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Micro

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Productivity Revisited

This issue of *MICRO* revisits the productivity question. Previous issues featured work that underlined the importance of productivity growth, as well as the many different elements that drive it. These studies argued that productivity growth is essential to long-term income growth, and that Canada's productivity growth compared with other countries, such as the United States, is a major factor determining our relative income performance. They also showed that productivity is a complex phenomenon, affected by a wide range of economic and social forces.

This issue features two studies that offer a closer examination of selected aspects of the many forces driving productivity. The first, by Steven Globerman, assesses the growth of electronic commerce and its potential impact on productivity growth. The second, by Jianmin Tang and Someshwar Rao, asks whether the lower R&D propensity of foreign-controlled firms adversely affects the productivity of the Canadian manufacturing sector. Another study, by Randy Wigle, that estimates the potential cost to the Canadian economy of plans to reduce greenhouse gas emissions within the framework of the Kyoto accord, is also reviewed.

MICRO also reports on two lectures given as part of Industry Canada's Distinguished Speakers Series: Adam Jaffe examines intellectual property rights, while Richard Freeman speaks on the impact of profit-sharing plans on firm performance.

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OCCASIONAL PAPER SERIES

No: 25: *The Economic Determinants of Innovation*, by Randall Morck and Bernard Yeung.

No: 26: *SMEs, Exports and Job Creation: A Firm-Level Analysis*, by Élisabeth Lefebvre and Louis A. Lefebvre.

RESEARCH MONOGRAPH

Industry Level Productivity and International Competitiveness between Canada and the United States, Dale W. Jorgenson and Frank C. Lee, editors.

FORTHCOMING

Sectoral Impacts of Kyoto Compliance, by Randy Wigle.

R&D Propensity and Productivity Performance of Foreign-Controlled Firms in Canada, by Jianmin Tang and Someshwar Rao.

North American Economic Integration: Issues and a Research Agenda, by Richard Harris.

The Location of Higher Value-Added Activities, by Steven Globerman.

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Electronic Commerce and Productivity Growth: Defining and Assessing the Linkages

While supporters of electronic commerce predict substantial benefits from its spread, there is significant disagreement about how it will affect economic activity and

represents a relatively modest proportion of total sales, and that substantial productivity effects are unlikely without significant continued growth in its use. Predictions of

tions carried out on the Internet must occur if e-commerce is to have substantial economy-wide productivity consequences.

The author argues that e-commerce could affect productivity through two channels, primarily: reduced transaction costs, and increased competition and contestability. He cautions, however, that substantial investments may still be required to create brand awareness of new Websites, as well as to offer security, privacy and other features of importance to online consumers.

In fact, the need for such investments may give existing firms that hold a dominant marketplace position in conventional distribution channels substantial first-mover advantages. He concludes that it

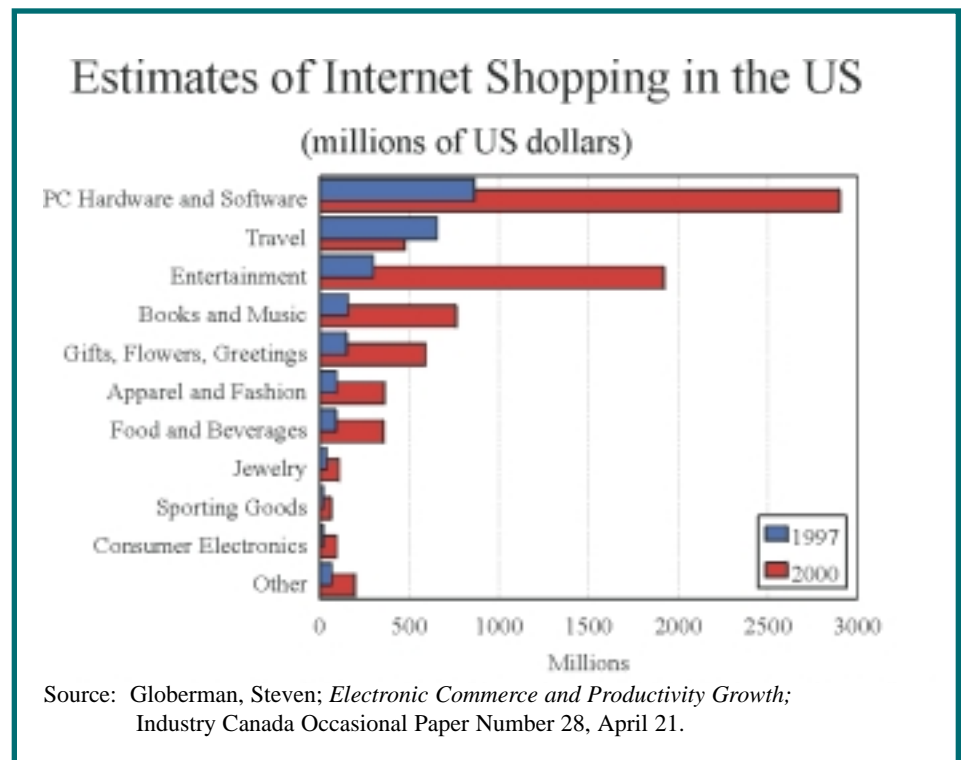
“...e-commerce is a relatively modest economic phenomenon, and substantial productivity effects are unlikely in the absence of significant continued growth in its adoption.”

-Steven Globerman

real income levels. Because e-commerce is still in its very early stages, it is difficult to predict the scope or timing of these impacts. Nevertheless, policymakers must come to grips with its emergence and its probable impact on future economic growth and, ultimately, on income levels. In Industry Canada Occasional Paper Number 28, entitled *Electronic Commerce and Productivity Growth: Defining and Assessing the Linkages*, Steven Globerman examines the links between e-commerce and the productivity performance of the Canadian economy.

The author notes that systematically collected data on the magnitude and nature of e-commerce transactions are generally unavailable. Available estimates apply primarily to the United States and vary widely, depending on the source. He observes that e-commerce still

such growth abound, but Globerman notes that consumer use of e-commerce is still concentrated on a relatively narrow range of products. He concludes that a broadening of commercial transac-



is not clear that e-commerce will prove a major boon from the standpoint of market contestability. With respect to competition, he claims that, while it is not difficult to accept the working hypothesis that e-commerce will promote competition and, therefore, higher productivity in the long run, the magnitude and timing of that link are much more uncertain.

Globerman concludes that, at this relatively early stage, one can only speculate about the economic impacts of e-commerce, including its effects on industrial productivity. Nevertheless, he argues that theory and early evidence point to the likely economic consequences of e-commerce as being evolutionary rather than revolutionary in nature. He cautions against public policies that

tilt unduly towards the promotion of Internet-based business activities while failing to recognize the costs imposed on conventional economic activity. Unless productivity spillovers from e-commerce are significantly larger than those from conventional forms of commerce, there may be little theoretical justification for promoting e-commerce as a public policy goal.

R&D Propensity and Productivity Performance of Foreign-Controlled Firms in Canada

Foreign direct investment plays a significant role in the Canadian economy, especially in the manufacturing sector. Today, foreign-controlled firms generate more than half of revenues and provide more than one third of well-paid jobs in the Canadian manufacturing sector. But the total R&D propensity – defined as the ratio of R&D spending to sales – of foreign-controlled firms in the Canadian manufacturing sector is significantly lower than that of their Canadian-controlled counterparts. Because of this gap in manufacturing R&D propensity, foreign-controlled firms are often blamed for Canada's innovation problems and, ultimately, productivity problems.

In order to investigate these issues and provide a clearer picture of the impact of the lower R&D propensity of foreign-controlled firms, Jianmin Tang and Someshwar Rao have addressed the phenomenon in Industry Canada

Working Paper Number 33, entitled *R&D Propensity and Productivity Performance of Foreign-Controlled Firms in Canada*. They examine a range of variables that could contribute to the observed gap in man-

R&D propensity of high-tech and export-oriented firms is significantly higher than that of low-tech and non-exporting firms. Third, R&D propensity and firm size are significantly and negatively related.

"Despite the fact that foreign-controlled firms spend less on R&D, they are, on average, more productive than Canadian-controlled firms..."

-Jianmin Tang and Someshwar Rao

ufacturing R&D propensity, including: differences in firm size, industry composition, and export orientation.

They report several interesting observations. First, after neutralizing the influence of other factors, they find that foreign-controlled firms spend significantly less on R&D than Canadian-controlled firms. Second, as expected, the

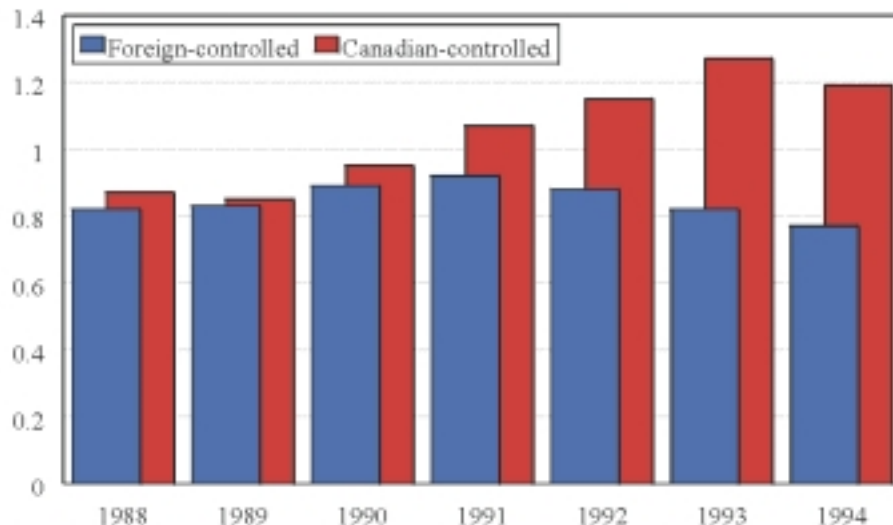
Finally, the R&D propensity of both foreign- and Canadian-controlled firms has been increasing, but foreign-controlled firms fell behind during the 1988-94 period.

According to the authors, however, the data show that foreign-controlled firms actually outperform Canadian-controlled firms in productivity despite the fact that they do less R&D per unit of output

than their Canadian-controlled counterparts. They postulate that this is due to technology transfers from parent companies to their Canadian subsidiaries, and note that the evidence from international transactions linked to technology transfers supports this hypothesis. While Canadian-controlled firms are net exporters of technology, foreign-controlled firms are massive net importers of technology, mainly from affiliated firms. The authors conclude that these technology transfers are the key explanation behind the superior productivity performance of foreign-controlled firms in Canada.

Tang and Rao come to the conclusion that, despite the fact that foreign-controlled firms spend less on R&D, they are, on average, more productive than Canadian-

R&D Propensity in Manufacturing
(R&D expenditures as a percentage of sales)



Source: Tang, Jianmin and Rao, Someshwar; *R&D Propensity and Productivity Performance of Foreign-Controlled Firms in Canada*; Industry Canada Working Paper Number 33, March 2001.

controlled firms because of their superior technological and managerial capabilities, imported from their parents. An important implication of this result is that R&D as an indicator of innovation is biased against foreign-controlled firms, which suggests that the innovative

performance of foreign-controlled firms should not be judged by their R&D propensity. Instead, it should be judged on the basis of a broad set of performance indicators such as output and productivity growth, export orientation, and technology adoption.

Sectoral Impacts of Kyoto Compliance

The US Administration has indicated its unwillingness to implement the Kyoto Protocol which binds signatories to reducing their greenhouse gas emissions, arguing that it is "seriously flawed." One major concern appears to be that the costs involved would be too high. This

leads to the question: What would the costs of the Kyoto Protocol be for Canada and Canadian industry? Randall Wigle examines this question in Industry Canada Working Paper Number 34, entitled *Sectoral Impacts of Kyoto Compliance*. In particular, he tries to identify the sectoral effects of

the Kyoto Protocol under several different administrative scenarios (all assuming domestic trading of emissions permits): a broadly based carbon tax; targeting energy-intensive sectors; exempting some energy-intensive sectors; and permitting global trading of carbon permits.

The author notes that most previous research suggests that Canada will face one of the higher marginal costs of reducing CO₂ emissions. Among OECD coun-

as much if they have a lower energy intensity than that of the corresponding sector in our major import or export market.

The author then turns to the

domestic carbon tax on the rest of the economy would be so high as to suggest that the Kyoto target would be unachievable with such restrictions. In terms of sectoral effects, one of the important conclusions from this study is that while the most energy-intensive sectors in Canada tend to decline, the consequences are dramatically reduced, and in some cases reversed, with unrestricted global trading. With global trading, the most serious output and emissions reductions take place in energy-intensive sectors abroad.

Finally, Wigle suggests two main avenues for future research into different administrative regimes: situations where different countries exempt different sectors, and situations where emissions trading is not part of the domestic regime.

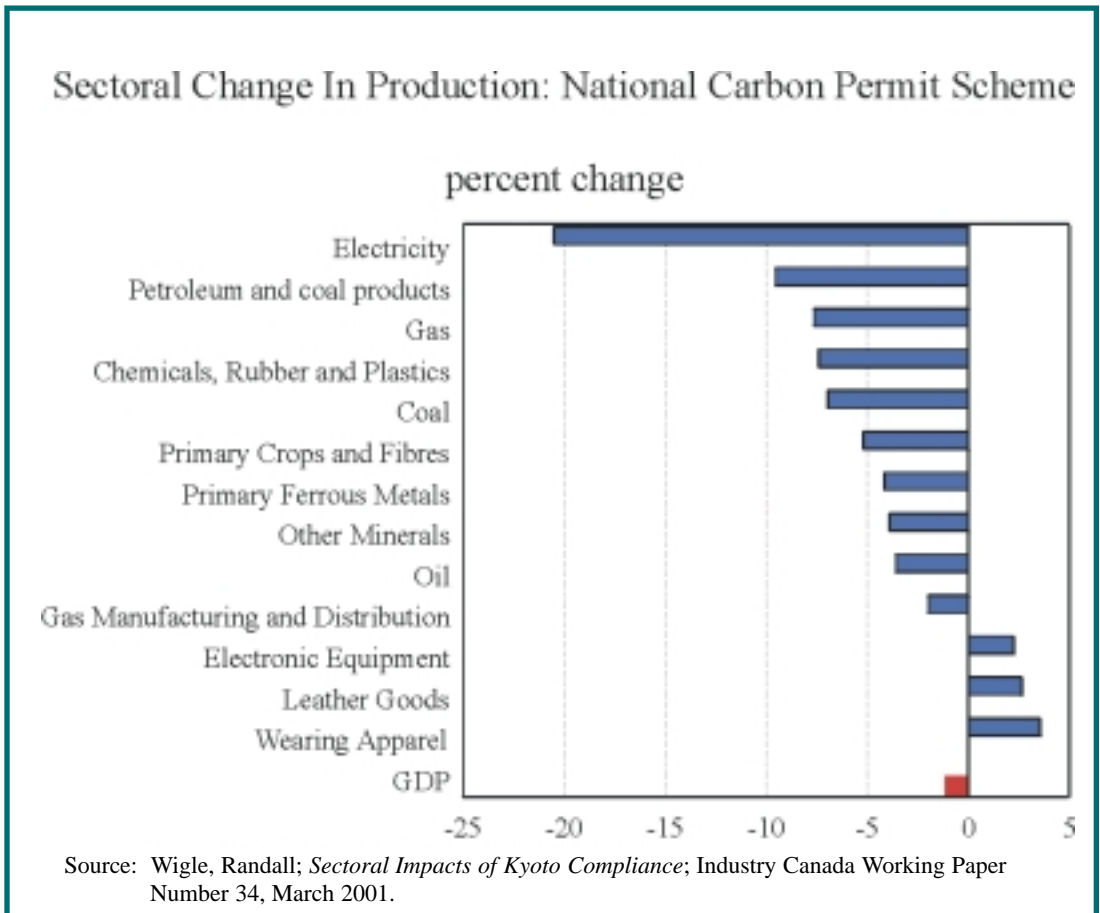
"...the problem of reducing carbon dioxide emissions will be relatively difficult for Canada."

-Randall Wigle

tries, Canada's economy is relatively energy intensive, but not as carbon intensive because it already relies less on coal and more on hydroelectric energy than other countries. This limits the scope for low-cost abatement and suggests that Canada would require one of the highest carbon taxes to meet its commitments.

alternative administrative scenarios. Restricting application to a subset of energy-intensive sectors can raise compliance costs, in some cases markedly. On the other hand, exempting energy-intensive sectors to control costs would lead to an ill-advised expansion of these sectors. As a result, welfare costs would be very high and the

Wigle concludes that the predicted welfare costs for Canada are modest (approximately 1.1% of GDP) when a broad-based carbon tax or permit scheme with domestic trading of emissions, but no international trading, is adopted simultaneously by all industrialized countries. However, under such a scenario, Canada's carbon tax would be one of the highest, estimated at \$US 250 per tonne. As might be expected, the sectoral shifts implied by a carbon tax scheme involve energy-intensive sectors declining most and those that are least energy intensive expanding somewhat. In some cases, energy-intensive sectors may not contract





DISTINGUISHED SPEAKERS SERIES



The Effect of Shared Capitalist Institutions on Efficiency

***Richard Freeman
Harvard University and NBER***

One salient feature of the high-tech economy has been the increasing importance of stock options as a form of employee compensation. Stock options are just one example of a broader trend, particularly in the United States, toward compensation systems based on the economic performance of the firm. Richard Freeman assessed this trend and its impact on economic performance in a lecture entitled *The Effect of Shared Capitalist Institutions on Efficiency*, presented on April 6, 2000.

The speaker noted that in the United States, new forms of compensation based on incentive pay for group or company performance, or on ownership of company shares have spread rapidly. Instead of compensating workers solely with fixed wages, more and more firms have made part of their pay dependent on the economic performance of the firm: awarding stock options, giving profit-sharing bonuses, offering group incentive schemes (gain-sharing) or employee stock ownership programs, and investing defined contribution pension plans in the equity of the firm.

During the 1980s, employee stock ownership programs have grown rapidly, but during the 1990s broad-based stock options came into favour and the proportion of workers covered by such regimes increased sharply. In 1987, 26% of Fortune 1000 firms reported

having profit/gain sharing plans. The proportion had risen to 45% in 1995. In many instances, the introduction of pay linked to company or group performance coincided with the development of institutions aimed at increasing employee involvement in decision-

making: teams, total quality management, quality circles, and employee involvement committees.

Freeman examined the extent to which shared compensation practices and employee involvement activities

affect performance and productivity. He found that employee involvement has a significant impact on worker productivity, job satisfaction, and attitudes toward the firm. In fact, employee involvement had a larger impact than shared compensation. This implies that participation in decision-making matters more than participation in financial rewards. The best results, however, occur when firms combine three elements: pay for company/group performance, an ownership stake in the firm, and employee involvement committees.

"Firms that give workers financial incentives but do not empower them to make decisions are unlikely to benefit from their incentive regime..."

- *Variable incentive pay has become increasingly common in the United States.*
- *Variable pay is sometimes part of a package that seeks to increase employee involvement in decision-making.*
- *Employee involvement improves productivity more than incentive pay alone.*
- *Firms that give workers financial incentives but do not empower them to make decisions are unlikely to benefit from their incentive regime.*



The Effect of Intellectual Property Protection on Innovation

Adam Jaffe
Brandeis University

Since the 1980s, governments in Canada and the United States have moved to strengthen intellectual property protection. Supporters of these changes argue that they are key to encouraging innovative behaviour, while opponents claim that they may in fact do the opposite. Adam Jaffe examined these arguments in a lecture entitled *What We Really Know About the Effect of Intellectual Property Protection on Innovation*, presented on April 14, 2000.

Jaffe observed that since the 1980s, the United States has put in place a range of measures to strengthen intellectual property protection: it has become easier to enforce protection, entities which earlier could not patent (such as researchers receiving public funds) can now do so, and there has been a significant increase in the scope of what can be patented, including organisms and software. Since then, patenting by US residents has risen sharply. As well, the number of biotechnology and software patents has increased rapidly as a fraction of total patents. On the surface, this would seem to vindicate the supporters of stronger intellectual property protection. However, the speaker cautioned that a

closer examination of the process does not support the contention of a strong link between stronger protection and the observed increase in patenting.

He argued that patenting is more closely related to R&D expenditures and that the increase in patenting activity reflects a significant rise in R&D spending in the United States. Since the increase in R&D spending predates the strengthening of intellectual property protection, he concludes that

it is not possible to say that the changes in protection have affected innovative behaviour. These changes have certainly made the patenting process easier, particularly for public laboratories and universities. Aside from this group, however, it is not clear how much of the increase in patenting can be attributed to changes in intellectual property protection. He noted that, although it is easier to file patents, estimates of application success rates have been declining over time.

Jaffe then turned to the question of whether the changes in intellectual property protection have resulted in too much patenting. He observed that the ratio of patents to R&D expenditures has in fact been declining and remains at an historical low. Despite the rapid growth in patenting activity, it has not kept pace with the growth of R&D, which leads Jaffe to state that it is not possible to say that the changes have resulted in too much patenting overall. He concluded that it is not possible to assert with any confidence that changes to patent law have had a significant impact on the innovation process, other than in the case of publicly funded research.

"...even significant changes in patent policy may have only limited effects."

- *Since the 1980s, the government of the United States has introduced a wide range of measures to strengthen intellectual property protection.*
- *Subsequently, there was a sharp rise in patenting by Americans.*
- *However, an increase in R&D expenditures preceded the introduction of new intellectual property protection.*
- *It is not clear, therefore, that increased intellectual property protection caused the increase in patenting.*

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