# Session 3: Comments

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## Historical and Innovation Perspectives on the Canada-U.S. Manufacturing Productivity Gap

The papers (Bernstein and Mamuneas and Keay) for this afternoon's session are complementary to each other in many respects. Bernstein and Mamuneas are talking about productivity change, that is, **growth rates** for the entire Canadian manufacturing sector. By way of contrast, Ian Keay discusses relative productivity **levels** between Canadian and the U.S. companies. He then moves to the industry level. Another very important distinction between the two studies is the length of the time period being investigated. Keay's paper covers the period from 1907-1990 while the other study has data from 1966-94. Productivity growth is basically a long run phenomenon and major economic shocks can move growth rates temporarily from their long-term trends. Keay's paper is therefore unique to this conference in its contribution.

Both studies focus on the concept of TFP (total factor productivity) rather than labour productivity, the latter being a partial measure. The TFP approach is more appropriate. It is the perspective adopted by economists who seek to integrate productivity accounting measures into an economic analysis of production incorporating technical change. Readers may wish to consult May and Denny (1977, 1979) for details concerning the relationship between the two productivity measures. Our continuing use in the media and in some policy circles of the labour productivity concept reflects, in my opinion, the historic association of labour productivity with crude measures of economic well-being. However, if our interest in the global economic context is on competitiveness then surely we must take all of the factors of production into consideration as well as the post-tax prices paid for those factors.

The two papers should be of particular interest to us since the Keay paper challenges the underlying hypothesis of this conference that a productivity gap exists between Canadian and U.S. manufacturing industries. Keay finds that while there is a gap it is far smaller than one might suppose. This finding is not unique, but is similar to the findings of other Canadian studies (see Denny et al (1992) and Baldwin and Green (1987)). Bernstein and Mamuneas provide an explanation for this result since their paper forcefully argues that TFP growth in Canadian manufacturing can be largely explained by R & D spillovers from the U.S.

Let me now turn to the Bernstein and Mamuneas paper, which reflects the division of labour that Tom Wilson and I have chosen.

I have already noted that this paper concentrates on productivity **change** over time. Recall in growth accounting that, under some fairly strong assumptions, productivity growth is the difference between output growth and the weighted growth of the inputs. This Solow residual has been casually referred to as a measure of our ignorance. Bernstein and Mamuneas argue that this residual, this unknown, can largely be explained by spillovers from R & D capital in the U.S.

How do the authors reach this conclusion? Well let's examine the list of candidates that could explain any residual. They are:

1) Scale economies;
2) Actual differences in technology;
3) Differences in capacity utilization;
4) Externalities of some sort; or
5) Measurement error.

The answer to the question just posed is that the authors skillfully eliminate each of the competing explanations and end up with 4) externalities/spillovers.

They quite correctly relate productivity change accounting to production analysis by means of an appropriate production function. Their innovation is to introduce R&D spillovers (S) as a specific argument in the production function. They note, and I concur, that the sector's own R&D expenditures (R) would be captured in the measurement of the other factors of production such as labour services and therefore must netted out.

I wonder, however, about the details of what is occurring in the production transformation process with respect to R&D. Surely there is a time dimension here. What must occur is that research occurs and then development occurs with respect to the development of products. R&D can then be thought of as a separate production activity with its own output. This output then becomes an intermediate input at some later time period. In the model that we are presented with there are no sequential activities only simultaneous ones.

A related point to the one introduced above is that S is measured by the stock of R&D capital in the U.S. But surely what counts are the outputs of R&D not the inputs but such output data do not exist. A recent article in the Globe and Mail said that many larger companies felt that they were getting much smaller returns from their R&D dollars than smaller innovative firms, thus threatening their potential long-term viability. Writing about the decline in competitiveness of the U.S. Automotive industry vis-à-vis their Japanese counterparts Fuss and Waverman (1992) note, "U.S. motor vehicle firms in 1980 spent 160% more on research than Japanese motor vehicle firms." They continue: " In the nine years 1980-8, the U.S. motor vehicle industry spent $48.39 billion on R&D while their Japanese counterpart spent $28.12 billion." The point of this discussion is that we must develop a better understanding on an industry-by-industry basis of what is going on in the R&D process.

Returning to the productivity growth accounting framework, Bernstein and Mamuneas get to the heart of the matter when they state that if we want to tie simple accounting measures of productivity change to the theory of production incorporating technical change then we must assume Hicks-neutral technical change, that is, technical change falls like manna from heaven on all factors of production equally.

In their model, the authors attribute any spillovers, S, to R&D from the U.S. But why from just the U.S.? Why from just R&D? What contributions do universities play? We know universities play some because of the concentration of the knowledge-based firms in the Boston area and around Stanford in the Silicon Valley of California. What is the contribution of public infrastructure? What's networking all about? A much wider set of spillovers must ultimately be considered.

In Section 3, the authors test a set of factor intensity input demand equations derived from a generalized flexible functional form for the production function. The data used are summarized in Appendix 2. A number of points can be made with respect to the data. Firstly, a lot of aggregation is occurring: we are dealing with total manufacturing and with total capital and total labour etc. A number of authors have examined the issue of whether such aggregation can be justified in terms of being consistent with underlying assumptions consistent with production analysis. Almost invariably such aggregation has not been justified and almost invariably this evidence has been ignored. Indeed studies such as May and Denny (1978) show that we can reject a Cobb-Douglas functional form for total Canadian manufacturing as well as Hicks neutral technical change. I shall return to this issue shortly.

Let me now turn to data measurement problems, a theme that was introduced into the conference discussion this morning. In particular, the measurement of capital stock is always troublesome. One might expect *ceteris paribus* that a faster rate of depreciation would imply a lower net stock of capital and a higher price (user cost) of capital services. But from Table A2.1 that does not seem to be happening. In fact, the two series seem to be surprisingly close in spite of large differences in the depreciation rates. Well, the authors inform me that much more than just the rate of depreciation differentiates the two capital stock estimates. These Statistics Canada estimates follow two different methodologies[1].

Identifying problems with the measurement of capital stock does not imply that we should revert to measures of labour productivity and away from total factor productivity. There are three reasons for this:

1) As already noted relating labour productivity change to the underlying production function with technical change implies some strong assumptions about technical augmentation that can be tested as a hypothesis;
2) In order to understand the sources of labour productivity change we need the stock of capital as Table 4 in this paper clearly demonstrates;

[1] Readers should consult Serge Coulombe's paper in this conference for an in-depth discussion about this issue.

3) Using labour as the only input does not avoid measurement problems since person-hours worked must be adjusted for education/experience.

As already pointed out in this Section of th their paper, the authors estimate their input demand equations. Using the flexible form permits them to test some underlying hypotheses. The authors maintain the hypothesis that it is disembodied technical change that generates productivity growth. Such disembodied change can be further disaggregated into exogenous change and that due to R&D spillovers. The authors are not able to reject the hypothesis of no exogenous change but not that there are no R&D spillovers. The conclusion is that disembodied technological change occurs through spillovers from U.S. R&D capital. Now given that Denny and May (1978,1979) have rejected disembodied technical change then the specification might be tested for robustness. Bernstein and Mamuneas find that they cannot reject constant returns to scale. Again work at the disaggregated industry level has shown the existence of strong scale economies in some industries.

In Section 4 of their paper, the authors revert to the growth accounting framework having determined that the theoretical assumptions needed to support this framework exist in the underlying data. Recall that this approach measures rates of total factor productivity growth to the differences between output and input growth rates. As a result of the findings in Section 3, these differences are due to U.S. R&D spillover effects. From Tables 4 and 5 we see that the U.S. R&D spillover contribution to labour productivity growth relative to the industry's own contribution is huge. Free riding may be optimal. However, these same tables show a marked drop in the U.S. spillover effect in the period from 1989-94. Why should this be? Especially since the stylized facts as to the productivity gap between Canadian and U.S. manufacturing shows that the gap is increasing during this period.

The introduction of the concept of efficiency-based productivity growth into the discussion of this conference and its comparison to observed productivity growth is welcomed.

Many of the issues that I have raised are in many ways generic to the productivity literature.

Let me conclude by stating that Bernstein and Mamuneas have presented an excellent paper with exciting results. In my opinion, the two major contributions of this paper are:

1) It continues the task of trying to explain the sources of disembodied technological change in the underlying analysis of production by something other than a time trend, t. It does so by focusing on U.S. R&D spillovers.
2) It notes the differences between observed and efficiency-based productivity growth.

As for the road ahead, it is clear that there are many measurement issues still to be resolved. Greater insights will be gained by reaching out, as these authors have done, to incorporate new dimensions into the analysis of production. Candidates for this adventure might include other sources of spillovers, the incorporation of spatial aspects, market structures or greater industrial disaggregation.

The bottom line, however is that this is a job that is very well done.

## References

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