explains most of the outsourcing thrust. In contrast, external collaboration is more commonly designed to support new

product development by tapping outside sources of complementary expertise. Here, the resource-based theory of external linkage development appears to offer stronger insights (see Yasuda, 2005).

Summary and Conclusions

External *collaboration* to support product innovation is common in the U.S. biopharmaceutical industry and is likely to persist or even expand in light of the need for most firms to exploit the specialized expertise of complementary producers. The *outsourcing* of noncore functions such as clinical trials or marketing is also likely to increase over time, though the same cannot be said for strategic areas such as R&D or formulary development. Medium-sized firms are the innovation leaders, as evidenced by recent rates of new product development. Such firms appear to manage their external collaborations and outsourcing relationships more efficiently than their larger and smaller counterparts. Medium-sized firms are also among the most non-locally oriented in terms of external partner selection, with few firms in this size-class indicating an important technological or business role for location within a bio-pharmaceutical cluster. Medium-sized firms are also the most export-intensive, though we suspect that average levels of export-orientation among these firms will decline as they transition toward large firm status (i.e., the inverted-U mentioned at the start of the paper).

At this stage, however, it should be conceded that some of our survey results raise more questions than answers. For example, it is not clear why large firms tend to view location within a biopharmaceutical cluster as being important from a business performance perspective. Perhaps these firms are equating cluster location with wider agglomeration or urbanization economies rather than the presence of similar types of firms? At this point, we simply do not know. In a similar vein, we are unable to explain why medium-sized firms stand out as being so radically different from the crowd. Qualitative research based on personal interviews would be appropriate to probe for possible explanations.

We suspect that the days of substantial R&D outsourcing are destined to wane in light of poor results over the last 10 years. All 20 of our interviewees noted that specialized aspects of their R&D outsourcing ventures were initially viewed with enthusiasm (major cost savings were envisioned), but that outcomes were not impressive from either a cost or quality standpoint. In short, we do not believe that R&D outsourcing in the 2000s will ever again match the levels that were recorded in the 1990s unless the quality of the external supplier-base improves dramatically. This does not mean that R&D outsourcing will stop. Rather, the intent is to suggest that outsourcers will become increasingly selective in the future, subcontracting only to those vendors that have a track record of good results.

Finally, it would seem that most of the collaborators in our sample had forged strategic alliances with at least one biotechnology company over the study period. Although we are only at the preliminary stages of a follow-up study based on personal interviews, our early follow-up results suggest that these biotechnology partners are very young (less than 10 years old), very small (less than 10 employees), and research-intensive. At this stage, however, we do not know very much about the nature or durability of these alliances.

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1. Articles

Lindahl, D. & Beyers, W. 1999 The creation of competitive advantage by producer service establishments. *Economic Geography* 75:1-20.

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3. Presentations

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5. Working Papers or Other Resources

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