

Explaining Productivity Growth in Canada

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Outline of Presentation

- Present the Paper
 - Review the formula used to calculate Canadian MFP:
 - The Canadian accounts do not follow the standard TFP formulas precisely.
 - The paper then explores including capital utilization, natural resource capital, public infrastructure capital and intangible capital in the MFP calculations.
 - Next, the paper presents a re-organization of the productivity accounts to show TFP growth by final demand category rather than industry.
 - Finally, introduce TFP statistics for government healthcare and education.
- Comments on Paper
 - This paper combines great data with useful innovations in the productivity literature.
 - I'd like to thank Wulong for his help preparing the slides and apologize that I don't have time to give each innovation the attention it deserves.
 - My comments will be brief and focused on implementation.

Standard TFP Formula

$$t_{V,i} = \Delta \ln V_i - \left(\frac{\alpha_{K,i}}{1 - \alpha_{\Pi,i}} \Delta \ln K_i + \frac{\alpha_{L,i}}{1 - \alpha_{\Pi,i}} \Delta \ln L_i + \frac{\alpha_{M,i}}{1 - \alpha_{\Pi,i}} \Delta \ln M_i \right)$$

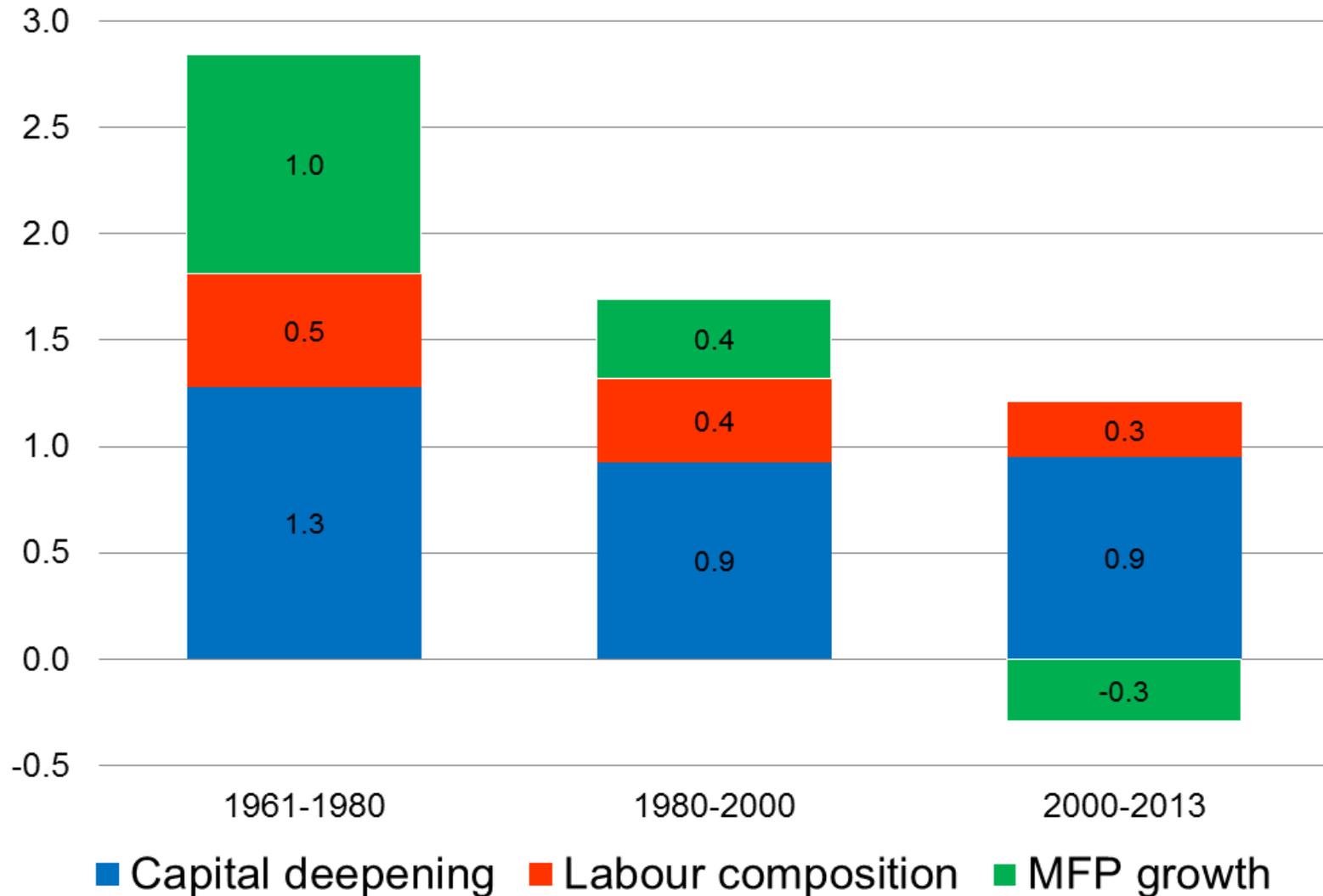
- Main Assumptions:
 - The approach assumes perfect competition and constant returns to scale.
 - It implies that the cost of all inputs including capital, labour and intermediate inputs exhaust the value of output.
- Historically, this formula has focused on produced physical capital when measuring K_i
 - Buildings and equipment are typically easier to measure than natural resources, public capital or intangible capital.
 - Capital utilization rates are assumed to be 100%.

- Endogenous (internal) rate of return method:
 - The rate of return for estimating the user cost of capital and capital input can be estimated from the identity that the sum of costs of capital across productive assets is equal to capital income (endogenous rate of return method).
 - This method can sometimes produce problematic numbers.
- Gu introduced a variant of the internal method in 2014.
 - Internal rates of return are used for industries with reasonable internal rates of return
 - External rates (average internal rates of return in major sectors) are used to estimate capital input for industries with extremely high or low rates.
 - This variant addresses comments by Diewert and Yu (2012),

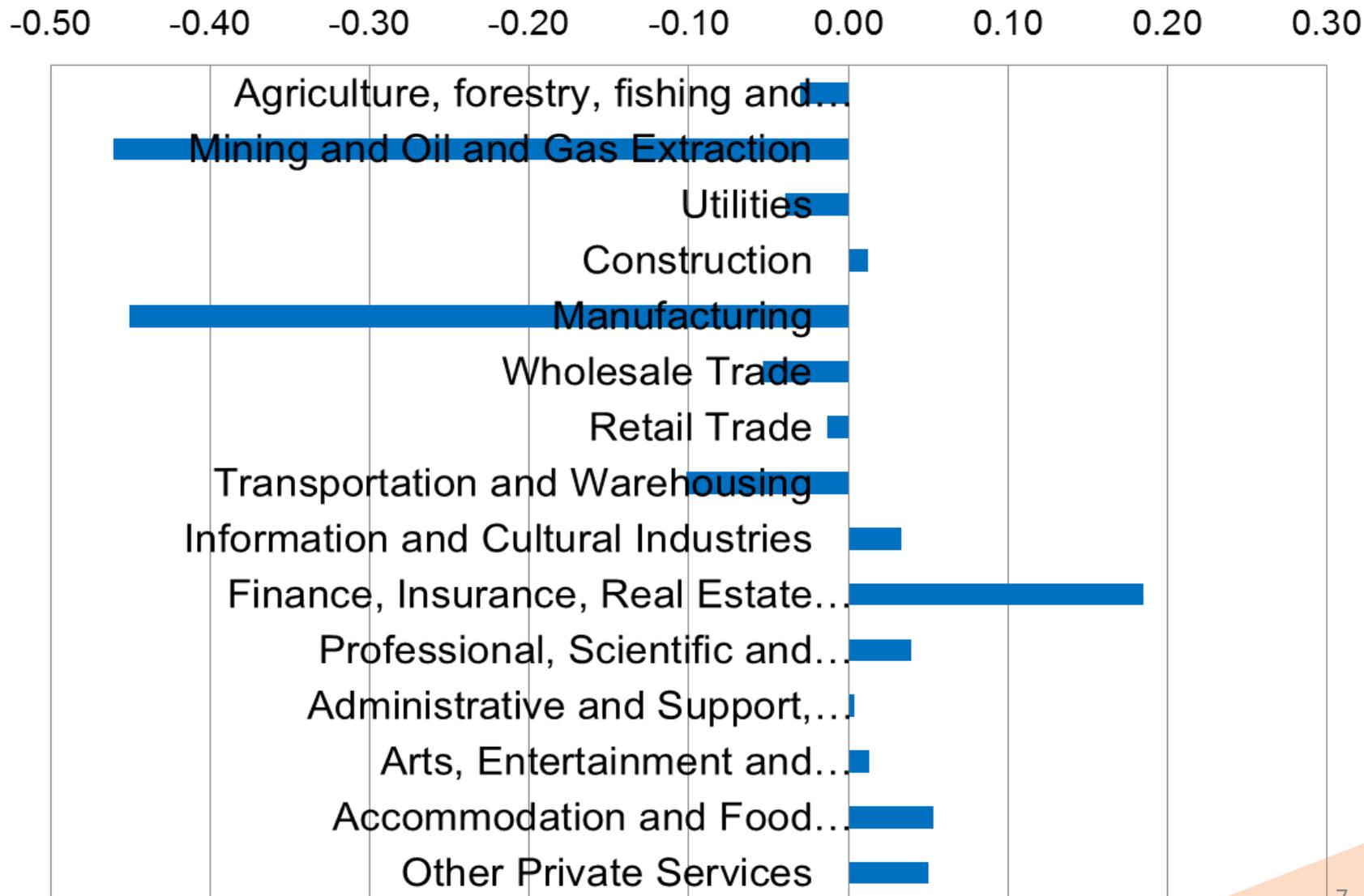
- The revision introduces a residual or surplus: the difference between the nominal value of output and the sum of input costs.
- The surplus is a result of large number of factors: imperfect competition, scale economies, omitted inputs.
- As a result of the residual, the Domar aggregation needs to be modified to relate industry productivity growth to aggregate productivity growth:

$$t_A(\textit{bottom}) = \sum_i w_i^c t_i^A + \sum_i (w_i - w_i^c) \Delta \ln A_i$$

Sources of Labor Productivity Growth



Contributions to Decline in MFP Growth: 2000-2013 minus 1980-2000



- MFP Adjusted for Utilization

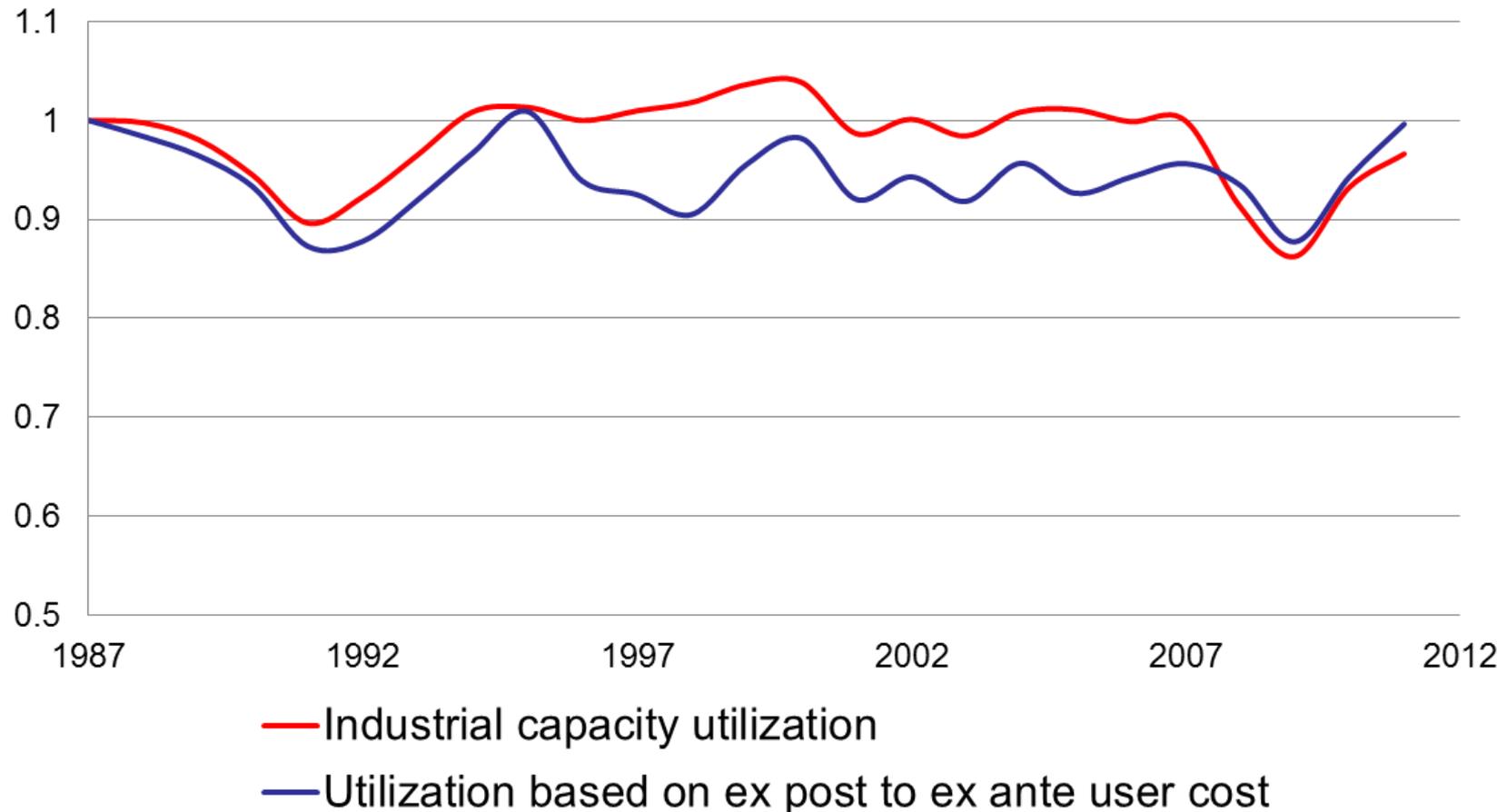
- Productivity statistics published do not correct for short run variations in capacity utilization
- Gu and Wang (2015) proposed a simple and intuitive approach for such adjustment:

$$\Delta \ln MFP = \Delta \ln MFP^* + \alpha_K^{cost} \Delta \ln(P_K^{ex\ post} / P_K^{ex\ ante})$$

- Intuitions for such Adjustment

- The approach is similar to the approach by Denison who used *ex-post* profit rates to correct for capacity utilization
- The approach is inspired by Berndt and Fuss (1986) who argued that when the *ex-post* rate of return is used to value the *price* of capital input, MFP corrects for utilization. (not in practice, Basu and Fernald 2001)
- We argue that the *ex-post* return should be used to adjust the *quantity* of capital input to correct for utilization.

Capacity Utilization in Manufacturing

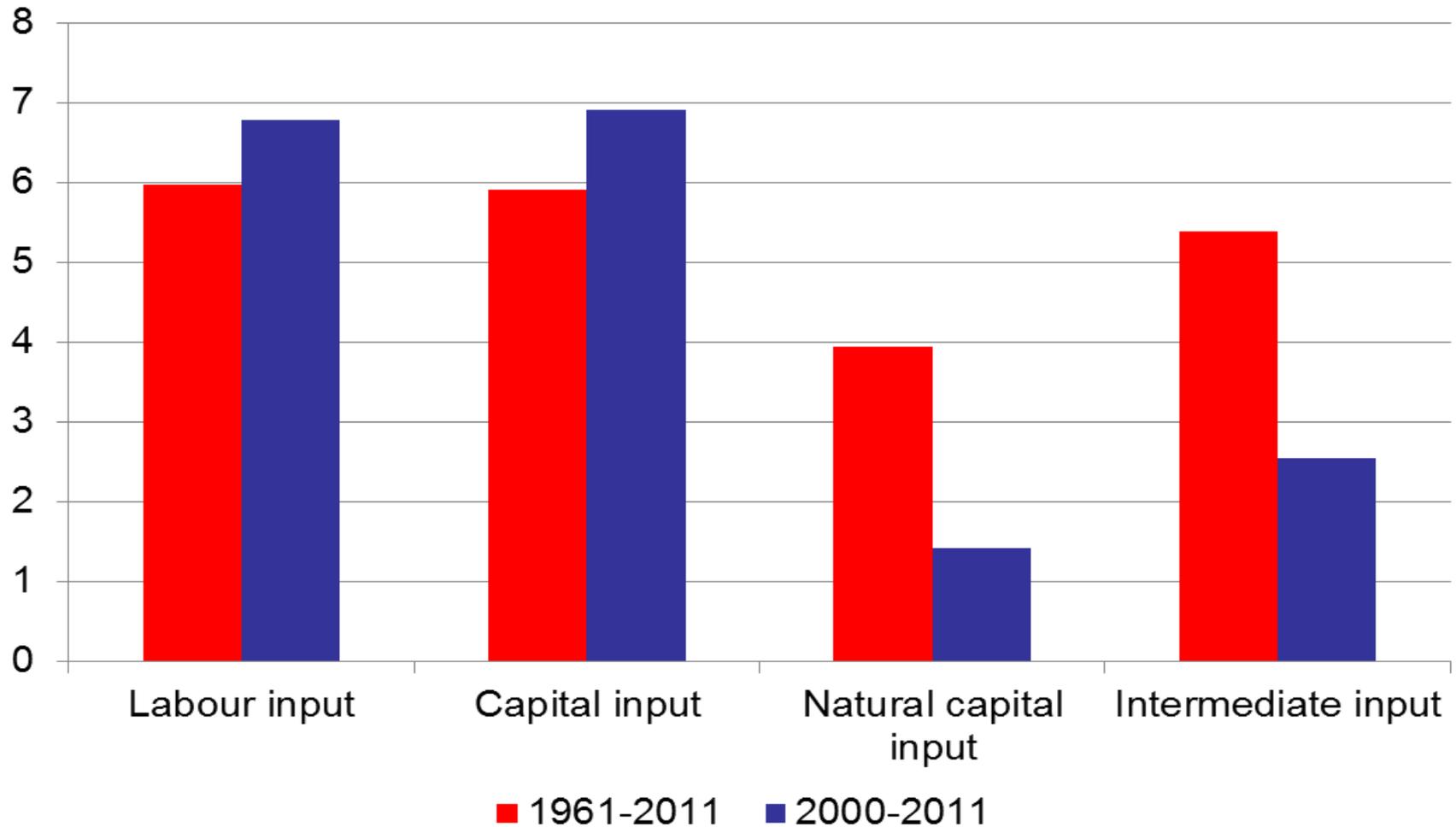


- This adjustment has little effect on long-term MFP growth rates, but it does affect short-term MFP changes over the business cycle.

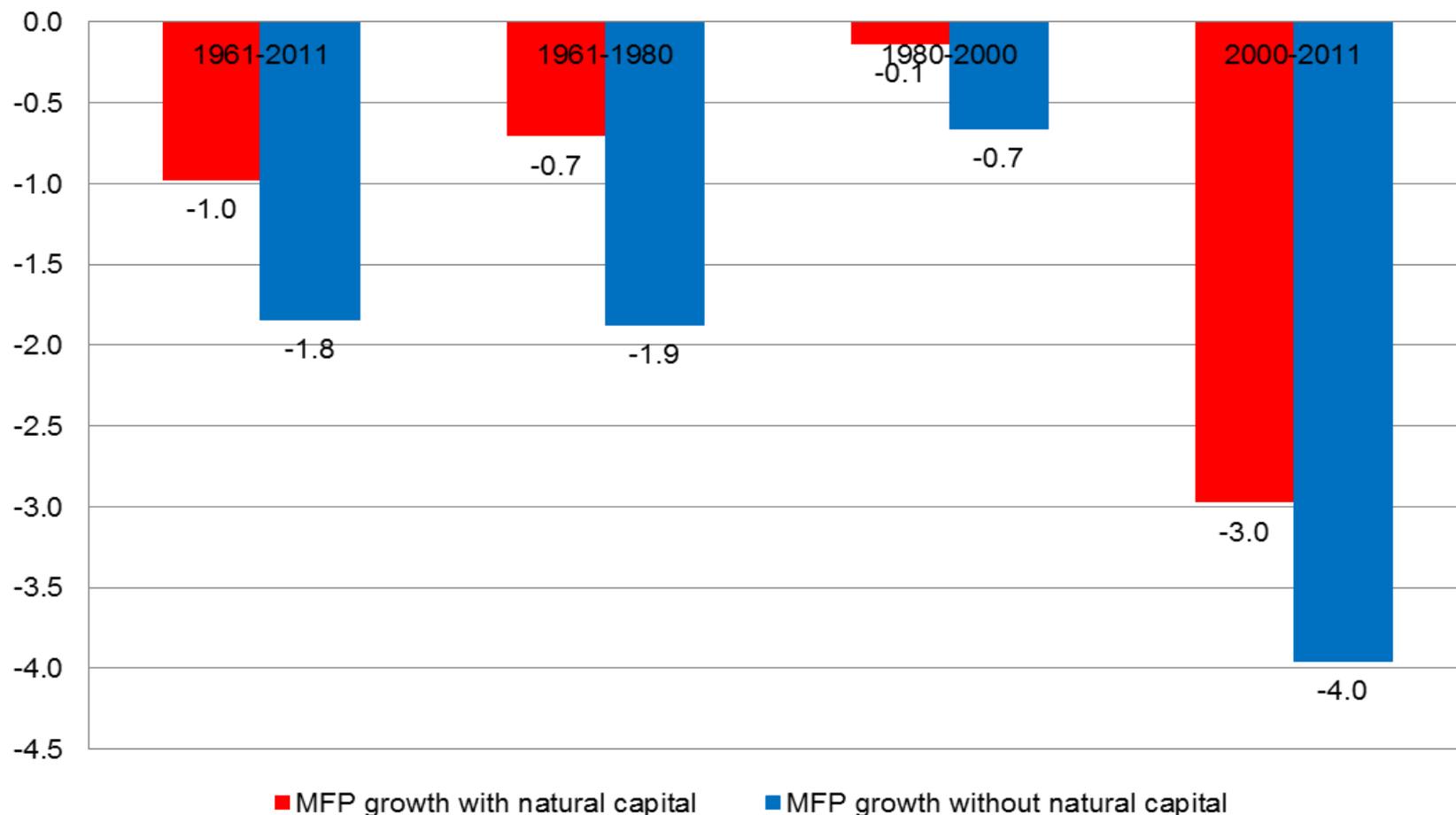
Natural Capital in Mining

- Multifactor productivity declined for the mining, and oil and gas extraction industries in Canada.
 - The decline in MFP in the mining and the oil and gas extraction does not necessarily suggest that there is a decline in technical efficiency (ABS, Netherlands)
 - As the output includes the rent while the natural capital used to generate the rent is included in the input in the sector, the current MFP measure may be biased.
- Adams and Wang (2015) introduced natural capital in the extended growth accounts for the oil and gas extraction and other mining sectors, explored alternative methods.
 - The resource rent or user cost of natural capital is estimated as the value of gross output net of the costs of labour, intermediate and produced capital inputs.
 - The volume of the service from natural capital is estimated by the volume of extraction.

Input Growth in the Oil and Gas Extraction



MFP in the Oil and Gas Extraction



- Even with natural capital, we still can't solve the puzzle of declining TFP growth completely

- Public infrastructure capital (the nation's roads, bridges, sewer systems and water treatment systems) constitutes a vital input for business sector production: market access and lower transportation costs
 - The impact of public capital at present is subsumed in MFP as the current framework focuses in private inputs.
- Growth Accounts with Infrastructure

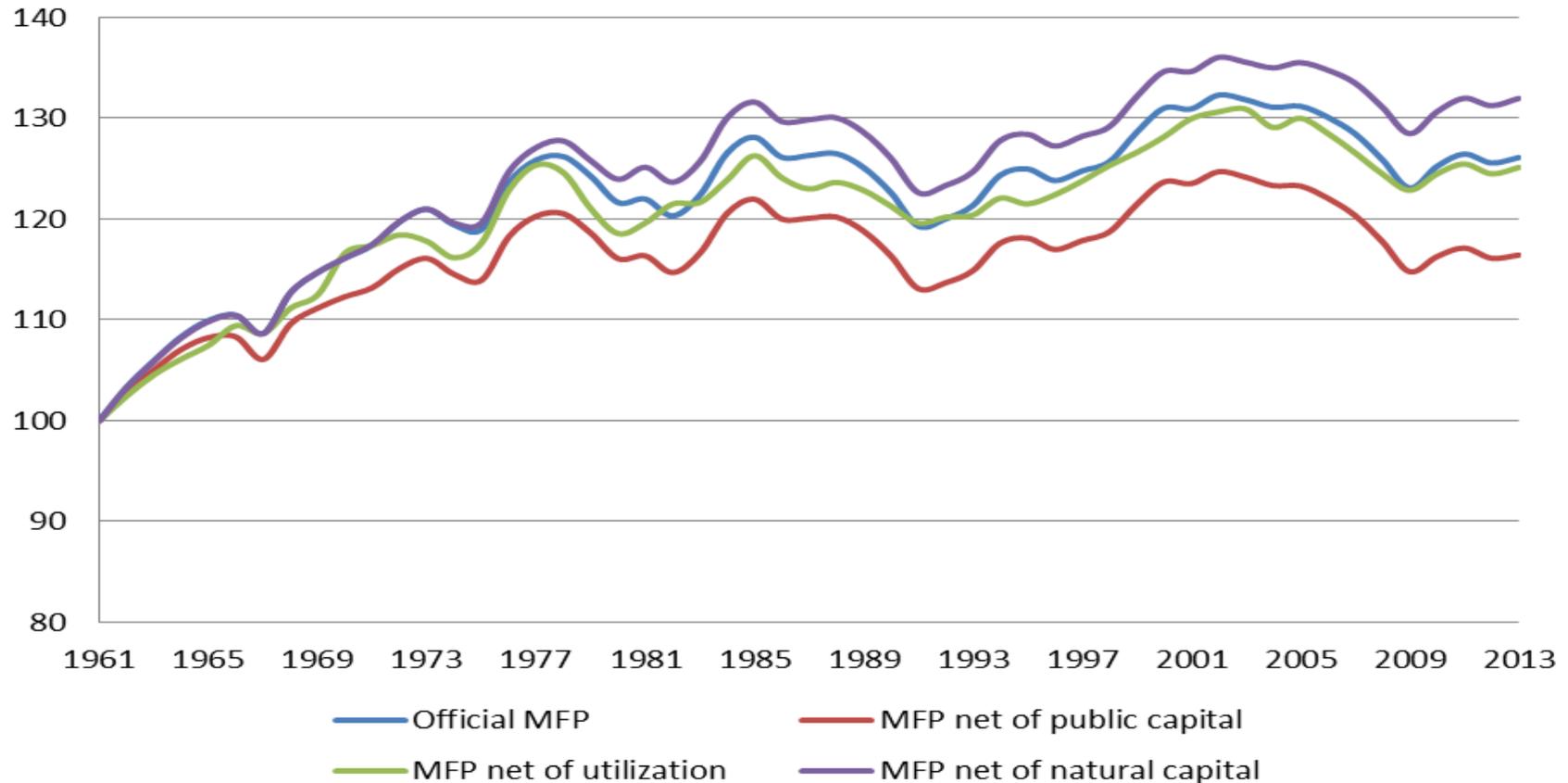
$$\Delta \ln MFP = \Delta \ln MFP^* + \beta_G \Delta \ln G$$

$$\beta_G = \frac{c_G G}{P_A A}, c_G = P_G (\gamma + \delta - \pi)$$

- These formulas may have implications for measured GDP

Adjustments to Measured TFP

Figure 5. Multifactor productivity in the business sector



- None of these adjustments ‘fix’ the problem of declining TFP growth.
 - Perhaps it’s a genuine economic problem, and not just measurement error?

Intangibles and Productivity Growth



- The MFP measure published at Statistics Canada only includes a portion of intangible assets (those related to R&D, exploration and software).
 - It has been argued that a number of intangible assets exist that have not been appropriately taken into account in measuring the growth in capital. It consists of:
- However, the effect on measured MFP growth is theoretically ambiguous
 - On the one hand, measured output is underestimated if investment in intangible capital is excluded.
 - On the other hand, measure capital inputs are underestimate if the intangible capital stock is excluded.
- Baldwin et al. (2012) finds that intangibles made a significant contribution to labour productivity growth and the contribution of intangibles to labour productivity growth was almost as high as that of tangibles in the Canadian business sector. MFP growth had no change.
 - But the estimates of intangibles lack precision in some areas.
 - More accurate measure of intangibles are important to have a more comprehensive view of economic growth.

MFP by Final Demand Products

- Statistics Canada and most other statistical agencies publish the estimates of MFP growth by industry.
 - Denison (1989) recommended that statistical agencies introduce an alternative way of dividing the total economy and measure the productivity by final demand products. Basu and Fernald (2010) and Oliner et al. (2007) produced estimates for the U.S.
- MFP growth by end products is the difference between growth in the output of final product and growth in the combined total capital and total labour inputs (that are used directly and indirectly to produce the final product).
- Gu and Yan (2015) find that productivity growth tends to be higher in the production of investment and export products than in the production of consumption products.
 - A substantial portion of MFP growth for the production of final demand products, especially for Canada, is a result of offshoring.

Output in Health and Education Sectors



- In Canada, output in the non-business sector is essentially measured with inputs and deflated with input costs. This means that productivity growth as estimated from the Accounts is essentially zero.
 - Measured real output and GDP depend on the precise inputs tracked.
- Recent research has focused on the output measure of the health and education sectors. Experimental measures of output and productivity have been developed for the education sector, hospitals, residential care facilities and physicians paid under fee-for-service model.
 - The direct output measures are based on the number of activities weighted across various types using their costs as a weights and taking into accounts changes in quality.
- Results from Experimental Methods:
 - The education sector is found to have low productivity growth.
 - Labour productivity growth in the hospital sector is faster than the average labour productivity growth in the business sector.
 - But there were little productivity growth in residential care facilities and physicians paid under fee-for-service model.

Comment 1: Natural Resource Capital

- I think natural resources are very important, so I'm excited to see this research.
 - Natural resources are an input into almost every industry, and economists have worried about limited natural resources since the 18th century (Malthus 1798).
 - Including natural resources in the productivity accounts allows policy-makers to measure these concerns systematically.
- I'd prefer to treat natural resources as produced capital rather than completely exogenous
 - Industries invest in environmental quality by reducing pollution, protecting endangered species and cleaning up past environmental damage.
 - Perhaps the MFP decline for mining could be an unmeasured increase of investment in environmental quality?
 - Conversely, some of the MFP increase in the overall economy might be an unmeasured increase of environmental quality stock (Zivin and Neidell 2011), (Change, Zivin, Gross and Neidel 2014 and 2016)
- Some natural resources investment fits into SNA 2008 already
 - Land improvement investment is considered part of structures (10.79)
 - The category 'cultivated assets' (10.88) could be broadened to include landscaping trees, protected wildlife and other biological resources.
 - The category 'mineral exploration' (10.106) might also cover natural resource discovery.

Comment 2: Public Infrastructure Capital



- This research is really interesting because it has the potential to explain TFP differences across regions or times.
 - Across countries, there are enormous differences in physical infrastructure.
 - In addition, environmental quality, legal history, social norms and other outside factors could be analyzed as a type of public infrastructure.
- However, I'd like to raise some practical issues:
 - This paper is focused on long-lived public infrastructure, but short-lived services (like weather reporting) may be just as important.
 - It's very difficult to disentangle the infrastructure devoted to private businesses from the infrastructure devoted to consumers.
 - It's also difficult to allocate business infrastructure across industries.
 - Public infrastructure and services aren't free gifts to businesses. Instead, they're generally paid for with property taxes and other business taxes.
 - In a poster session, Jon Samuels and I explored treating government property taxes as if they were homeowners association or business improvement district dues.

- Overall, I really liked the paper.
 - This paper combines useful data collection with exciting theoretical innovations.
 - I apologize for not giving each innovation the attention it deserves.
 - I highly recommend that interested individuals read the previous productivity papers that Gu has written to get a deeper understanding of his productivity accounts.
 - Gu also deserves credit for his education accounts and other research.
- Long-term, I'd like to see how these innovations would affect measured GDP and other NIPA's statistics.
 - Policy-makers are often focused on GDP rather than TFP.