



# Micro

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## *Micro-Economic Policy Analysis Branch Bulletin*

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## ***The Productivity Puzzle***

In 1987, Robert Solow wrote "You can see the computer age everywhere but in the productivity statistics." This much quoted comment sums up neatly a paradox that continues to bedevil economists. Widespread technical changes, new products, new services and other innovations, particularly in computers and communications, have convinced many that we have entered the era of a new economy which, sooner or later, will drive up productivity growth. But until recently, official measures of productivity growth have remained stubbornly low, giving rise to many theories attempting to explain this apparent paradox. And some have dismissed the recent uptick in productivity growth as an indication of widespread recovery in productivity growth, outside the computer industry itself. At times it has seemed that economists could not agree on many fundamental questions, such as how to measure productivity, much less on how to stimulate its growth.

But gradually, agreement on some of the key drivers of productivity growth as well as some of the appropriate policy levers to stimulate that growth has begun to emerge from the debate. In an effort to focus on this growing consensus and put in place a few more pieces of the productivity puzzle, Industry Canada has commissioned several studies on productivity and its workings.

This issue of *MICRO* highlights an overview of productivity by Richard Harris, an analysis of Canada's innovation performance by Manuel Trajtenberg, an examination of the links between foreign direct investment and productivity growth by Industry Canada researchers Surendra Gera, Wulong Gu and Frank Lee, and a look at foreign ownership restrictions by Steven Globerman.

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## INDUSTRY CANADA RESEARCH AND PUBLICATIONS PROGRAM

### RECENT RELEASES

#### DISCUSSION PAPER SERIES

No. 8: *Determinants of Canadian Productivity Growth: Issues and Prospects*, Richard G. Harris.

No. 9: *Is Canada Missing the “Technology Boat”?* Evidence from Patent Data, Manuel Trajtenberg.

### FORTHCOMING

#### WORKING PAPER SERIES

No. 31: *Are Canadian-Controlled Manufacturing Firms Less Productive than their Foreign-Controlled Counterparts?* Jianmin Tang and P. Someshwar Rao.

No. 32: *The Canada-US Productivity Growth Paradox*, Serge Coulombe.

#### OCCASIONAL PAPER SERIES

No. 22: *A Regional Perspective on the Canada-US Standard of Living Comparison*, Raynald Létourneau and Martine Lajoie.

No. 23: *Linkages Between Technological Change and Productivity Growth*, Steven Globerman.

### DISTINGUISHED SPEAKERS

April 6, 2000, Richard Freeman, NBER, *The effect of shared capitalist institutions – incentive pay, profit sharing, broad based stock options. – on efficiency*

April 14, 2000, Adam B. Jaffe, Brandeis University, *What we really know about the effect of intellectual property protection on innovation.*

April 20, 2000, Gary Hufbauer, Institute for International Economics, *North American Integration.*

May 5, 2000 Paul Davenport, University of Western Ontario, *Universities and the knowledge-based economy.*

May 12, 2000 Gale Johnson, University of Chicago, *Population and Food.*

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## Determinants of Canadian Productivity Growth

Developing economic policies which can increase the chances that Canada will improve its productivity record, and ultimately its living standards, are high on both private and public agendas these days. Despite this apparent consensus, there remains considerable disagreement as to exactly how this can be achieved.

still considerable debate on the policy levers to use in order to attain higher productivity growth and on the way in which innovation acts on productivity.

Notwithstanding this debate, Harris identifies three factors that will be very important to future productivity growth: demography and its impact on savings rates; globalization and the

The demographic challenge arises from three main developments: the median age of the labour force will gradually increase from about 35 to 45; the share of the population over 65 will have more than doubled by 2030; and after 2011 the growth of the labour force will slow substantially. As a result, spending on dependents

as a share of GDP will rise dramatically and the average productivity of those who will be working is likely to decline as they get older.

**"Over long periods of time productivity is the single most important determinant of a nation's living standard."**

-Richard Harris

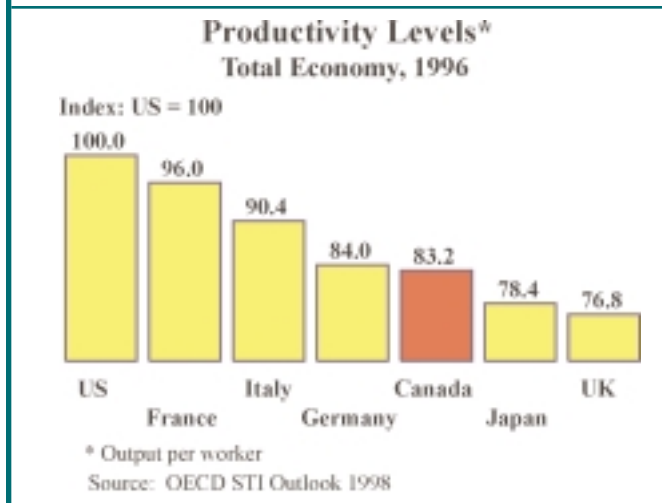
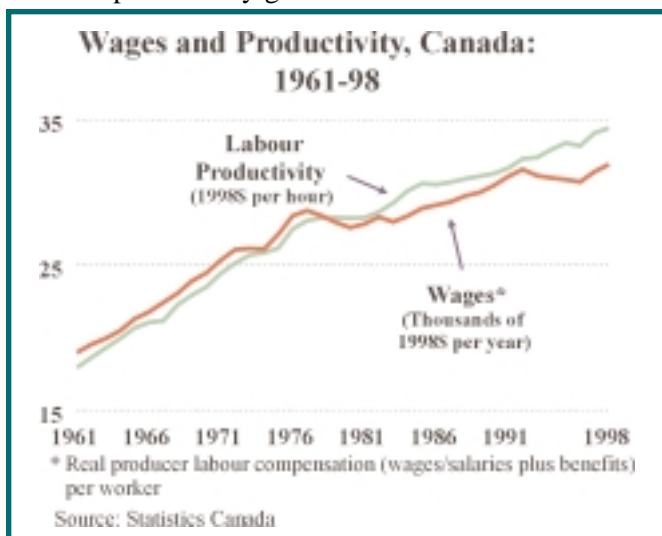
In an effort to clarify what economists know, or think they know, about productivity, Richard Harris examines the issue in Industry Canada's Discussion Paper No. 8, *Determinants of Canadian Productivity Growth: Issues and Prospects*.

According to Harris, part of the disagreement is ideological in nature, but much of it stems from ambiguity in statistical and historical productivity records that makes the measurement of productivity problematic. In addition, while it is largely recognized that productivity growth has declined, there is disagreement as to why. In spite of the many different approaches to both measuring and explaining productivity (which are reviewed in the paper), the author concludes that there is consensus on the three key drivers of national productivity growth: investment in machinery and equipment; human capital development; and openness to trade and investment, within an overall framework where innovation creates the opportunities for growth. Having said this, he acknowledges that there is

extent to which integration in additional areas, such as services, can generate further returns; and the role of the "new economy" in stimulating productivity growth.

Three aspects of globalization have important implications for productivity: the potential slowdown in the growth of world trade and foreign investment; the trend toward agglomeration within an integrated North American market; and the emergence of a international market for the very highly skilled. Harris observes that world trade has been growing faster than GDP and asks how long this trend can go on? He wonders as well whether, as an integrated North American economy emerges, some or all of Canada's regions will become backwaters as the forces of agglomeration push high value-added activities toward growth centres in the United States? Also, as more economic activity depends on human capital advantages, the emergence of a global labour market for highly skilled workers, who are critical to a firm's success, may have a significant impact on Canada's productivity.

Harris' thorough review of productivity issues will prove very useful to researchers and policy analysts.



## Is Canada Missing the "Technology Boat"?

In recent years, Canada has been lagging other countries in terms of productivity growth. Given that innovation and technical change are key determinants of productivity growth, attention has focused on Canada's performance in these areas. In Industry Canada's Discussion Paper No. 9, *Is Canada Missing the "Technology Boat"?* Evidence from Patent Data, Manuel Trajtenberg assesses Canada's relative

performance in innovation. soon. Trajtenberg argues that these countries are experiencing much faster rates of innovation than Canada, primarily due to deliberate policies aimed at encouraging industrial R&D.

The author also suggests that the technological composition of Canadian patents is out of step with the rest of the world. In Canada, traditional fields still comprise the largest share of patents, whereas in fields such as com-

puters and communications, and electrical and electronic equipment we are well below the world mark. With respect to the former, a closer examination reveals that Canada's problem lies with computers rather than communications. He warns us that lagging innovation in computers may have dire consequences for the performance of

the Canadian economy, because computers and communications are the leading "general purpose technology" of our time. Trajtenberg concludes that there is considerable room for improvements in the rate and type of innovative activity in Canada and that Canada seems to be "missing the boat". He observes that Canadian patenting is highly correlated with R&D spending in Canada, and

**"Essentially, Canada seems to be 'missing the boat' ...it continues to innovate in traditional fields."**

**-Manuel Trajtenberg**

suggests that a policy shift in favour of R&D spending may boost innovative output in 2-3 years. On a positive note, the author stresses

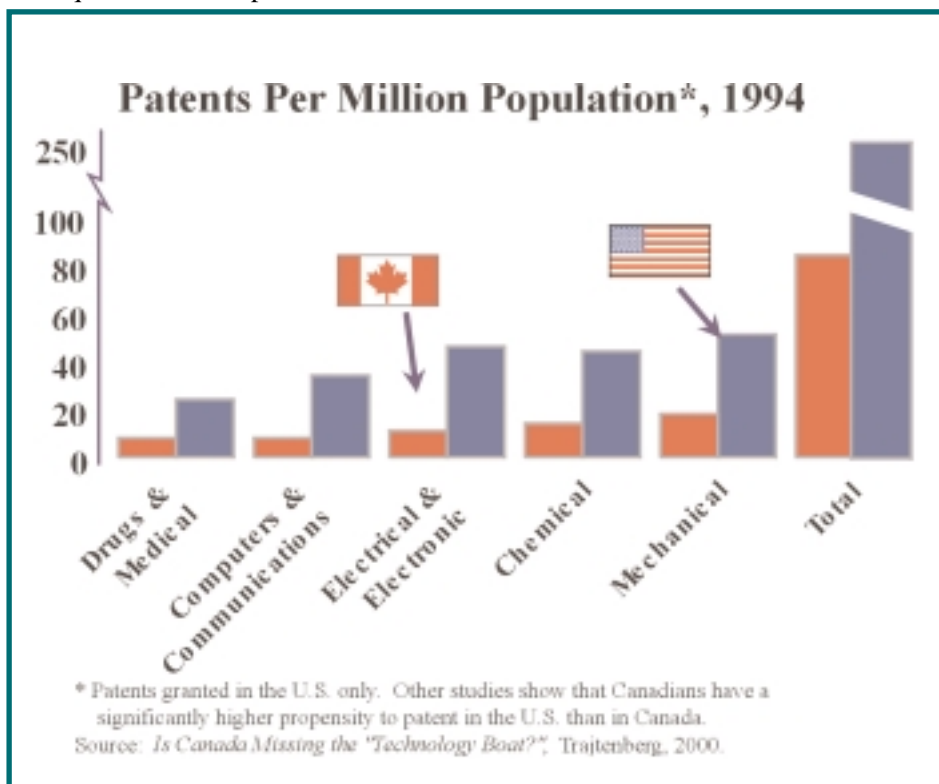
performance in innovation.

To this end, the author uses data from patent applications filed with the U.S. Patent Office to compare Canada's performance to that of two groups of countries: the other members of the Group of Seven (G7) and a reference group of countries with fast-growing high-tech sectors: Finland, Israel, Taiwan and South Korea. The author finds that Canada stands mid-way among the G7 in terms of patents per capita and patents per dollar spent in R&D. For the number of patents per capita, Canada compares well with France and the United Kingdom and is almost even with Germany, but it is well behind the United States and Japan. Canada also ranks below the other G7 (except for Italy) in terms of the relative amount of resources devoted to innovation, with a R&D/GDP ratio of 1.5%, as opposed to 2.0-2.8% for Germany, Japan and the United States.

The comparison with the reference group yields more worrying results. In terms of patents per capita, Canada outperformed all four countries in the 1970s, but Taiwan, Finland and Israel have since overtaken Canada, while South Korea is poised to do so very

that Canada has the human capital and the infrastructure needed to benefit from and innovate successfully in cutting-edge technologies. Whether Canada will do so depends both on increasing the level of R&D spending and on encouraging innovation and entrepreneurship.

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## Foreign Direct Investment and Productivity Growth

Spectacular growth in foreign direct investment (FDI) has accompanied the increasing globalization of production. Over the past ten years, the stock of inward FDI has more than doubled in Canada, reaching 22.6 percent of GDP in 1996. The larger role of FDI in the economy has rekindled the debate about its impact on such areas as employment, production and export

inward FDI alters the structure of production as industries adjust their demand for factor inputs. The authors' results show that inward FDI is biased against the use of capital, labour and intermediate goods. In contrast, inward FDI is somewhat biased toward the use of domestic R&D. Third, international R&D spillovers significantly reduce production costs across Canadian

of ideas and innovations. In this regard, the authors point out that, while Canada's inward FDI stock has increased over the past decade, its share of North American and world wide FDI has declined since the implementation of the Free Trade Agreement (FTA). They conclude that attracting more FDI into Canada poses an important policy challenge to policymakers.

### "Inward FDI lowers production costs and hence increases productivity in most Canadian industries."

-Surendra Gera, Wulong Gu & Frank Lee

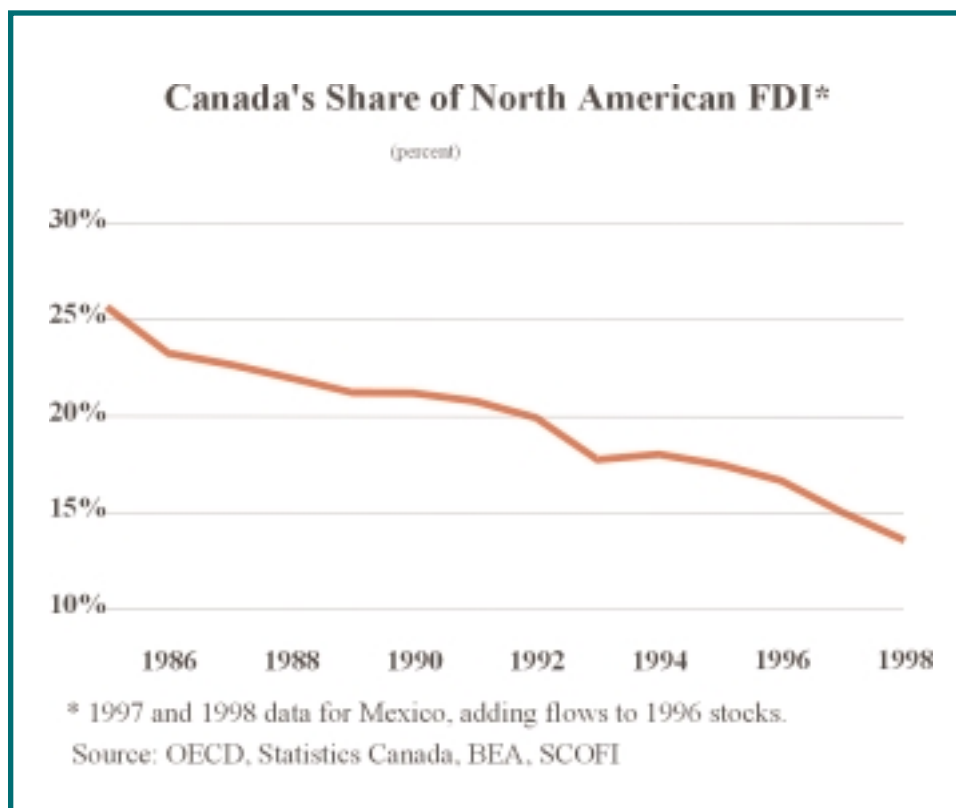
growth. In Industry Canada's Working Paper No. 30, *Foreign Direct Investment and Productivity Growth: The Canadian Host-Country Experience*, Surendra Gera, Wulong Gu and Frank Lee investigate the effects of technology transfers and spillovers from inward FDI on the cost of production and total factor productivity of Canadian industries. They also examine their impact on the structure of production — through the demand for factor inputs such as capital, labour, intermediate goods and R&D capital.

The study makes two contributions to the empirical literature. First, the authors apply a cost-function approach — a rigorous framework of factor-demand analysis. This allows them to trace the response of factor demands to FDI in the production process while investigating the impact of inward FDI on production costs. Second, their analysis controls for domestic and international R&D spillovers, which have been found to affect productivity growth in small open economies such as Canada.

Their major findings are as follows: First, inward FDI lowers production costs and hence increases productivity in most Canadian industries. Second,

industries.

The observed relationship between domestic R&D and international R&D spillovers suggests that domestic firms must invest in R&D to capture the benefits of R&D spillovers from abroad. In addition, inward FDI appears to act as an important channel for the diffusion



## ***Implications of Foreign Ownership Restrictions for the Canadian Economy – A Sectoral Analysis***

Over the past decade, a wide consensus has emerged in the economic literature around the notion that inward FDI imparts substantial net benefits to the host economy and governments have been reducing both formal and informal barriers to inward foreign direct investment (FDI).

benefits from reduced inward foreign direct investment were probably modest. With the shift to greater competition in the telecommunications industry and the accelerating rate of technological change in the sector, along with a growing convergence between telecommunications and computer

to "negative externalities" associated with the loss of control over credit creation and allocation.

In general, Gliberman observes that there are very few studies of the relevance and impact of restrictions on foreign direct investment in these sectors that would justify continued

existence of these restrictions. He concludes that theoretical considerations suggest that there is no compelling welfare-economics case

**"..there is no compelling welfare economics case to be made in support of general restrictions of FDI at the sectoral level."**

**-Steven Gliberman**

However, significant government restrictions remain on inward FDI, in Canada and elsewhere, in so-called infrastructure industries such as transportation, telecommunications and financial services. Given the consensus on the need to reduce barriers to FDI, what evidence is there to justify these sectoral restrictions? In Industry Canada's Discussion Paper No. 7, *Implications of Foreign Ownership Restrictions for the Canadian Economy – A Sectoral Analysis*, Steven Gliberman assesses the implications of foreign ownership restrictions for the Canadian economy at a sectoral level, as well as the practical need for an empirical analysis of these situations.

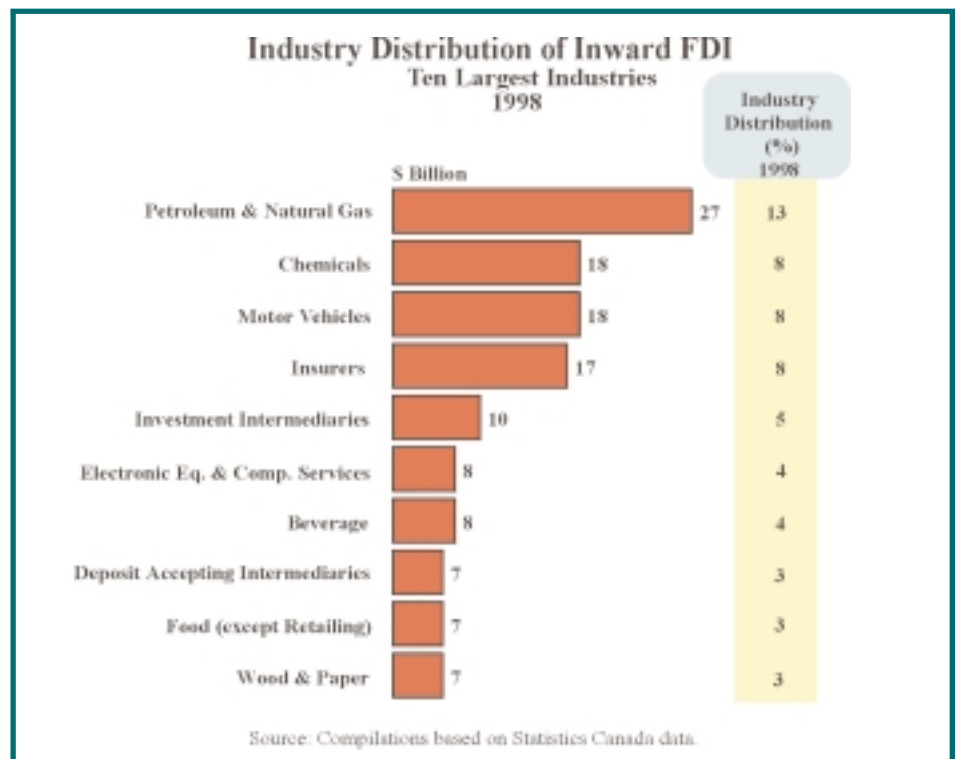
Gliberman observes that critics of inward FDI often argue that while the net costs of inward FDI may be insignificant in other industries, infrastructure industries are "critical" to the economic development of the host economy, and the role of infrastructure firms will only be satisfactorily discharged if the latter are domestically owned.

Gliberman notes that because the telecommunications market was highly regulated in the past, the foregone

technologies, he suggests that the cost of restrictions on foreign direct investment may be substantially higher now and in the foreseeable future than in the past.

He reaches largely similar conclusions concerning the transportation sector. In the financial services sector, on the other hand, the main concerns about foreign ownership relate more

in support of general restrictions on FDI at the sectoral level. However, if non-economic considerations favour the continuation of sectoral restrictions, studies focused on the potential consequences of these restrictions would be in order.





## DISTINGUISHED SPEAKERS SERIES



### Computers and Work

**Frank Levy**

*Massachusetts Institute of Technology*

In a lecture given on April 30, 1999 entitled *Computers and Work*, Frank Levy discussed the use of case studies to demonstrate specific ways in which computers may affect economic activity. Much theorizing about computers' impact on the economy center on two

least-educated workers. But this is not the case. Some of the least skilled operations turn out to be the hardest for computers. With computers, the key criterion is the number of lines of code required to replicate a task, rather than the number of years of

can be replicated by computers in a cost-effective manner, such as cheque clearing; and those that are expensive to do by computer. If jobs were made up entirely of the first category, they would be eliminated. For jobs that include both types of tasks, the result

**“There is a disconnect in the way in which artificial intelligence people think about skills and the way in which economists think about skills.”**

issues: computers' ability to increase productivity and the rate of economic growth, and their ability to generate skill-biased technical change. In Levy's view, however, empirical work on these subjects is still not well developed.

The speaker described how he carried out a case study on how the introduction of computers and information technology affected the work in a large Ford car dealership. He soon found that there is a disconnect in the way in which artificial intelligence people think about skills and the way in which economists think about skills. Economists equates skills with years of schooling. If computers were causing skill-biased technical change, they would have their biggest impact on the jobs of the

schooling. So the notion of a simple correspondence between what computers do and ranking by years of education doesn't work.

is more complicated. The introduction of computers can cause a shift in job composition from the first type of tasks toward more tasks of the second type.

- *Empirical work on how computers affect the nature of work is not well developed.*
- *Case studies show that some of the least skilled operations are hardest for computers.*
- *What matters in the shift of job composition is not the number of years of schooling, but the number of lines of code required to allow a computer to perform the function.*
- *Case studies would help understand the actual impact of computers on work and generate testable hypotheses.*

Levy conceded that the case study approach is still crude and there needs to be further study of individual channels. In undertaking case studies, however, he was not trying to prove any particular argument. Rather, he was attempting to find pictures consistent with skill-biased technical change and higher productivity, and at the same time illustrate the role of computers. He concluded that by using case studies to understand the actual impact of pieces of work that are being computerized, economists could generate testable hypotheses.

Instead, Levy categorized work into two groups of tasks: those which



## ***Reforming the International Financial System: Motion or Commotion?***

***Peter B. Kenen***  
*Princeton University*

Currency crises in emerging market economies and the "Asian flu" which destabilized a series of countries, starting with Thailand in 1997, have prompted a search for more effective ways to deal with such events. In March 1999, Peter B. Kenen addressed this

was caused by rising interest rates in the United States and political shocks in Mexico, which dried up the large capital inflows the country had been enjoying, forcing it to finance its current account deficit from reserves. The massive official financial support provided

publication of economic and financial data by countries seeking access to international markets. An effort to prevent similar crises spawned an initiative to promulgate standards by which to judge the quality of financial institutions and of financial supervision, espe-

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**“The official community may be paying too much attention to the architecture of the international financial system and ignoring what might be fixed more expeditiously—a flaw in the architecture of the international monetary system.”**

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issue in a lecture entitled *Reforming the International Financial System: Motion or Commotion?*

He argued that events have been interpreted by pointing to the weaknesses in the international financial system, and this has oriented the debate toward the need for a reform. However, in Kenen's view exchange rate arrangements and policies in emerging market economies, rather than the financial system itself, were largely responsible for the build-up of conditions that led to the crises in Southeast Asia and elsewhere. Consequently, in the debate about potential reforms, we pay too much attention to the architecture of the global financial system, while ignoring what might be fixed more expeditiously: a flaw in the structure of international monetary arrangements.

Kenen examined the Mexican exchange crisis of 1994-95 that triggered the debate over reforming the financial system. In his view, the crisis

to Mexico led to accusations that the U.S. Treasury and the IMF had bailed out Mexico's creditors. As well, the weakness of the Mexican banks as a contributing factor focused the debate

cially in emerging market economies. This focus on the financial system carried over in the official reaction to the Asian crisis, although in Kenen's view, pegged exchange rates played a greater role in this case.

He concluded that the official community is simply too preoccupied with long-term structural and financial reform as the key to crisis prevention and management. In his opinion, authorities should concentrate more narrowly on things that can be done and should be done quickly, both for crisis prevention and crisis management, in particular the introduction of greater exchange rate flexibility and the imposition of controls or taxes on short-term capital inflows, like those applied by Chile and Colombia.

- *As a result of the Mexican exchange crisis of 1994-95, the official community is focused on strengthening the financial system.*
- *But most currency crises are the result of pegged exchange rates and political and debt crises.*
- *This is also true of the Asian crisis.*
- *The official community should focus instead on fixing the international monetary system.*

on the role of the financial system.

As a result, subsequent discussions were aimed at encouraging prompter





## Quality Improvements and Productivity

**Jack Triplett**  
*Brookings Institution*

Despite rapid technical progress in information technology and the widespread introduction of computers, official measures have shown low levels of productivity from the early 1970s until recently. In response, economists

put it into proper historical perspective. Triplett identified the measurement of services as a key issue because that is where investments in computers have been strongest. In the United States, the four top computer-using industries —

ilar. The problem is that service industries have shown a marked slowdown in productivity growth.

The output of most of these industries is inherently hard to measure. For example, Triplett noted that the dispute over how to measure the output of the banking industry goes back to 1932, and is still going on. He indicated also that in the OECD tabulation of productivity growth in finance and insurance, countries

like Finland, Sweden and Japan show strong productivity growth in these industries, but all had banking crises. In contrast, countries like the United

States, the United Kingdom and Canada, which seem to have a dominant position in financial services, are the ones displaying negative productivity numbers. This implies that there is something fundamentally wrong with the way we measure productivity in banking and insurance, and indeed in other services as well. This leads him to conclude that if computers are having an impact on productivity growth in these and other service industries, it is mismeasured.

Triplett observed that many of these services are intermediate goods, so whatever is happening in these industries should show up in the aggregate figures. Still, economists want to be able to measure the key industries that are producing or absorbing high-tech products.

As a result of mismeasurement problems in services, they are faced with a major problem in trying to understand what is going on in the economy.

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**“All the major hypotheses [explaining low productivity growth] have been refuted, leaving the mismeasurement hypothesis...”**

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have developed many theories to explain this apparent paradox. But one by one, these have been refuted, with one exception. In a lecture given on April 9, 1999, entitled *Quality Improvements and Productivity*, Jack Triplett examined the main remaining explanation, the mismeasurement hypothesis.

Triplett noted that one reason economists suspect a mismeasurement problem as a key explanation of the productivity slowdown has to do with the notion of the "new economy". We see all sorts of new services and products, but they are not reflected in the productivity numbers. He countered this observation by arguing that many of the new products available simply do not have the same significance as products developed in earlier years. As well, he suggested that if productivity gains depend on new consumer products, we would need an ever increasing rate of introduction of new products simply to maintain the rate of productivity growth. According to the speaker, proponents of this view have failed to

financial services, wholesale trade, business services, and miscellaneous equipment rental and leasing — account for over 40% of computer investments. If

we add communications and insurance, these six industries account for over 50% of US investments in computers. The figures for Canada are roughly sim-

- *Most potential explanations for slow productivity growth have been refuted, except that of mismeasurement, particularly of services.*
- *Measurement of services is key because four service sectors account for 40% of US investment in computers.*
- *Many services are intermediate goods so productivity growth in these industries should be reflected in the aggregate figures.*
- *Unresolved measurement difficulties in services mean that we still do not have a good understanding of what is going on in a key sector of our economy.*

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