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Research Paper

The Canadian Economy in Transition

A guide to research on the new economy

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This paper represents the views of the author and does not necessarily reflect the opinions of Statistics Canada.

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1. Economies in Transition

Industrial transitions involve a continuous process of competitive reorganization. At any phase in an industry's lifecycle, evidence of competitive restructuring is legion: new startups challenging existing incumbents; more-productive firms gaining market share from less-productive competitors; large corporations acquiring new horizontal or vertical partners; growth-orientated companies shifting resources into new high-yield ventures. Innovation is the driving force behind competitive restructuring. New products, production techniques and organizational practices are continually reshaping the characteristics of the marketplace.

Survey-based research on innovation and technology use has substantially improved our understanding of industrial competition. Innovation surveys measure the rate at which new products and manufacturing processes find their way onto the marketplace. These help us understand how innovation and technology strategies vary—across industries at different stages of their lifecycle, and in different production environments, from traditional manufacturing to high-technology services. The innovation capabilities that firms develop have a direct impact on the organization of the marketplace; firms that invest in innovation, especially in core inputs such as research and development and advanced technology, are statistically more likely to outperform their less-innovative competitors (Baldwin and Gellatly, 2003).

Innovation captures a broad range of entrepreneurial activity.[1] Many innovations are modest, incremental changes, while others are more pathbreaking. Both contribute to the process of industrial renewal. The continuous introduction of a stream of incremental innovations can be expected to engender, over time, significant changes in market structure (Baldwin and Hanel, 2003). But it is the more monumental, pathbreaking innovations—particularly those that embody new advances in technology—that garner the majority of the limelight. Technology-based innovations embodied in computer hardware, software and telecommunications products are at the center of the structural transformation toward what many claim to be a *New Economy*.[2] New technologies have transformed how firms develop,

[1] For discussion and analysis of international standards for measuring innovation, see Holbrook and Hughes (2000).

[2] Productivity-based research on the New Economy has focused on ICT investments in hardware, software and telecommunications equipment. For a recent Canadian example, see Armstrong et al. (2002).

deliver and support traditional products; they have also opened up new avenues for innovation, helping foster the proliferation of brand new products and services.[3]

The impact of technological innovations on the economy's industrial structure can be studied in several ways. Macroeconomic analysts may choose to study how the composition of capital investment has shifted towards technology-based products, and the implications of this transition for the economy's output or productivity performance.[4] Industry analysts may instead concentrate on how aggregate technology profiles differ across sectors, and on evaluating the flow of innovative products from technology-producing sectors to technology-using sectors.[5] Microeconomic analysts may be more interested in the range of technological competencies within specific business populations, and in understanding how differences in innovation and technology strategies correlate with firm-specific growth and performance histories.[6]

Each level of analysis contributes to a better understanding of how technological innovation is transforming the industrial landscape.

The Canadian Economy in Transition is a series of new analytical reports that explore the dynamics of industrial change. The idea for this new series grew out of several independent research projects at Statistics Canada, all of which address topics related to the growth and development of the New Economy. In the near term, the series brings together several studies that focus on science and technology industries and knowledge workers. These include:

- A major report on the production and performance trends that have shaped the growth and development of Canada's information and communications technology (ICT) industries and science-based industries;
- A geographic analysis of ICT- and science-based employment growth in Canadian provinces, urban/rural regions and cities;
- A study investigating the long-run shift in Canadian labour markets towards knowledge-intensive occupations;

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[3] There is an emerging literature on the New Economy which examines the characteristics of this structural transformation. An excellent discussion of different "schools of thought" within this literature is found in Stiroh (1999). A brief review of microeconomic and macroeconomic perspectives on the New Economy is presented in Beckstead and Gellatly (2003a), the first analytical report in *The Canadian Economy in Transition* series.

[4] The OECD's Growth Project is illustrative; their analysis (2000) explores the role that ICT investments play in accounting for growth differentials across Member countries.

[5] This production-versus-use distinction draws extensively on the analytical framework developed by Robson, Townsend and Pavitt (1988). In their seminal study of innovation flows, the authors develop a classification system that distinguishes between core (innovation-producing) industries and secondary industries that integrate production technologies developed in the core sector.

[6] For example, see Baldwin and Sabourin (2002). Their study examines relationships between technology use and plant performance in the food processing sector.

- A report that examines empirical relationships between ICT and science-based definitions of the New Economy and occupational-based definitions of the Knowledge Economy;
- An analysis of whether firm-specific technological competencies or membership in ICT and science-based industries are the more influential determinants of training incidence and training intensity in Canadian plants.

Brief summaries of these analytical reports are provided below.

2. Research on the New Economy

2.1 The growth of New Economy industries

Information and communications technology (ICT) industries develop, deliver and support many of the products and services at the heart of the technology revolution. The first analytical report (Paper No. 002) in *The Canadian Economy in Transition* series—*The Growth and Development of New Economy Industries*—examines long-run production and performance trends in Canada's ICT sector. *Growth and Development* offers a detailed statistical profile of the ICT sector during the 1980s and 1990s, the formative growth years of the information technology revolution. Drawing on a diverse collection of data resources, the report offers a long-run analysis of productivity, profitability, output, capital investment, trade, research and development, employment and labour quality. *Growth and Development* controls for industry differences by disaggregating the ICT sector into three sub-sectors: (1) core ICT services (e.g., computer services and telecommunications), (2) other ICT services (e.g., cable television, ICT distributive trades), and (3) ICT manufacturing (e.g., electronic products industries).

Growth and Development argues that ICT industries should not be viewed as the sole source of industrial innovation in the New Economy. Accordingly, the report also focuses on a larger collection of *science-based* industries—industries that make contributions to industrial innovation via relatively large investments in research and development and human capital. Almost all ICT industries are science-based. But the science sector also includes many R&D-intensive and skill-based industries beyond the boundaries of the technology sector. These include 28 science-based goods industries (e.g., aircraft industries, industrial chemicals and pharmaceuticals) and 9 science-based services (e.g., architecture, engineering and technical services industries). The authors round out their analysis by comparing the long-run production and performance characteristics of ICT and science industries to large collections of *other goods* and *other services* industries.

ICT industries have dynamic long-run input and performance profiles. GDP growth, employment growth, productivity growth, investments in technology, and R&D expenditures are all areas in which the ICT sector excels. In many respects, science industries are comparably dynamic. Long-run job gains and output growth in (non-ICT) science industries have been substantial, particularly in services. Long-run multifactor productivity growth in (non-ICT) science-based goods industries actually exceeds the sectoral average for the technology sector, as do long-run profit margins. Knowledge workers are just as prevalent

in many science environments, and science industries, on average, exhibit higher investment intensities than ICT industries.

The report cautions that neither ICT nor science industries should be viewed as homogeneous. Productivity growth (both labour and multifactor) is far more apparent in ICT manufacturing than in highly-visible core ICT services (i.e., computer services and telecommunications). Science-based goods industries enjoyed better multifactor productivity performance than any combination of service industries studied. Service industries excel in other dimensions. Core ICT services stand out in terms of GDP and employment growth. But science-based services are home to the largest improvements in labour quality. Profit margins are higher in science-based goods and core ICT services—reflecting higher levels of capital intensity.

The report also highlights examples of dynamic performance outside of technology and science-based environments. Significant numbers of industries in non-ICT, non-science environments outperform the ICT average in each of the analysis categories studied. And a small number of industries, including a cluster of automotive industries, surpass the ICT average across a range of input and performance categories. Significant industrial transitions are occurring in many economic sectors.

2.2 The emerging geography of the New Economy

Agglomeration economies, the benefits from locating in large, industrially diversified areas, are often posited to influence the location decisions of technology-based firms. Paper No. 003 in the *Transitions* series—*A Decade of Growth: The Emerging Geography of New Economy Industries*—investigates how employment growth in ICT and science-based industries is distributed across Canada's provinces, urban/rural regions and major cities. The report examines employment growth over the 1990 to 2000 period.

A Decade of Growth compares the absolute size of ICT and science-based workforces in different locations along with the proportional representation of ICT and science workers within local and regional economies. In addition, the report evaluates a series of possible explanations for why certain cities develop more intensive ICT-based economies than others. Multivariate regressions are used to test whether different urban characteristics—the size of the employment base, the amount of industrial diversification, and the contribution of (non-ICT) science industries to the employment mix—are useful predictors of local ICT-intensity.

High rates of entry fueled employment growth in ICT industries during the 1990s. *A Decade of Growth* shows that ICT employment growth was largely confined to major urban centers. Canada's large cities, led by ICT job creation in Toronto and Montreal, benefited significantly from the technology revolution. By 2000, the Ottawa-Hull region led all other urban areas in terms of the percentage of the local workforce employed in ICT industries. For most cities, employment growth in non-ICT science industries has been much more modest.

Calgary, Edmonton and Montreal enjoyed the largest gains in science industries (in absolute and percentage terms) over the decade. Many other cities witnessed low or negative employment growth in non-ICT science industries during the 1990s.

The report's multivariate analysis suggests that agglomeration economies play an important role in the formation of ICT industries. Cities with large employment bases and diversified industrial structures exhibit greater local ICT representation. In both 1990 and 2000, industrial diversification is positively associated with local ICT intensity. However, the analysis suggests that, over the course of the decade, community size is a more important determinant of ICT growth in Canadian cities.

2.3 Long-run growth of knowledge workers

Strategies for attracting, developing and retaining highly-skilled workers are widely perceived as requisites for success in the New Economy. Paper No. 004 in the *Transition* series, *Dimensions of Occupational Changes in Canada's Knowledge Economy, 1971-1996*, investigates the long-run growth of high-knowledge occupations in Canadian industry. Using occupational data from census files, 40 separate occupational groups are identified as knowledge-based. These are classified into three major categories—professional workers, technical workers and management workers.

Dimensions reports that the share of employment accounted for by knowledge workers increased at a steady rate over the 25 year study period. Gains in the early-to-mid 1990s were comparable to those in earlier periods. Within the aggregate knowledge workforce, compositional trends become apparent. High-knowledge workers in professional and management occupations have expanded their ranks more rapidly than those in technical occupations. Although males make up a larger percentage of knowledge workers, growth in the proportion of workers who are classified as knowledge-based is more apparent in the female employed labour force.

Across the industrial landscape, Canada's knowledge sector has grown about equally in goods and services industries. High-knowledge workers are much more likely to be located in urban areas. Because of differences in industrial and urban structure, the growth of the high knowledge workforce is most apparent in Ontario and Quebec. After controlling for differences in urbanization and industry mix, most provinces have similar concentrations of knowledge workers.

In focusing solely on changes in occupational structure, *Dimensions* takes a different approach to quantifying high-technology transitions within Canada's economy. Although labour inputs constitute only one aspect of a firm's high-technology profile, they are important determinants of industrial competitiveness. Research from a special survey has found that technology-based manufacturing firms place more stress on skilled workers than their

competitors. Technology-based firms are also more likely to train their workers in response to skill shortages that arise from the introduction of advanced technologies (Baldwin and Peters, 2001). In service industries, the line between labour development strategies and formal innovation strategies is often blurred. For many small firms, skill development strategies, such as training, effectively serve as their innovation strategy (Baldwin and Gellatly, 2003).

2.4 Are knowledge workers part of the New Economy?

Paper No. 005 in the *Transition* series—*Are Knowledge Workers Part of the New Economy? A note on the concentration of knowledge workers in different industrial environments*—explores empirical differences between science and technology-based definitions of the New Economy and occupation-based definitions of the Knowledge Economy. Two basic issues guide the analysis. First, which industries, beyond those located in technology and science-based environments, emerge as New Economy leaders when industry rankings are based solely on differences in occupational structure? Second, do high-knowledge industries outside of ICT and science-based environments "measure up" to the standard set by the ICT sector when evaluating different aspects of their growth and performance profile?

Knowledge Workers is a straightforward extension of the occupational methodology advanced in *Dimensions*. *Dimensions* defines the high-knowledge sector as the proportion of the employed labour force in certain occupational categories; counts of workers in all industries are used to estimate this share.

Knowledge Workers generates a high-knowledge sector—a small collection of industries with the highest knowledge scores—based on the proportional representation of knowledge workers in different industry environments. *Knowledge Workers* then compares the industrial composition of this high-knowledge sector with the ICT and science definitions used extensively in the *Transition* series to study the growth of the New Economy.

Eighteen industries are classified as *high-knowledge*. Together these industries make up 10% of business sector employment, about the same employment share as science industries. This high-knowledge group includes several ICT industries (e.g., computer services and electronic equipment manufacturing) along with other R&D and skill-based science industries (e.g., architecture, engineering and scientific services, and motion picture production industries). But the analysis also shows that many industries outside of ICT and science environments can be seen as New Economy leaders on the strength of their human capital characteristics. Financial and professional services are illustrative, with financial intermediaries, accounting, investment intermediaries, management consultants and legal services all making the grade as knowledge-based. Also designated as high-knowledge are industries—such as theatrical and entertainment services, services incidental to fishing, and services incidental to air transport—that would not necessarily garner headlines in studies of the New Economy.

While the non-ICT, non-science industries identified in *Knowledge Workers* make large investments in human capital, most do not have performance histories that put them on par with the technology sector. None of the high-knowledge industries outside of ICT or science environments experienced faster long-run GDP growth or multifactor productivity growth than the ICT industry average. However, several high-knowledge industries compare well with the ICT sector in other respects. Crude petroleum and natural gas industries have higher wages, faster growth in labour productivity, and higher profit margins. Accounting and legal services have experienced faster employment growth (in terms of workers and total hours), and higher profits.

2.5 Training in high-technology firms

The last of the first set of reports in *Transitions* (Paper No. 006) builds on earlier Statistics Canada research that asks whether the high-technology landscape is more about firms than industries. Using firm-level data from a special business survey, Baldwin and Gellatly (1998) found that new technology-based firms—successful young businesses that make significant investments in innovation, technology or human capital—operate in large numbers in many different sectors of the economy, not just in highly-visible, high-technology hubs. They also found that many industries could be classified as high-technology leaders, depending on the criteria used to define high-tech.

Paper No. 006 in the *Transition* series—*Who Trains? High-Tech Industries or High-Tech Workplaces?*—investigates whether the incidence and intensity of training follows from membership in ICT and science-based environments, or is more dependent upon firm-specific technological competencies, irrespective of the business's host industry. *Who Trains* is consistent with the latter view: training incidence is more firm-specific than industry-specific. Establishments that develop technological competencies are more likely to train than other businesses. Size effects are also apparent, as large plants are more likely to train than small or medium-sized plants.

3. *Future Directions for the* Canadian Economy in Transition Series

The first set of analytical reports in *Transitions* deals extensively with conceptual and measurement issues that help shape our understanding of abstract constructs such as the New Economy or the Knowledge Economy. New research projects are currently being developed that either build on existing themes, or extend the series in new analytical directions. Below is a brief survey of topics that are currently being considered.

3.1 Boom and bust cycles in technology markets

The first three analytical studies in *Transitions—Growth and Development, A Decade of Growth,* and *Dimensions*—focus on a period of long-run growth in technology markets. These studies tell us about the development of the New Economy in the 1980s and 1990s, prior to the downturn in technology markets in recent years.

The decision to begin the series with studies that focus, in effect, on the "calm before the storm" was largely conditioned by data considerations. Several of the databases that were used to develop growth profiles had operational constraints which limited data availability for more recent years. Many of these data limitations are subsequently being addressed. A priority for future studies is to profile the shakeout in technology markets during the 1999-2002 period. New studies that focus on the boom and bust cycle are apt to be more selective in the topics they cover. Several performance indicators published in *Growth and Development*, such as labour and multifactor productivity growth for New Economy industries, will be featured in upcoming reports as new data become available. But other lines of analysis also need to be developed. In particular, we need to learn more about the competitive restructuring that occurred in science and technology markets during the recent period of rapid growth and rapid decline. New studies on entry and exit may reveal much about the risks of entrepreneurship in science and technology industries.

3.2 Commodity flows in the New Economy

Armstrong et al. (2002) recently published a study which examines the relationship between technology investments and output growth. Their analysis is based on the economy's stock of major ICT products—computer hardware, computer software and telecommunications equipment. Over the 1981 to 2000 period, Canadian businesses increased their investments in these products by an average rate of 16% per annum. Forthcoming studies in *Transitions* will extend our knowledge of the *use* or *commodity* dimensions of the New Economy by (1) examining the flow of technological capital between different economic sectors, and (2)

investigating industry-level relationships between technology use and productivity performance. Future technology profiles will also focus on alternative definitions of ICT capital. These include, first, a more extensive list of the commodity outputs produced by domestic technology industries, and second, commodity definitions that conform with the emerging ICT goods and services standards that are currently being developed by the OECD.

3.3 Economic dynamism beyond ICT and science

The *Transition* series features analytical reports that explore the dynamics of industrial change and competitive restructuring. Studies that focus on science and technology industries, knowledge workers, and ICT capital are featured prominently in *Transitions* because these topics shed light on the emerging dimensionality of the New Economy. But future studies will not limit themselves to these themes. New reports will focus on a broad spectrum of topics related to industrial change. These studies will make use of alternative industrial taxonomies in order to investigate (e.g.) how performance trends in labour-intensive industries compare with those in resource-based industries, or how growth in financial services compares with growth in the automotive sector. Other studies will draw on new survey data to develop profiles of specialized firm populations, such new technology-based firms or high-technology small firms, across a range of industry environments and/or performance categories. All will provide readers with rich, new empirical perspectives on competitive restructuring.

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