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Abstract

We study the behaviour of Canadian total factor productivity growth over the past 60 years. We find that the observed stagnation during the last 20 years is entirely accounted for by the Oil sector. Higher oil prices made capital-intensive sources of oil like the oil sands viable to extract on a commercial scale. However, the greater input required per barrel of oil slowed productivity growth. Comparing Canadian TFP growth to that of the United States reinforces these results. However, our result should not be interpreted to carry any welfare implications.

Keywords: Canadian Productivity Stagnation, Oil Sector, TFP.
JEL Codes: E01, O47, O51

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1 Introduction

Economists and policy-makers have expressed ongoing concern about the lack of productivity growth in Canada.[1] Conesa and Pujolas (2019) identify the "Canadian Productivity Stagnation" during the period from 2002 to 2014, where Canadian Total Factor Productivity (TFP) growth was negligible, lagging behind both previous decades in Canada and contemporaneous U.S. TFP growth. Our paper extends the period of Canadian Productivity Stagnation up to at least 2018 (the last year for which data is available, as detailed in Appendix A), and demonstrates that the the absence of aggregate TFP growth during this period can be attributed entirely to the oil sector.[2] Increases in oil prices made resource-intensive, lower TFP oil production (such as the oil sands) viable, which in turn reduced aggregate Canadian TFP growth.

In essence, the lack of TFP growth is entirely accounted for by excluding the oil sector from the Canadian national accounts and recalculating TFP accordingly. To measure TFP, we need data on output (real GDP), inputs (a measure of the capital stock in the economy, as well as total hours worked), and an assumption on how inputs combine to generate output (which we employ through a Cobb-Douglas production function). Then, TFP is calculated as changes in output that cannot be attributed to changes in inputs, as first proposed by Solow (1957). Our methodology is based on the approach in Kehoe and Prescott (2007) and is similar to that of Conesa, Kehoe, and Ruhl (2007).

Our initial TFP measurement for the overall economy aligns with the well-established pattern of a lack of TFP growth since the early 2000s. However, we also calculate a net-of-oil TFP, which involves removing the contributions of the oil sector from GDP, capital, and hours worked. We find that net-of-oil TFP grows at rates similar to those observed in previous decades in Canada and in line with corresponding rates in the United States. This suggests that the oil sector has played a significant role in suppressing TFP growth in Canada.

To compare Canadian and U.S. TFP growth accurately, we repeat the analysis using U.S. data from the Bureau of Economic Analysis. We find that unlike Canada, U.S. measured aggregate TFP growth during this period is not significantly affected by excluding the oil

[1]See, for instance, the Fraser Institute's monograph on Improving Productivity Growth in Canada (Douglas et al., 2021); Op-Ed by William Robson, CEO of the C.D. Howe Institute, in the Financial Post titled "Faster Productivity Growth Would Solve Many Problems" (Robson, 2022); OECD's Canada Economic Snapshot (OECD, 2023); Deloitte's Future of Productivity volume (Currie, Scott, and Dunn, 2021); or the Charter of Proessional Accountants in Canada's "Solution to Canada's plummeting productivity" (Fong, 2019) to name a few.

[2]Throughout the paper we refer to the industry named "oil and gas Extraction," NAICS code 211, as the"oil sector."

sector.

Our findings indicate that it is crucial to grasp the distinctive aspects of Canada's oil industry in order to comprehend the significant divergence in productivity trends between Canada and the United States.

Our analysis highlights that the oil sector has undergone a significant surge in capital usage, with a disproportionate increase compared to other sectors. 60 years ago, the oil sector utilized only about 8 percent of the total capital used in Canada, but this proportion has risen sharply to around 35 percent in recent years. By contrast, the oil sector's contribution to value added has remained relatively constant at approximately 5 percent, revealing a stark discrepancy between the increase in capital used and the increase in output produced.

The surge in capital used by the oil sector coincides with the early 2000s oil price boom and the commencement of commercial oil sands extraction in 2001. [3] It is noteworthy that the proportion of capital in the oil sands as a percentage of the overall capital in the oil sector has seen a remarkable surge, rising from a steady 5 percent between 1961 and 2000 to an astonishing 30 percent as of 2019.

In the past two decades, the oil sector has seen a significant decrease in its TFP, which we attribute to an imbalance between its increased capital input and the stagnation of its output. It is important to note that TFP, computed using real value added, does not account for the positive effects of rising oil prices. The drop in TFP may be attributed to a combination of increased oil prices and a technology that exhibits decreasing returns to scale. Higher oil prices might encourage the extraction of costlier barrels of oil, which would lead to a lower TFP due to a composition effect.

Lastly, it is important not to interpret our results as a critique of the oil sector. While the industry confronts a host of challenges, such as carbon emissions, our findings do not necessarily imply any additional negative aspects. Rather, it is plausible that the Canadian economy is responding optimally by exploiting a resource when its value is high.

The paper is organized as follows: Section 2 contextualizes our contribution in light of the literature. Section 3 presents the methodology used to measure TFP and highlights that TFP in Canada has remained stagnant since the early 2000s, but increases when the oil sector is excluded from the calculations. In Section 4, we perform a comparative analysis of TFP between Canada and the United States. Moving on, Section 5 offers additional information regarding the Canadian oil sector that is pertinent to understanding the productivity of the sector. Finally, in Section 6, we provide further context and propose potential avenues for

[3] The offshore oil project Hibernia in Newfoundland and Labrador, which started producing in the late 1990's, also fits this analysis. However, its production is much lower than the oil sands.

future research.

2 Literature Review

The lack of productivity growth in Canada post-2000 is an ongoing topic of discussion among scholars and policy-makers. This paper builds on the previously mentioned work by Conesa and Pujolas (2019) and other studies that have investigated the sluggish productivity in Canada. For example, Boothe and Roy (2008) reviews labour and multi-factor productivity (MFP) in the Canadian business sector and links weak MFP growth to Canadian firms' lackluster innovation performance. They also note a sharp decline in productivity in the oil and gas sector from 2000 to 2006. Similarly, Alexopoulos and Cohen (2018) finds that the slowdown in productivity growth in the Canadian business sector since 2000 was due to a decrease in the rate at which Canadian firms adopt new technologies and a lack of innovative activity. Our paper complements these studies by focusing on the connection between TFP and the Oil sector, rather than firm level innovative activity.

Shao and Tang (2021) examines the role of allocative efficiency in driving aggregate labour productivity growth and explored the reasons behind the labour productivity gap between Canada and the United States. The paper identifies capital allocation as the primary factor responsible for the decline in Canadian allocative efficiency. Similarly, Gu (2018) investigates the impact of various measurements of capital on slow productivity growth in Canada, and finds that a quarter of Canada's productivity slowdown between 2000 and 2015 is due to the use of capital in the Oil and gas sector. Our analysis in Section 5 is consistent with these findings, as we demonstrate that Canada's capital has been heavily utilized by the Oil sector since the late 1990s and that this trend can explain the lack of TFP growth during the same period.

Sharpe (2010) focuses on 12 different industries in Canada and argues that the decline in labour productivity growth in the manufacturing sector is responsible for the entire slowdown in business sector productivity growth between 2000 and 2007. Similarly, Baldwin and Willox (2016) suggests that the low productivity growth in three different industries (including Oil extraction) explain the entirety of the slowdown in business sector labour productivity growth from 2000 to 2014. While we recognize the validity of these analyses, in Appendix B, we show that even if one excludes the manufacturing sector (or the agricultural, services, or "rest of mining" sectors) the lack of TFP growth persists. Therefore, while all these findings invite further investigations into areas where Canadian productivity growth may be improved, it is striking that the stagnation in aggregate TFP growth can be so singularly attributed to oil.

According to Keay (2009), the resource extraction sector had a positive impact on per capita economic performance in the Canadian economy from 1970 to 2005. Although our paper attributes the recent lack of TFP growth to the oil sector, our growth accounting decomposition with and without the oil sector also reveals that TFP growth was higher during the 1970s and the 1990s thanks to the oil sector (see Table 1 in Section 3 for more information). Similarly, Olewiler (2017) suggests that Canada has benefited from exporting natural resources, but notes that failing to account for the environmental externalities of resource extraction raises concerns about the long-term economic benefits.

3 Canadian TFP, with and without the oil sector

In this section, we describe our methodology for measuring total factor productivity (TFP), which is then used to conduct a growth accounting decomposition of the Canadian economy. We also compare TFP growth rates with and without the oil sector across different time periods.

To measure TFP, we assume a standard Cobb-Douglas production function, where GDP (Y_t) is a function of capital (K_t), labour (L_t), and a productivity factor (A_t):

$$Y_t = A_t K_t^{\alpha} L_t^{1-\alpha},$$

where α is the parameter that measures the capital intensity of the economy. We obtain data on GDP (Y_t), capital (K_t), labour (L_t), and compensation of employees from StatsCan.[4] Using the compensation of employees data, we can calculate the capital share of income (α) as:

$$\alpha = 1 - \frac{1}{T}\sum_t \frac{w_t \times L_t}{Y_t},$$

where $w_t \times L_t$ is the series of compensation of employees.

With all this information, we can calculate TFP as a residual,

$$A_t = \frac{Y_t}{K_t^{\alpha} L_t^{1-\alpha}},$$

and decompose GDP per working-age population (N_t, henceforth WAP) as

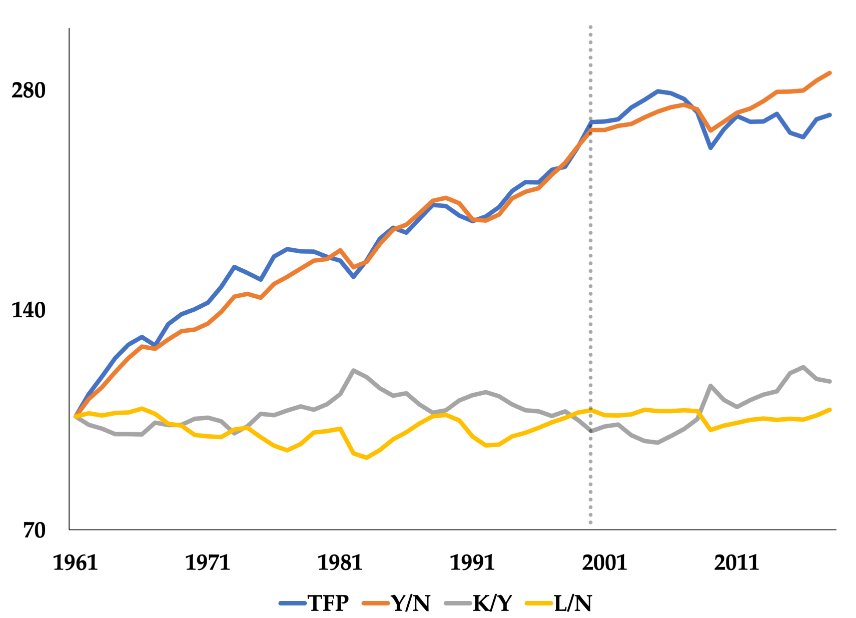
$$\underbrace{\frac{Y_t}{N_t}}_{\text{GDP per WAP}} = \underbrace{A_t^{\frac{1}{1-\alpha}}}_{\text{TFP}} \times \underbrace{\left(\frac{K_t}{Y_t}\right)^{\frac{\alpha}{1-\alpha}}}_{\text{Capital-Output ratio}} \times \underbrace{\frac{L_t}{N_t}}_{\text{Hours per WAP}}.$$

[4]See Appendix A for details.

The Growth Accounting Decomposition of the Canadian economy from 1961 to 2018 is shown in Figure 1, where the y-axis is presented in logarithmic scale due to the exponential growth observed in both the series for GDP per WAP and TFP.

It is worth noting that from 1961 to 2001, the Canadian economy followed the typical pattern of developed economies, with almost all growth in GDP per WAP attributed to improvements in TFP. During this period, the Capital-Output ratio and Hours per WAP series remained relatively stable, with minor fluctuations reflecting business cycle movements. Neither variable had a significant impact on the overall growth of GDP per WAP.

Figure 1: Growth Accounting Decomposition.



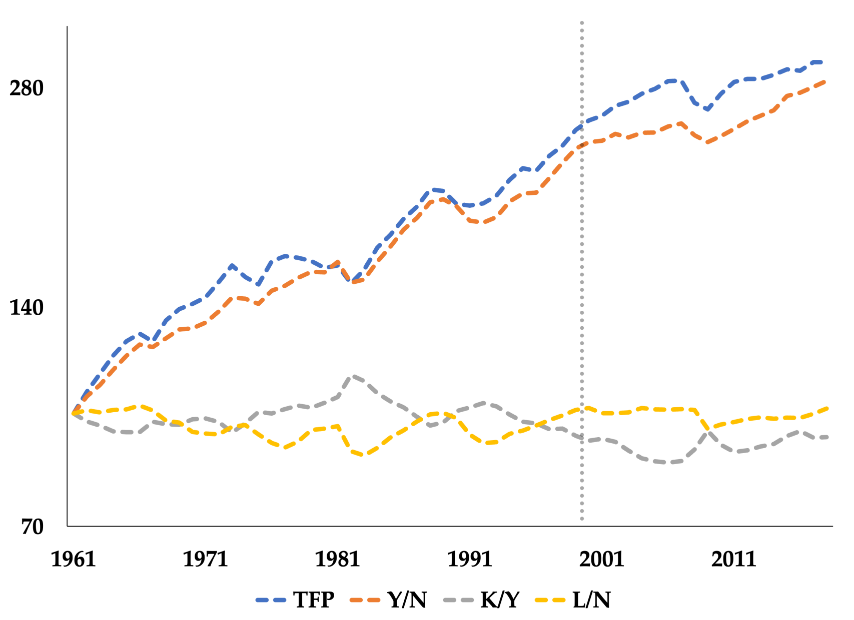
Beginning in 2001, the analysis reveals a marked shift in the Canadian economy's productivity trends, labelled as the "Canadian Productivity Stagnation" by Conesa and Pujolas (2019) Between 2001 and 2018, the TFP series exhibits little to no growth, fluctuating around a horizontal line and yielding an annualized growth rate of a mere 0.08 percent.

In the next phase of our analysis, we eliminate all components of the oil sector from our TFP calculation. We perform the same analysis but substitute $Y_t^{NO}, K_t^{NO}, L_t^{NO}$ in place of Y_t, K_t, L_t, respectively, where X_t^{NO} is defined as X_t minus X_t^{Oil} for X being Y, K, or L, and "NO" indicates "Net-of-Oil". To ensure consistency in our analysis, we revise α^{NO} to exclude oil sector labour payments from the economy.[5]

[5] We find that using the same α value as in the previous Net-of-Oil TFP analysis (Figure 1) has no impact on the results, as shown in Figure 14 in Appendix C.

We present the results of the Net-of-TFP Growth Accounting Decomposition exercise in Figure 2.

Figure 2: Net-of-Oil Growth Accounting Decomposition



After removing the oil sector components from the analysis, our results indicate that the economy did not display stagnant TFP post-2001. On the contrary, TFP increased at an annualized rate of 0.65 percent between 2001 and 2018. These findings align with Canada's historical TFP growth rate.[6]

Table 1 presents the annualized growth rates of TFP for different periods, comparing the economy with and without the oil sector. TFP has grown at 0.96 per cent per year for the period considered, from 1961 to 2018. When the oil sector is excluded, this figure increases to 1.18 per cent. This difference in growth rates, however, is not consistent throughout the period. Net-of-oil TFP rises faster than overall TFP during the 1980s but not during the 1970s or the 1990s. Most importantly, while the annual TFP growth rate when the oil sector is included is a meager 0.08 per cent since 2001, the growth rate increases to 0.65 per cent during that time period when we exclude the oil sector from the analysis. This figure is more in line with other growth rates presented in the table, higher than the Net-of-oil TFP growth rate in the 1970s, and similar to TFP growth in the 1970s and 1980s.

[6]As already noted, we find that removing any sector other than oil from the Canadian economy is inconsequential for the evolution of TFP. The result of these exercises can be seen in Figures 10, 11, 12, and 13 in Appendix B.

Table 1: TFP and Net-of-Oil TFP growth rates

Period	TFP growth	Net-of-Oil TFP growth
1961-2018	0.96%	1.18%
1971-1981	0.72%	0.56%
1981-1991	0.78%	1.21%
1991-2001	1.80%	1.70%
2001-2018	0.08%	0.65%

4 Comparison of Canadian and U.S. TFP

In this section, we explore whether the lack of TFP growth driven by the oil sector, which was observed in Canada post-2000, also occurs in the United States. Specifically, we investigate the evolution of TFP and Net-of-Oil TFP in the United States and compare them to their Canadian counterparts. We find that, unlike Canada,excluding the oil sector has no significant effect on measured aggregate TFP growth in the United States.

To conduct our analysis, we use the same approach as in our analysis of Canada, utilizing data on capital, value added, hours worked, and labour compensation from the Bureau of Economic Analysis in the United States.[7]

Figure 3 displays the TFP and Net-of-oil TFP evolution for Canada and the United States from 1961 to 2018, normalized to 100 in 1961. [8] As expected, all series increase with some fluctuations, with the U.S. curve smoother. Nevertheless, until 2000, both Canadian TFP series followed similar trends. The primary contrast between the two Canadian series emerges after this year.

To gain insights into the evolution of TFP post-2000, we narrow our focus in Figure 4, normalizing the series to 100 in 2001. The figure highlights a clear trend: while all the TFP series for Canada and the United States have business cycles, only Canada's TFP series displays stagnant growth post-2001. In contrast, the TFP series for the United States and the Net-of-Oil TFP series for both countries exhibit strikingly similar growth patterns. They all experience fluctuations but consistently grow throughout the period, indicating that the lack of TFP growth in Canada is a unique phenomenon, linked to the oil sector.

We consider Figure 4 to be a clear representation of the key message conveyed in this paper. If measured without the oil sector, Canada's TFP growth would have been similar to that of the United States, and there would not have been a "Canadian Productivity Stagnation." Canada has been on par with the United States in terms of TFP growth,

[7]See Appendix A for details.

[8]While Canadian TFP has grown faster than the U.S. during this period, it is still the case that Canadian output per person is lower.

Figure 3: TFP and Net-of-Oil TFP, Canada and United States, since 1961

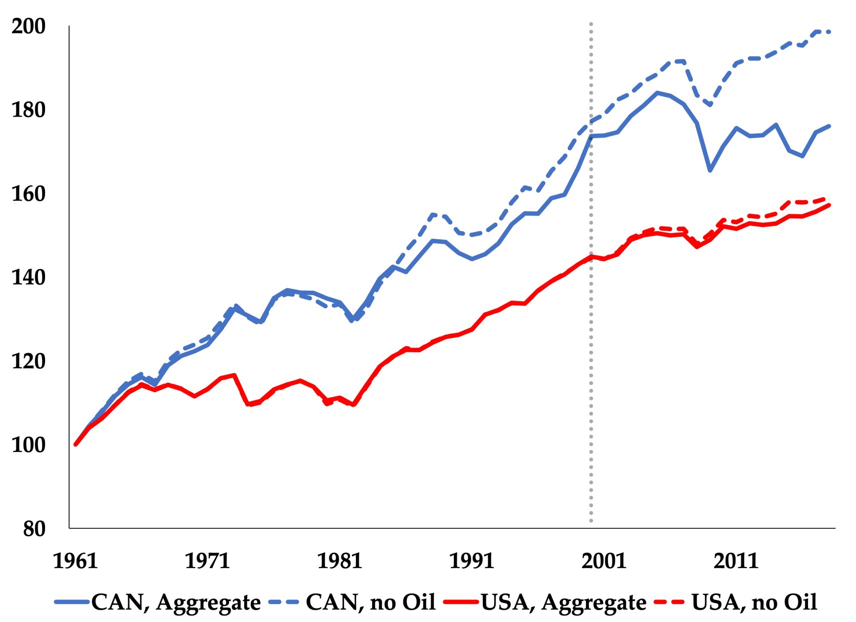
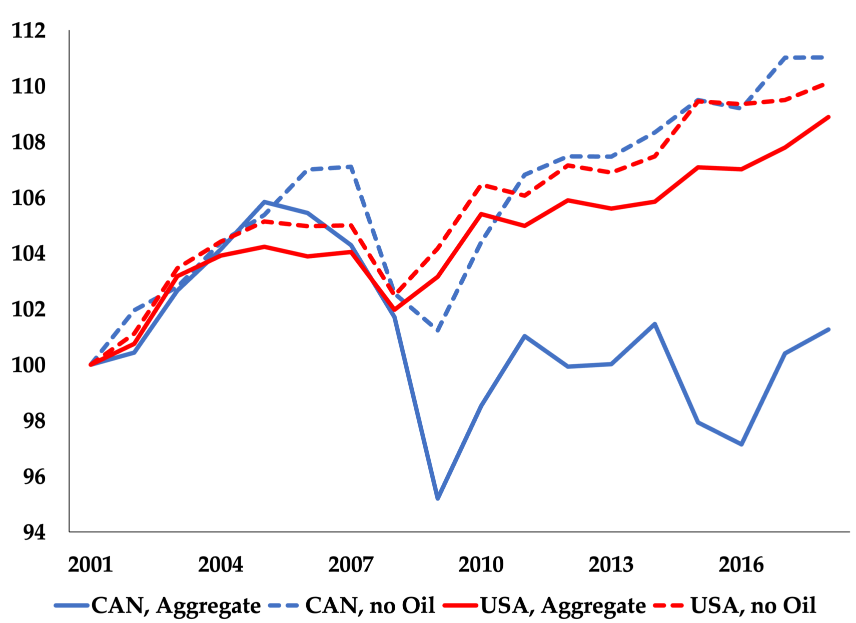


Figure 4: TFP and Net-of-Oil TFP, Canada and United States, 2001 onwards

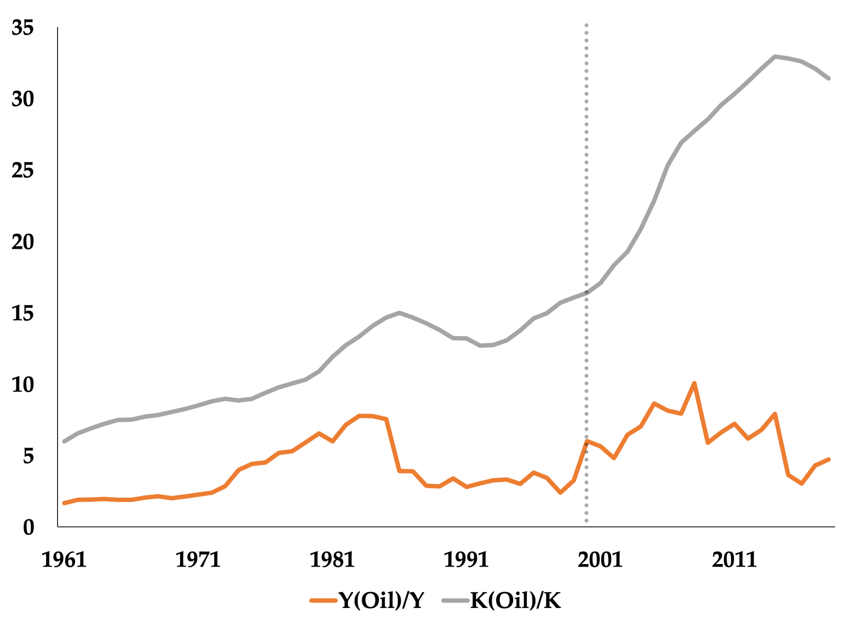


except for the impact of the oil sector. In the following section, we examine the Canadian oil sector during this period, in order to gain insights into the factors contributing to the decline in Canada's oil sector TFP.

5 More details about the oil sector in Canada

The oil sector holds significant importance for the Canadian economy. Figure 5 illustrates the trend in the ratio of capital invested in the oil sector compared to the total capital in the Canadian economy and the ratio of value added contributed by the oil sector as a fraction of the total value added in Canada.

Figure 5: Importance of the oil sector in Canada

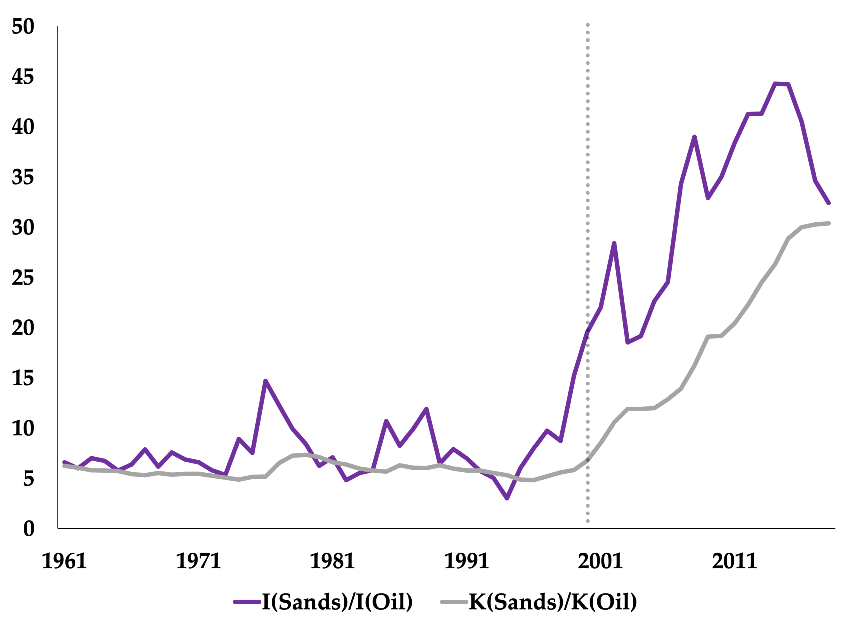


During the period of analysis, the oil sector's share of value added remains around 5 per cent, while the proportion of capital allocated to the oil sector has surged from 8 per cent to approximately 30 per cent. This growth is mostly observed after 2001, suggesting that the oil sector is using a relatively greater amount of input to produce relatively the same amount of output. Since the oil sector has low labour requirements, the divergence between the growth of capital and value added mechanically accounts for the lower TFP.

To shed light on the reason behind the oil sector's increasing capital allocation, particularly after 2001, we present a crucial piece of evidence in Figure 6, which shows the importance of capital allocated to the Oil sands as a fraction of the total capital invested in the oil sector. The proportion of capital installed in the Oil sands ranged from 5 to 8 per cent between 1961 and 2001, but it surged to over 30 per cent afterwards.

In Figure 6, we also show the proportion of investment in the Oil sands relative to the total investment in the oil sector over the period. As expected, the chart has a similar pattern to that of capital allocation, although it is more erratic and reaches a significantly

Figure 6: Importance of Oil sands in Oil's capital



higher peak of 45 percent.

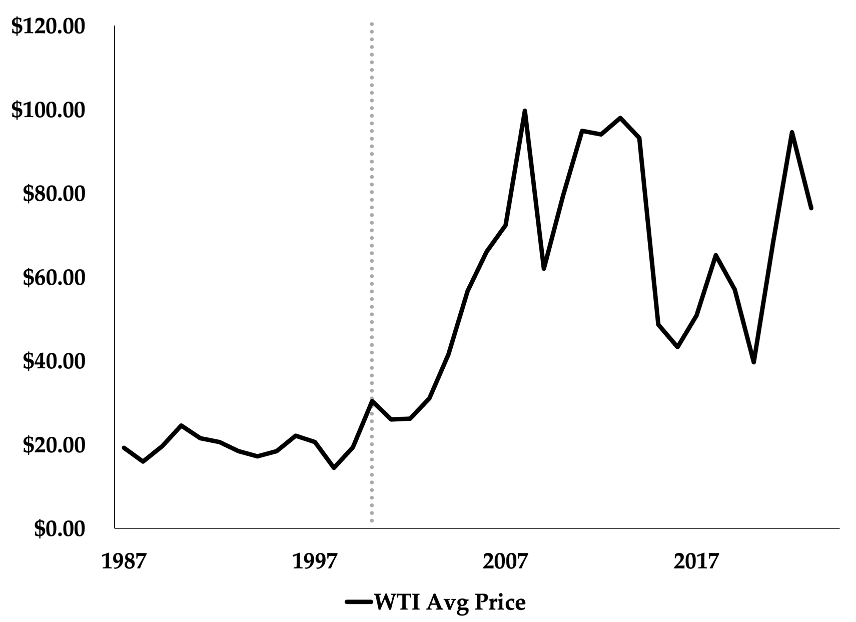
The increase of capital allocated to the Oil sands is consistent with two occurrences: the technological advancement allowing for the opening of the first commercial Steam-assisted gravity drainage (SAGD) project at Foster Creek in 1996 and the potential profitability of exploitation.[9] Figure 7 plots the evolution of the Oil price, measured as the West Texas Intermediate. It was roughly $20 per barrel in the 1990s but surged to approximately $100 per barrel by 2007 and has since fluctuated but at significantly higher prices than before the year 2000.

Hence, it is reasonable to assume that once the technology for extracting oil from the Oil sands becomes available and the oil price is high enough to make it profitable, significant investments were made to seize the opportunity. However, each unit of oil now requires more inputs. If oil production exhibits decreasing returns to scale, the marginal unit extracted will be less productive than the previous ones. Consequently, an increase in the price of oil could mechanically result in a decline in TFP in the oil sector, although this may not necessarily have negative implications.

We observe a significant difference in the evolution of TFP between the oil sector and the rest of the economy. As shown in Figure 8, the Oil-sector TFP and the overall TFP exhibit a negative correlation. While TFP for the overall economy grows, TFP for the oil

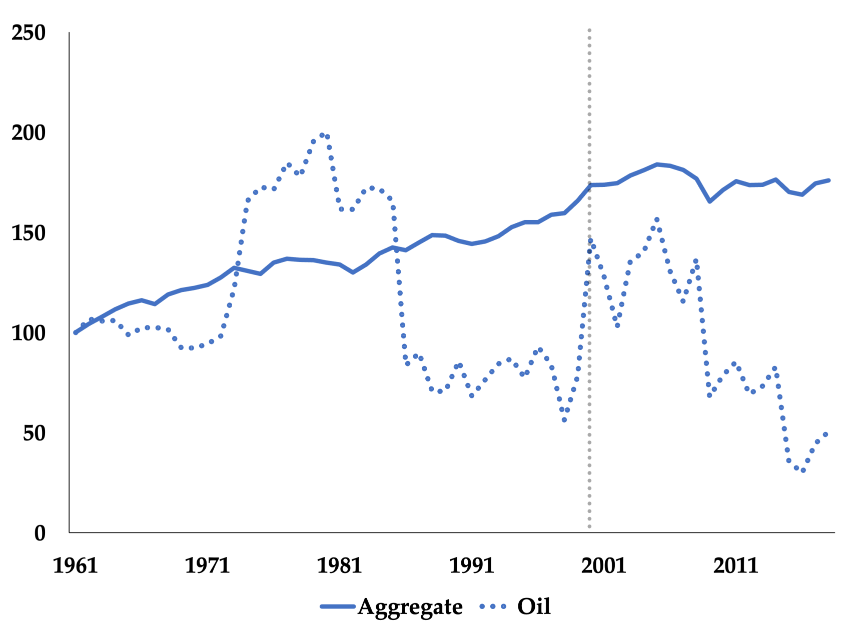
[9] More details on the history of the Oil sands and technology used can also be found in the 2008 report prepared for the US Congress (Humphries, 2008).

Figure 7: Evolution of the price of Oil



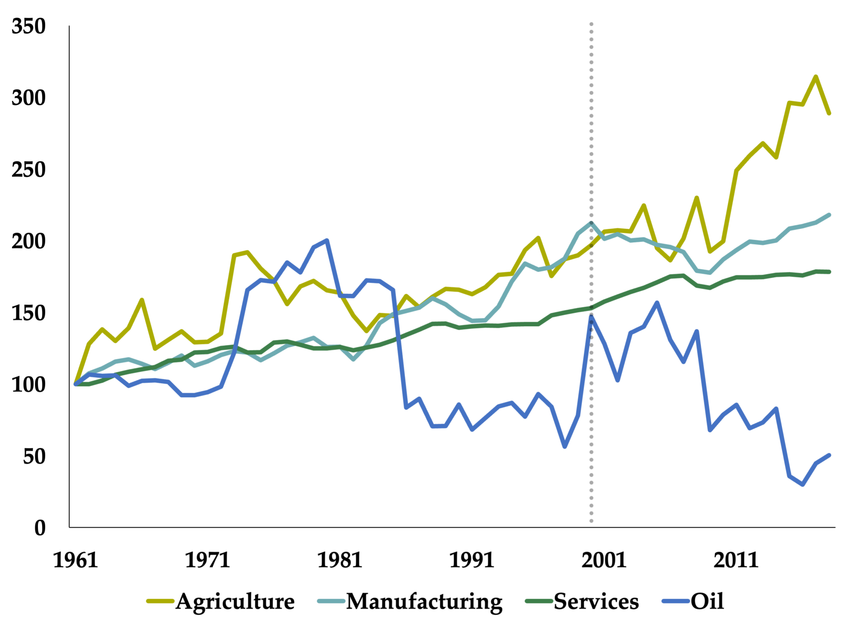
sector experiences a decline, except for two notable increases. Thus, the oil sector in Canada stands out as a distinctive sector with unique characteristics.

Figure 8: Oil TFP vs aggregate



To further support this perspective, Figure 9 illustrates the trends of TFP in the oil sector, as well as in Agriculture, Manufacturing, and Services sectors. It is evident that the volatile and somewhat declining pattern of TFP in the oil sector is not observed in any of the other sectors. On the contrary, their TFP grows in tandem with that of the overall economy over the entire period.

Figure 9: Oil TFP vs other sectors



6 Concluding remarks

Our research has shown that the oil sector is the primary reason for the lack of TFP growth in Canada and that it does not generate a similar lack of TFP growth on the United States. Hence, our result concludes that the difference in productivity between Canada and the United States can be entirely attributed to the oil sector.

While we believe that our result sheds light on the underlying cause of differential evolution of productivity between the two countries, it should be used with caution: we find that the oil sector can explain, in an accounting sense, the lack of Canadian TFP growth. Our findings do not, however, make a judgement on the desirability of this result, nor get into the debate surrounding an industry that confronts a host of challenges, such as carbon emissions.

Namely, it is perfectly plausible that the Canadian economy is responding optimally by exploiting a resource when its value is very high. Whether this represents the best course of action is a question that requires further exploration. Consequently, we defer the answer to this crucial issue to future research.

References

Alexopoulos, M. and Cohen, J. (2018). 'Canadian Productivity Growth, Secular Stagnation, and Technological Change'. *International Productivity Monitor*, volume 35, 113–137.

Baldwin, J. R. and Willox, M. (2016). 'The Industry Origins of Canada's Weaker Labour Productivity Performance and the Role of Structural Adjustment in the Post-2000 Period'. *International Productivity Monitor*, volume 31, 19–36.

Boothe, P. and Roy, R. (2008). 'Business Sector Productivity in Canada: What Do We Know?' *International Productivity Monitor*, volume 16, 3–13.

Conesa, J. C., Kehoe, T. J., and Ruhl, K. J. (2007). 'Modelling Great DepressionsL The Depression in Finland in the 1990's'. In Kehoe, T. J. and Prescott, E. C., editors, 'Great Depressions of the Twentieth Century', pages 427–475. Federal Reserve Bank of Minneapolis.

Conesa, J. C. and Pujolas, P. (2019). 'The Canadian Productivity Stagnation, 2002-2014'. *Canadian Journal of Economics*, volume 52, no. 2, 561–583.

Currie, B., Scott, L. W., and Dunn, A. W. (2021). 'The Future of Productivity: Clear Choices for a Competitive Canada'. Deloitte's Future of Canada series.

Douglas, C., Di Matteo, L., Fuss, J., Geloso, V., Globerman, S., Johan, S., Jones, L., Mintz, J., Murphy P., R., Sobel, R. S., Tombe, T., and Whalen, A. (2021). *Achieving the Four-Day Work Week: Essays on Improving Productivity Growth in Canada*. Fraser Institute.

Fong, F. (2019). 'The solution to Canada's plummeting productivity'. CPA Pivot Magazine.

Gu, W. (2018). 'Accounting for Slower Productivity Growth in the Canadian Business Sector after 2000: The Role of Capital Measurement Issues'. *International Productivity Monitor*, volume 34, 21–39.

Humphries, M. (2008). 'North American Oil Sands: History of Development, Prospects for the Future'.

Keay, I. (2009). 'Resource Specialization and Economic Performance: A Canadian Case Study, 1970-2005'. *Canadian Public Policy*, volume 35, no. 3, 291–313.

Kehoe, T. J. and Prescott, E. C. (2007). 'Great Depressions of the Twentieth Century'. In Kehoe, T. J. and Prescott, E. C., editors, 'Great Depressions of the Twentieth Century', pages 1–20. Federal Reserve Bank of Minneapolis.

OECD (2023). 'Economic Survey of Canada - 6 March 2023'. OECD Economic Snapshots.

Olewiler, N. (2017). 'Canada's Dependence on Natural Capital Wealth: Was Innis Wrong?' *Canadian Journal of Economics*, volume 50, no. 4, 927–964.

Robson, W. (2022). 'Faster Productivity Growth Would Solve Many Problems'. *Financial Post*.

Shao, L. and Tang, R. (2021). 'Allocative Efficiency and Aggregate Productivity Growth in Canada and the United States'. *Bank of Canada Staff Working Papers*, volume 21-1.

Sharpe, A. (2010). 'Can Sectoral Reallocations of Labour Explain Canada's Abysmal Productivity Performance?' *International Productivity Monitor*, volume 19, 40–49.

Solow, R. M. (1957). 'Technical Change and the Aggregate Production Function'. *The Review of Economic Studies*, volume 39, no. 3, 312–320.

Appendix

A Data details

The data utilized in Sections 3, 4, and 5 are obtained from StatsCan for Canada and the Bureau of Economic Analysis (BEA) for the United States. Specifically, we examine the sectoral information for all business sectors of the economy that report capital stock, hours worked, and value added.

We use Tables 36-10-0217-01, 36-10-0208-01 and 36-10-0096-01 from Statistics Canada. Capital ($K_{i,t}$) in each sector i for each year t is constructed using data (in current prices) on investment ($I_{i,t}$), geometric depreciation ($\delta_{i,t}K_{i,t}$) and geometric end-year net stock ($K_{i,t+1}$) so that in year t and sector i

$$K_{i,t} = K_{i,t+1} + \delta_{i,t}K_{i,t} - I_{i,t}.$$

The capital series is then deflated using the deflator for each year implied by the aggregate value added in current and 2012 prices. The aggregate capital series is constructed by subtracting the government sector and non-profits from the the investment, depreciation and end-year net stock of Total Industries.

The data for the United States is produced analogously using data from the BEA. Using the Tables on Value Added by Industry, we obtain value added for each industry in current prices and compute value added in 2012 prices using the tables for Chain-Type Price Indexes for Value Added by Industry. We combine the values from the current tables for the years 1997-2018 with the historic tables that cover 1961-1997. Where discrepancies for the year 1997 exist, we use the values from the current tables. Using the current price and 2012 price values for value added, we compute the aggregate deflator, which is then used to produce real valued estimates for value added in each industry.

For Capital, we combine Tables 3.7E, 3.4E, and 3.1E on investment, depreciation and net-stock of Private Fixed Assets by Industry respectively in the same way described above. We sum the value of equipment, private structures and intellectual property products to arrive at values for total investment, depreciation and net-stock. Many industries are presented at the 3 digit industry code level. For these, we sum up the value of their individual investments, depreciation and net-stock to produce the industry aggregate values. We then deflate the value of the capital stock using the aggregate deflator for value added.

For hours worked we use Tables 6.9B, 6.9C and 6.9D. Due to discrepancies between Tables 6.9C and 6.9D, we use the data for 1998-2018 from 6.9D, and 1987-1996 from 6.9C. The tables lack data for hours worked in oil and gas extraction. To get around this, we compute average hours worked in mining by dividing total hours worked in mining by the number of Full-Time and Part-Time employees in mining (from Tables 6.4B, 6.4C and 6.4D), and then multiply this value by the number of Full-Time and Part-Time employees in oil and gas extraction:

$$Hours_{oil} = Hours_{mining} \times \frac{Employees_{oil}}{Employees_{mining}}.$$

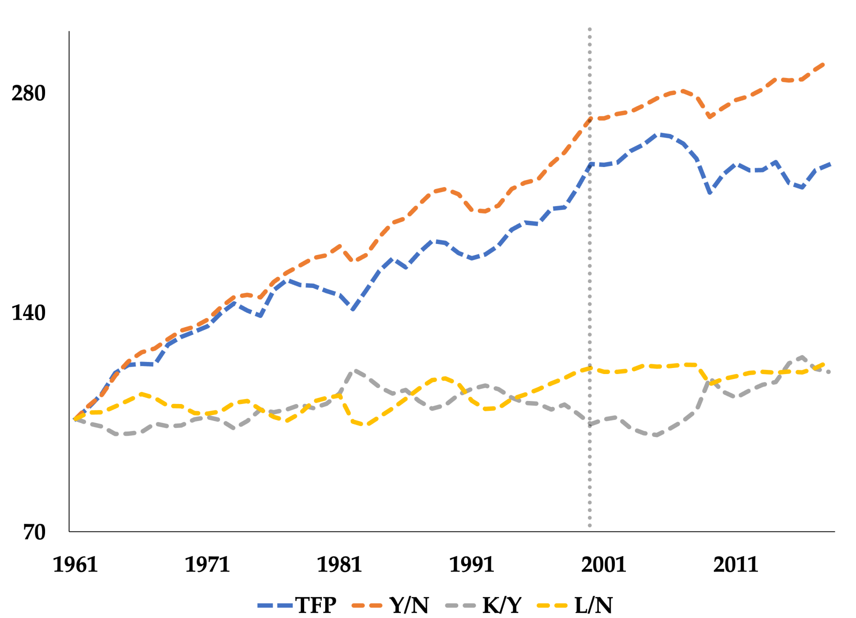
Similar to hours worked, the values for 1998-2018 come from Table 6.4D. Finally, for compensation we use Tables 6.2B, 6.2C and 6.2D in the same way.

For both Canada and the US, the parameters of the production function and TFP are computed as described in Section (3). Data on working age population in each country is taken from the OECD.

B Alternative exclusions in GAD exercise

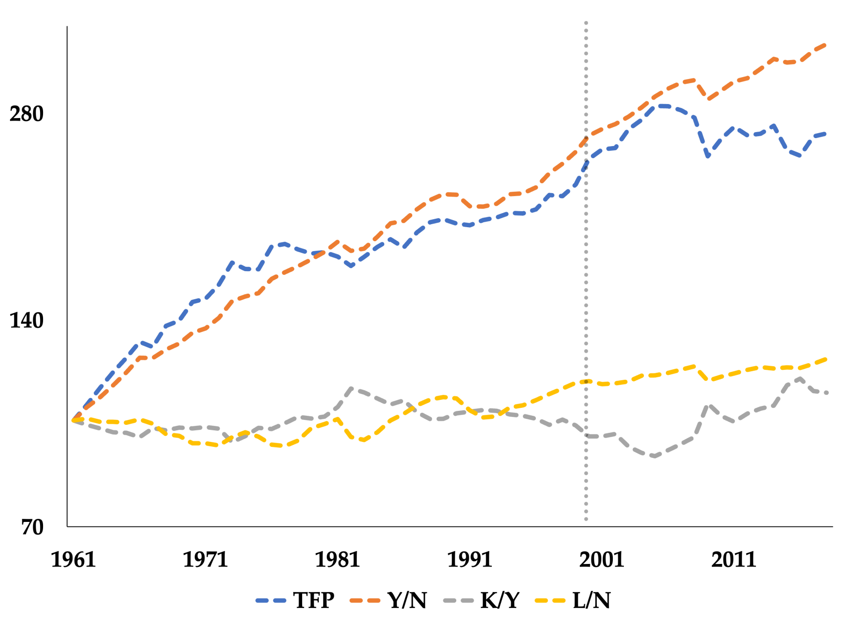
This appendix section presents alternative growth accounting decompositions that differ from those in the main text. Specifically, we demonstrate that the correction of the TFP series that arises when we exclude the Oil sector does not occur when we exclude other sectors such as Agriculture, Manufacturing, Services, or Mining-other-than-Oil. To illustrate this point, in Figure 10, we remove the Agriculture sector and observe that TFP remains stagnant during the 2000s. Thus, we can conclude that the Agriculture sector alone cannot account for the lack of TFP growth during this period.

Figure 10: Robustness: Net-ofAgriculture



In Figure 11, we conduct a similar analysis, but this time we exclude the Manufacturing sector. As before, we arrive at the same outcome, namely, that TFP remains stagnant during the 2000s even after removing the Manufacturing sector from consideration.

Figure 11: Robustness: Net-of-Manufacturing



In Figure 12, we repeat the same analysis by excluding the Services sector. Although we reach the same conclusion that removing this sector alone cannot explain the stagnant TFP, we obtain a much more volatile depiction. This is due to the fact that the Services sector constitutes a significant proportion of GDP, resulting in greater measurement error when it is excluded from the analysis. Additionally, the declining Hours per WAP line can be attributed to structural transformation, where the Services sector has grown significantly during this period. Removing it from consideration causes the total number of hours worked in the economy to fall mechanically.

Finally, Figure 13 demonstrates that the remaining mining sector, apart from Oil, is also not accountable for the stagnant TFP.

C Alternative α in GAD exercise

In our analysis of TFP performance between the whole economy and the economy net-of-Oil, we used different values of α, which is the parameter that governs the capital share of the economy. It is natural to wonder if the lack of TFP growth being accounted for by netting out the Oil sector is due to the use of different parameter values. To address this question,

Figure 12: Robustness: Net-of-Services

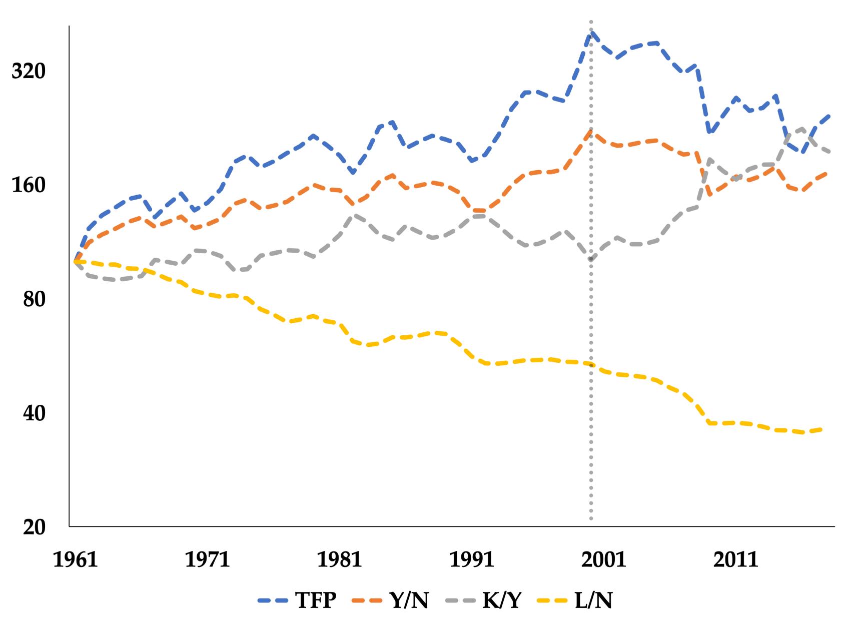
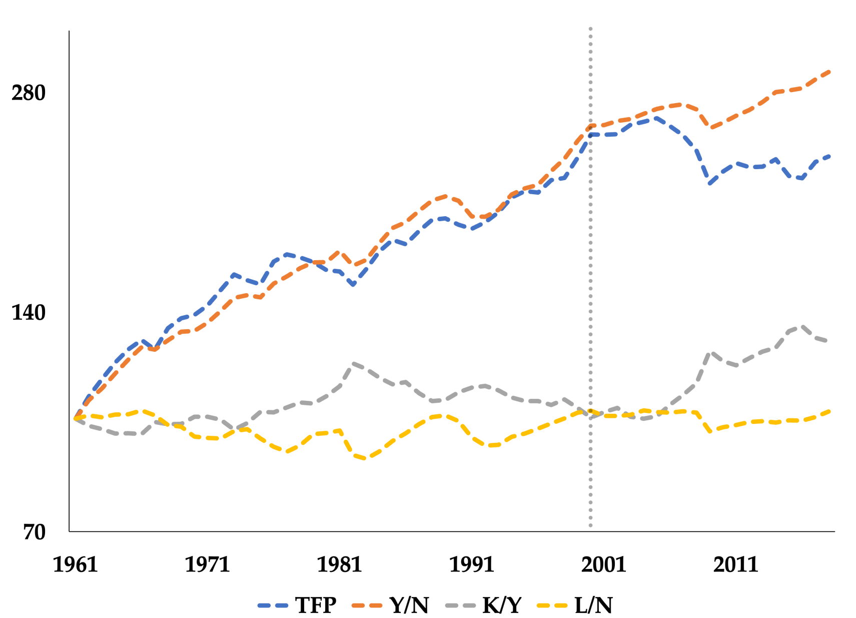


Figure 13: Robustness: Net-of-other-Mining



we performed an alternative decomposition using the benchmark α value on the net-of-Oil economy, and the resulting picture is very similar to the one in the main text. Figure 14 shows the decomposition. Therefore, we can conclude that the difference in TFP growth between the whole economy and the economy net-of-Oil is not an artifact of the parameter value α used in our analysis.

Figure 14: Robustness: Alternative α.