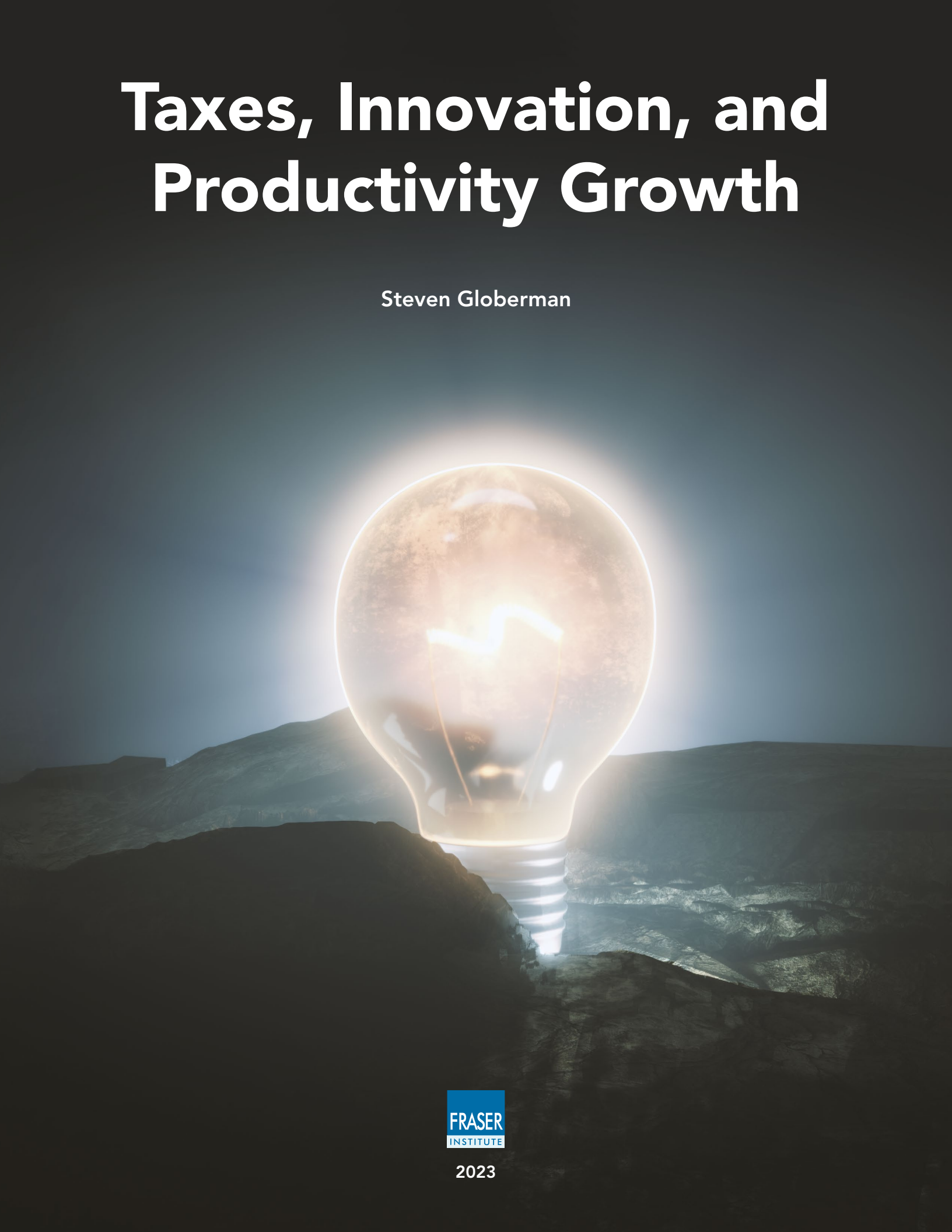
Taxes, Innovation, and Productivity Growth

Steven Globerman



FRASER INSTITUTE

2023

Contents

Executive Summary

The relationship between a nation's tax policy and its standard of living has been a longstanding topic of debate. While many economists and policy analysts argue that higher taxes discourage real economic growth, others reject the argument or claim that taxes are a relatively unimportant influence on standards of living compared to other determinants such as physical infrastructure.

Empirical studies document the critical role that technological change plays in improving the productivity of labour and capital, while improved productivity underlies increases in the real incomes of domestic factors of production. Technological change is broadly equivalent to innovation, where the latter can be thought of as the creation, introduction, and widespread commercial use of new knowledge that takes the form of new products, new production and distribution techniques, and new ways of organizing production and distribution activities.

Innovation is the main underlying contributor to improved total factor productivity (TFP) and, therefore, to higher standards of living. Hence, the influence of tax policy on the quantity and quality of innovation activity is an important public policy issue.

Tax policy encompasses the economic activities and payments to factors of production that are subject to taxation, the tax rates that are applied, particularly the progressivity of the relevant tax schedule, and the exemptions, deductions, and credits that are applicable to specific activities or sources of income.

Innovation activities are inherently risky and will be undertaken by private sector organizations only if the expected risk-adjusted returns from the relevant investments exceed the costs of capital for those organizations. Likewise, individuals involved in the innovation process, such as scientists and engineers, will invest in education and other training needed to participate effectively in innovation activities only if the expected returns to the necessary investments in human capital exceed the associated costs.

For all private sector organizations and individual entrepreneurs, scientists, and other participants in innovation activities, the relevant payoffs are net of taxes. Hence, a relatively straightforward insight is that higher taxes will discourage innovation, at the margin. However, the mag-

nitude of the relationship between taxes and innovation is an empirical issue. A related empirical issue is whether tax credits for activities such as research and development (R&D) are more effective at promoting innovation than reductions in general corporate and personal income taxes.

This essay reviews the relevant literature and documents the negative effect that higher corporate and personal income taxes have on innovation, where the latter is most typically measured by patenting activity. Entrepreneurship, as typically measured by business start-ups, is a less frequently used measure of innovation whose link to taxes has also been studied. As in the case of patenting, higher corporate and personal income taxes are found to discourage innovation, although the empirical relationship is not as strong as it is when patenting is used as the measure of innovation. Also, the effect of tax increases on innovation appears to be stronger than that of tax decreases. The strongest impact of innovation seems to come from marginal tax rate increases on high-income earners.

Companies and high-income earners, where the latter include "star" scientists, are geographically mobile. Hence, increasing marginal tax rates in specific geographical jurisdictions will reduce innovation activities in those jurisdictions by encouraging out-migration of companies and star scientists to jurisdictions with lower marginal tax rates.

Empirical studies also show that R&D tax credits and direct government grants for innovation activities do encourage increased R&D spending and other investments in innovation, at the margin. However, governments, including the Canadian government, typically target R&D tax credits and grants to small and medium-sized firms that produce fewer innovations per dollar of R&D spending than larger firms. In addition, R&D is only one activity in the chain of activities contributing to technological change. Hence, tax credits and grants aimed at promoting R&D do not address incentives to commercialize the new knowledge created by R&D, while government subsidies to promote innovation activities more broadly involve bureaucrats choosing the firms and industrial sectors that will be subsidized, which is less efficient than having capital markets determine the allocation of funding for innovation.

Canada has had an undistinguished record of innovation performance compared to other advanced economies. Its relatively poor performance in innovation is consistent with its uncompetitive tax environment. The Tax Foundation identifies Canada as having relatively uncompetitive corporate and personal income tax environments compared to other wealthy countries that rank higher in innovation performance. Of particular concern is the decline in Canada's tax competitiveness ranking relative to that of the US in recent years. Given the substantial cross-border migration of highly educated individuals between Canada and the US, as well as

the large amount of cross-border corporate investment, a less attractive tax environment in Canada relative to the US is a significant potential handicap to increased innovation in Canada.

Introduction

> *On the one hand, taxation is an essential attribute of commercial society… on the other hand, it is inevitably… an injury to the production process.*
> –Schumpeter, 1942: 198

The preceding quote highlights an ongoing debate among both economists and policymakers regarding the "appropriate" system of taxation. This debate takes various forms, but perhaps the most notable form is the controversy surrounding "supply-side" economics. The controversy resurfaced as recently as September 2022 when Great Britain's new prime minister, Liz Truss, announced the biggest set of tax reductions for that country since the 1970s (Reid, 2022, September 29). The announcement created a firestorm of protests from many economists, investment managers, and even the Bank of England as being reckless and likely to exacerbate inflation as well as increase government deficits. A reduction in the marginal income tax rate for the highest income earners came in for particular criticism as an unnecessary giveaway to the wealthy. Truss defended the broad-based tax reduction as a measure to encourage people to work and set up their own businesses, which, in turn, would promote future economic growth.[1]

To be sure, much of the criticism of Truss' proposed tax reductions was focused on the timing of the proposal. Specifically, critics argued that in a period of inflation, tax reductions would increase spending in the short run which would exacerbate inflationary pressures. The longer-run effect of lower taxes on economic growth did not figure prominently in the debate surrounding Truss' proposal. However, there has been long-standing skepticism about the efficacy of reducing personal and corporate tax rates in order to encourage long-run economic growth. For example, Ettinger and Linden (2012) acknowledge that tax policy can influence private

[1] In the face of spirited criticism and adverse reactions in the bond and foreign exchange markets, Truss subsequently announced that she was canceling the planned tax reduction for the highest income earners. Her resignation followed shortly thereafter.

sector decisions by changing incentives to work and invest. However, they question the practical importance for investment and economic growth of reducing tax rates, particularly the tax rates of upper-income taxpayers. Others question whether tax reductions in the past have had any positive effect on economic growth.[2] To be sure, still others interpret the available evidence as demonstrating that tax cuts have positive effects on real economic growth, while the strength of the effect depends on which taxes are cut, for whom, and when.[3]

Given the importance of tax policy and the voluminous literature on the economic effects of jurisdictions' overall tax structures and tax rates, the controversy surrounding the relationship between tax policy and real economic growth is, on the surface, surprising. However, as Durante (2021, May 21) and others discuss, identifying the relationship between changes in tax policy and real economic growth is empirically quite challenging.[4] Nevertheless, the importance of the relationship to public policy makes it worthy of continued study and evaluation. This paper attempts to add to our understanding of how changes in tax policy affect the growth rate of real per capita income. The latter is arguably a more relevant measure of a country's standard of living than changes in real GDP, since it implicitly "nets out" the growth in a country's workforce as a standard of living measure.[5] Economic growth that relies on commensurate increases in inputs such as labour does not equate to improved economic welfare, since economic welfare increases when a society can consume more tangible and non-tangible goods and services without needing to work longer hours or forego present consumption in order to save more to finance capital investments.

Gross Domestic Income (GDI) represents the income generated by all productive inputs employed in a country including labour and capital. Hence, increases in GDI per person will reflect increases in payments to all factors of production relative to the population. Increases in GDI per person therefore depend on increases in the overall productivity of labour and

[2] For example, Hope and Limberg (2020) argue that tax cuts enacted by advanced economies over the past five decades have had no measurable effect on real GDP per capita.

[3] See, for example, Durante (2021, May 21).

[4] The next section of this essay will briefly discuss the empirical challenges in identifying the relationship between tax policies and real economic growth.

[5] Real domestic income per capita is closely related to real GDP per capita, since the value of output produced is distributed as income to factors of production such as labour and capital. The two concepts are not identical because some payments for output produced domestically may be made to foreigners, e.g., shareholders of foreign-owned companies.

capital, which is referred to as total factor productivity (TFP). The latter is a measure of how much real output can be produced for given quantities of labour and capital. TFP increases therefore result in increased incomes per capita, since more real output is produced given the quantity of inputs used, which means that those inputs earn higher incomes.[6]

This essay therefore focuses on how a jurisdiction's tax regime is related to changes in total factor productivity. In particular, it reviews available theory and evidence concerned with how tax policy affects innovation, which is the main long-run determinant of changes in TFP. A jurisdiction's tax regime encompasses the economic activities that are taxed, and the rates applied to the various taxed activities.

The essay proceeds as follows. The next section discusses the conceptual and empirical determinants of TFP identified in the literature. This literature highlights the importance of innovation, broadly defined, as arguably the key contributor to TFP growth. Section 3 provides a conceptual analysis of the linkage between tax policy and innovation, while Section 4 reviews and summarizes empirical evidence on the linkages between tax policy and innovation. Section 5 provides evidence from league tables identifying Canada's innovation performance over approximately the past decade, as well as how its tax regime compares to those of countries that are leading locations for innovation. The final section offers concluding comments.

[6] In the case of capital, income takes the form of interest payments and profits. Hall and Jones (1999) show that differences in total factor productivity, rather than differences in the accumulation of factors of production, are the key explanation of cross-country variations in income levels.

Determinants of Total Factor Productivity Growth

There is a substantial empirical literature concerning the determinants of total factor productivity growth, and it is beyond the scope of this essay to provide a comprehensive review of the relevant literature. However, a number of studies provide comprehensive literature reviews, and this section of the study summarizes several of the relevant reviews.

Kim and Loayza (2019) identify the main determinants of productivity using data spanning the period 1985-2015 for more than 100 countries. Specifically, they identify five determinants: innovation, education, market efficiency, infrastructure, and institutions. Among OECD countries, their statistical analysis shows that the highest contribution among the determinants to the variation in TFP growth comes from market efficiency. Innovation encompasses the creation and adoption of new technologies. Education is related to the knowledge and skills of the population acquired as part of formal schooling and informal on-the-job learning. An educated population contributes to both the creation and faster adoption of new technologies, particularly since a more educated workforce can more easily assimilate new technologies. Market efficiency is defined as the efficient allocation of resources across firms and industrial sectors. In practice, market efficiency is promoted by the entry and growth of more productive organizations and the contraction and exit from the market of less productive organizations, a phenomenon clearly related to entrepreneurship. Infrastructure includes physical capital in sectors such as transportation, telecommunications, energy, water, and sanitation. Finally, the category of institutions covers a range of governance features such as the regulatory and judicial systems of a country, particularly as they influence property rights and civil rights. Each of the five determinants is positively related to TFP growth.

Isakkson (2003) provides a review of micro, sectoral, and macro studies of the determinants of TFP growth. Because the Isakkson study focuses on the levels of the firm and the industry, as well as the country, one should not expect perfect correspondence between Isakkson's conclusions and those of Kim and Loayza. However, Isakkson also identifies education, infrastructure, market efficiency, and institutions as positive determinants

of TFP growth. While Isakkson does not mention innovation explicitly, he does identify the capacity to absorb new technology, which is an aspect of the innovation phenomenon as noted above.[7]

Saleem, et al. (2019) explicitly claim that innovation contributes significantly to TFP growth.[8] They cite research and development capability as an important underlying contributor to innovation through the creation of knowledge and openness to international trade and foreign direct investment as promoting the transmission and use of new technologies in organizations. Inward foreign direct investment is a vehicle for introducing new technology and management techniques into a country, while imports are a vehicle for bringing new production inputs, particularly machinery and equipment that embody new technology, into domestic organizations. Saleem et al. also emphasize the role of human capital, including formal education, as augmenting a country's capability to create and use new technology. Finally, they mention the regulatory system and other governance institutions as factors conditioning the rate of TFP growth.

Whelan (2021) also identifies the invention and use of new technologies as the primary source of TFP growth based on a review of many models of economic growth. In particular, new technologies increase the productivity of physical capital which in turn contributes to continued real economic growth. Hence, capital accumulation embodying newer technologies is an important feature of the innovation process. Whelan also makes the important point that no country uses only technologies that were invented in that country. Hence, especially in relatively small economies such as Canada's, the willingness and ability to identify and use new technologies play a key role in determining productivity growth. He further notes that institutions help drive the pace of technology adoption. Relevant institutions include the legal and regulatory environment, the tax system, and services provided by government, as well as the political setting that determines those institutions.

In summary, the literature identifies a set of interrelated factors that influence TFP growth. Innovation, particularly the introduction and widespread adoption of new technologies, is a prominent contributor to TFP growth. Both the creation of new technologies and their use is promoted by a relatively highly educated workforce, as well as by investment in physical capital. Institutional governance at the national level, including a country's laws, regulations, and enforcement of property rights can

[7] Isakkson (2007) highlights investment in physical capital as an important contributor to an improved capacity of firms and economies to absorb new technology.

[8] Akcigit and Stantcheva (2020) assert that innovation is the source of technological progress and the main driver of economic growth in the long run.

directly affect TFP growth, as well as influence the creation and adoption of new technologies. Public policies that impede the entry and growth of relatively efficient organizations and that protect the market shares of relatively inefficient incumbent organizations obviously directly affect TFP growth. They can also indirectly affect TFP growth to the extent that such interferences into the competitive process discourage firms from taking risks on new technologies in order to enter and grow their market shares and their profitability.

While the literature on TFP growth in some cases acknowledges the tax structure as being a conditioning factor in the TFP process, the role of taxes is often implicitly subsumed as one of a number of institutional features of a country that are relevant to TFP growth. The studies that this section of the paper summarizes do not discuss how taxes condition economic behaviour that, in turn, influences TFP growth. However, to the extent that the tax structure significantly affects the creation and use of new technologies, it is likely to be an important institutional feature affecting TFP growth. Therefore, in the next section of this study we discuss the conceptual linkages between tax structure and innovation. As well, we review some available empirical evidence on the linkages identified.

Tax Policy and Innovation: A Conceptual Framework

Tax policy can affect innovation on various margins.[9] In this regard, it is a useful simplification to think of the innovation process as beginning with formal or informal research and development, which is the main source of new or improved products, production processes, and organizational governance that, in turn, are introduced into initial use and subsequently adopted on a more widespread basis. The adoption—or diffusion—of innovations is typically accompanied by improvements that make the innovations more economically valuable.

One important potential channel linking taxes to innovation is therefore the impact of taxes on research and development (R&D) including the amount of formal and informal R&D that individuals and organizations undertake, as well as the quantity and quality of the R&D outputs produced. Human capital, most typically embodied in formally educated scientists and engineers, is a critical input to the R&D process. Hence, taxes can influence both the amount and "quality" of R&D by affecting the supply of skilled scientists and engineers.

A second important potential channel linking taxes to innovation is the impact of taxes on the incentives of organizations to introduce and distribute new products and to adopt new production processes, techniques, and organizational structures. In turn, the introduction and spread of new technologies is facilitated by investment in physical capital as new technologies and intellectual property products such as software are typically embodied in newer vintages of capital equipment. It is also promoted by new firm start-ups (or entrepreneurship), as start-up organizations are frequently the first to introduce or adopt new technologies (Mohnen, 2022). A relatively well-trained labour force that is capable of adapting to new technologies also promotes the widespread use of those technologies.

A third potential channel is the infrastructure of an economy including government and university facilities that carry out basic research and that provide general scientific and technical education and training that,

[9] Akcigit and Stantcheva (2020) discuss various potential channels through which taxes can affect innovation.

in turn, increase the underlying knowledge base for applied research and development in the private sector, as well as the supply of scientists and engineers available to private sector organizations that can then provide education and training of an organizational-specific nature. In this case, taxes are linked to innovation by providing a source of funding for basic research, general education, and other infrastructure features financed by government such as the rule of law, public safety, and public health.

Tax policy is complex. In broad terms, tax policy encompasses the activities and payments to factors of production that are subject to taxation, the tax rates that are applied, particularly the progressivity of the relevant tax schedule, and the relevant exemptions, deductions, and credits that are applicable to specific activities or sources of income.[10] In principle, tax policy also should include so-called tax expenditures. These are fiscal subsidies that are provided either to specific taxpaying entities or for specific activities such as R&D.

As noted above, any activity or set of activities associated with innovation typically involves expenditures on physical and human capital to create and implement new technologies that promise to improve TFP in the future. As such, expenditures on promoting innovation can be seen as investments with uncertain outcomes. Private sector firms will make specific investments in innovation as long as the risk-adjusted expected rates of return on those investments exceed their costs of capital. The expected rate of return is the expected revenues associated with the relevant expenditures on innovation minus the expenditures discounted to a present value.[11] The cost of capital, in turn, is the cost of debt capital plus the cost of equity capital weighted by the respective shares of debt and equity in a firm's overall capital structure. The relevant expected return is the return net of taxes.

In this context, a relatively straightforward inference is that increasing taxes on corporate profits should reduce corporate expenditures on innovation, including expenditures for business start-ups, since it will reduce the expected returns from successful innovation activities, other things constant. Conversely, reducing corporate income taxes should promote increased innovation activity. Less straightforward is the relationship between innovation and personal income taxes.

For self-employed individuals involved in one or more stages of the innovation process, increasing personal income taxes should discour-

[10] Depreciation allowances on physical capital such as machinery and equipment and on intellectual property products such as software are examples.

[11] In principle, the discount rate should reflect the time value of money as well as the risk associated with specific innovation projects.

age their participation in innovation in part for similar reasons as applied to corporate income taxes. The income an entrepreneur earns from a business venture will typically include personal income. An increase in personal taxes will therefore reduce the total expected return to starting businesses by reducing the return to an entrepreneur's expected imputed labour income net of taxes.

Higher personal taxes can also reduce innovation activity in a geographical jurisdiction by reducing the supply of human capital used in various stages of the innovation process. For example, individuals might choose to leave higher tax jurisdictions for lower tax jurisdictions which implies reduced innovation activity in the higher tax jurisdiction. More generally, expected disposable incomes may play a large role in the decisions of individuals to enter an occupation with high up-front costs associated with obtaining necessary skills, such as in the case of scientists and engineers.[12] Hence, especially as top marginal tax rates increase, individuals may decide against working in activities related to the innovation process, such as in research and development, given relatively low expected returns to investing in acquiring the necessary human capital (see Watson and Kaeding, 2019). Increased personal income taxes may also reduce innovation activities that organizations undertake to the extent that those organizations must pay higher salaries to employees engaged in innovation in order to compensate the latter for higher personal income taxes.

Another straightforward inference is that allowing tax deductions for inputs used in innovation-related activities mitigates the negative effect of corporate and personal income taxes on those activities. However, even full deductibility does not eliminate the negative effect, since there will still be residual taxation of the profits that organizations earn from innovation. Less clear is the impact of tax expenditures such as R&D grants and innovation-related tax credits on innovation. On the one hand, tax-related subsidies to an activity should encourage more of that activity, other things constant. On the other hand, such subsidies might simply be used to substitute for investments in innovation that firms would have otherwise made from their own financial capital.

Tax changes can also affect innovation activities that businesses undertake to the extent that such changes affect the capability of firms to fund innovation through retained earnings. The latter may be a cheaper source of financing than funds raised through borrowing or selling shares in capital markets. If this is the case, tax increases will reduce the financial ability of firms to fund innovation through retained earnings and will, consequently, discourage innovation activities at the margin.

[12] Trostel (1993) discusses how higher personal tax rates discourage investments in human capital.

The conceptual relationship between corporate and personal income tax burdens and risk-taking becomes more complicated when the tax schedules are nonlinear and losses can be fully deducted against profits or, if investors do not have sufficient profits from other activities against which to deduct losses, they receive negotiable tax credits that fully offset financial losses from the relevant innovation activities. If investors are risk-averse and the tax schedule is sufficiently progressive, it is theoretically possible for higher taxes to encourage risk-taking activity. This is because the protection against losses provided by the tax scheme is worth more on a utility-adjusted basis than the loss in expected profits to taxes in the event that risk-taking is financially successful (Bruce, Gurley Calvez and Norwood, 2020). However, this theoretical caveat is relevant only if the overall tax burden on investors is unaffected by changes in the tax rate schedule. This is unlikely to be the case if tax rates are increased for specific income brackets, since presumably governments increase tax rates to raise more tax revenue.

In short, while the direction that increases or decreases in taxes and tax expenditures will have on innovation activities is relatively clear conceptually, the relationship is ultimately an empirical issue given the theoretical potential for higher taxes to encourage risk-taking. As well, the magnitudes of the responses to specific changes in the tax code are empirical questions (Akcigit and Stantcheva, 2020). Identifying the magnitude of the responses is a challenging task. For one thing, the expected returns to investments in innovation made by private sector organizations will depend, in part, on infrastructure investments often made by governments as discussed briefly earlier. Hence, it is not simply taxes that influence incentives to innovate but also how governments spend the tax revenues they collect. For another, since innovation is an investment-type activity whose returns are realized in the future, investors must form expectations about the future tax environment, among other things. A specific issue in this regard is the extent to which investors view government deficits as future tax liabilities that will likely lead to future tax increases. If government deficits are viewed by investors as future tax obligations, the accumulated value of outstanding government debt will influence decisions about investing in innovation, but when and how the requisite tax revenues will be collected are uncertain to investors. Therefore, relating innovation activities to the tax system involves assumptions about how individuals and organizations view their future tax obligations.[13]

The magnitude of tax-related impacts on innovation will also depend upon the unit of analysis chosen to study. In particular, the impacts are

[13] Akcigit and Stantcheva (2020) provide some evidence that companies and individuals tend to rely on current tax rates as predictors of future tax rates.

likely to be larger the smaller the unit of analysis. For example, if a single province in Canada increases general taxes, many would-be entrepreneurs who might have located their start-up organizations in that province will choose to locate their start-ups in another province. Likewise, many scientists and engineers might choose to locate or relocate in another province. While location choices at the national level will also be affected by differences in general tax rates across countries, relocating between countries is obviously more costly and difficult than relocating between provinces.

In the following section, we review seminal empirical studies of the linkage between jurisdictional tax systems and innovation activity levels, as well as innovation performance. While our primary interest is on the linkage at the national level, a number of key studies focus on the linkages at the sub-national or firm level. While the magnitude of the relevant linkage will depend upon the level of aggregation, sub-national studies can provide important insights into the likely linkage at the national level.[14] Given the very large literature on this relationship broadly viewed, as well as on specific elements of the relationship such as the impact of taxes and tax expenditures on R&D performance and outcomes, the review cannot be comprehensive. However, there is sufficient consistency across studies to draw some broad conclusions, notwithstanding the conceptual and statistical challenges associated with empirical evaluations of the linkage.

[14] For example, if skilled scientists and engineers do not migrate across states or provinces given significant differences in income tax rates, they are unlikely to migrate across countries given similar differences in income tax rates.

Summary of the Empirical Literature

Figure 1 summarizes one sub-set of empirical studies that examine the relationship between taxes and innovation that are reviewed below. An important point to highlight from figure 1 is the variety of indicators of the quantity and "quality" of innovation that are employed in empirical studies of the relationship between taxation and innovation. Some studies use the number of patents filed as a measure of the quantity of innovation, while others use the number of citations to individual patents as a measure of the quality of innovation. Some other cases use the number of establishments as a measure of innovation, as an increase in the number of establishments is viewed as a proxy measure of entrepreneurship. Yet other studies use spending on R&D or the number of R&D personnel as proxy measures of innovation. Any measure of innovation is subject to qualifications and criticisms.[15] However, the consistency of findings across a broad number of studies mitigates concerns about the lack of any single universally accepted measure of innovation.

A predominant share of the available studies this section summarizes focus on innovation in the United States, particularly at the state level. This empirical focus is driven both by the availability of comparable data, as well as the imperative to generate a relatively large sample of observations where tax rates differ across the observations. In the various studies reviewed, the authors attempt to hold constant other factors potentially influencing innovation besides differences in tax rates, such as general economic conditions. However, since available studies tend to use data covering different time periods, as well as different empirical specifications and estimation techniques, it is difficult, as a practical matter, to compare

[15] Capital investment is a significant channel for innovation, and there is a large literature on the relationship between taxes and investments in physical and human capital. However, since much capital investment is not directly undertaken as part of what are traditional innovation activities, this study does not review that literature. For a seminal study on tax structure and investment behaviour, see Hall and Jorgenson (1967).

Figure 1: Summary of Literature Linking Taxes to Innovation

Author(s)	Innovation Measure	Tax Measure	Unit	Impact
Akcigit, et.al.	Patent numbers and citations	Corporate and personal	US states	Significant negative impact on patent numbers
Lichter, et.al.	R&D spending; patent numbers and citations	Business	German plants	Significant negative impact on R&D, patent numbers, and citations
Balsalobre-Lorente, et. al.	Innovation Index from The Global Economy	Corporate tax and corporate tax rate	OECD countries	Significant negative impact of tax rate and number of taxes
Mukherjee, et.al.	R&D spending; patent numbers; innovation output	Corporate taxes	US states	Negative impact of higher taxes on all measures of innovation
Atanassov and Liu	Patent numbers and citations	Corporate taxes	US states	Negative impact of higher taxes and positive impact of lower taxes on both measures
Dimitriva and Eswan	Patent numbers and citations for start-up companies	Capital gains tax on VC companies	US states	Negative impact of higher prices on both measures
Gentry and Hubbard	Entry into self-employment; entry into business ownership	Marginal income tax rate	Individuals and households	Progressive marginal tax rates discourage entry
Block	Number of start-ups relative to incumbent firms	Corporate taxes paid as a share of profits	Countries	Negative relationship between corporate tax burden and entrepreneurship

Source: See References.

estimated tax elasticities across studies.[16] Nevertheless, the studies that figure 1 summarizes report the consistent finding that higher income and corporate taxes discourage innovation, where the latter is measured in various ways.

[16] A tax elasticity can be interpreted as the percentage reduction in the quantity or quality of innovation output for a given percentage change in the relevant tax rate.

In one recent study, Akcigit, et al. (2022) examine the relationship between tax rates in different US states and the quantity and quality of patenting activity for individual inventors and individual firms.[17] They find that both corporate and personal income taxes adversely affect the quantity and quality of innovation as measured by patenting and patent citations. That is, patenting quantity and quality by individual inventors and firms were lower in states with higher corporate and personal income taxes than in states with lower taxes. The estimated tax elasticities are relatively large. For example, at the individual inventor level a 10 percent increase in personal income taxes reduced patents produced by 6 percent and patent quality to a similar extent. At the state level the tax elasticities are substantially larger—close to twice the estimated elasticities at the individual inventor and corporate levels.

Lichter, et al. (2021) use a data sample which approximately covers the universe of plants in Germany that carry out R&D. They look at the impact of changes in municipal business tax rates over the period 1987-2013 on R&D performance and the citation-weighted numbers of patents. They identify a negative and statistically significant relationship between higher business tax rates and R&D spending by individual plants with an implied long-run elasticity of -1.25.[18] They also show that tax-induced reductions in R&D expenditures are accompanied by lower innovation output as measured by both new patent application numbers and by citation-weighted numbers of patents. The long-run tax elasticity with respect to number of patents is -0.9, which is close to Ackcigit et al.'s estimate (2022).

Atanassov and Liu (2019) also measure innovation output by number of patents and citation-weighted number of patents. They look at the relationship between corporate income tax reductions at the state-level in the US from 1988 to 2006 and innovation output by firms located in the individual states. They find that relatively large corporate income tax reductions boost corporate innovation, while corporate income tax increases have a quantitatively comparable negative impact on innovation output.

Mukherjee, Singh, and Zaldokas (2017) use a set of measures to show that an increase in corporate taxes reduces future innovation. They look at the effect of changes in corporate tax rates on R&D expenditures, patents, and a measure of new product introductions. Specifically, they look at income tax changes at the state level in the US from 1990 to 2006. They estimate that about 67 percent of those firms experiencing a tax

[17] Personal tax rates are applied to individual inventors and corporate tax rates are applied to individual firms. Patent quality is measured by the number of citations accorded individual patents.

[18] This implies that a 1 percent higher municipal profits tax is associated with a 1.25 percent reduction in R&D expenditures by the average plant in the municipality.

increase filed for approximately one fewer patent following the increase, as compared to firms in a neighbouring state that were not affected by any tax change. This amounts to approximately a 5 percent change in patenting activity. The drop in patenting is accompanied by comparable declines in R&D expenditures and new product introductions. The authors also tested separately for the effects of tax increases and decreases and found that most of the overall tax change effect comes from tax increases.[19]

Balsalobre-Lorente et al. (2021) use a broad measure of the environment for innovation for a sample of 36 OECD countries between 2000 and 2018. The measure they use is the World Intellectual Property Organization's Global Innovation Index (GII). The GII is a composite of different indicators including scientific publications, R&D expenditures, patent filings, venture capital activity, and others. The authors relate the corporate tax rate and the number of taxes paid by businesses to the innovation index and find that there is a negative association between the tax measures and a country's performance according to the GII.

Figure 1 also summarizes several studies that examine the relationship between taxes and indicators of entrepreneurial activity. Dimitrova and Eswar (2022) examine the effect of changes in state-level capital gains tax on the patenting activity of venture capital start-ups. The largest share of the typical VC's funding comes from pension funds and foundations which are tax-exempt in the US. However, general partners are taxed as individuals and are therefore affected by the capital gains tax. Their data set comprises over 5,000 predominantly private, US-backed start-ups. A portion of the start-ups are those where their lead VC firm is in a state that is affected by a capital gains tax change. The remainder of the sample consists of firms where their lead VC firm is in a state that is not affected by a tax change. They find that an increase in the capital gains tax leads to a decrease in the quantity and quality of start-ups' innovations as measured by the patent count and citation-weighted patents, respectively.[20] The authors argue that VC firms respond to higher taxes by reducing the supply of financial capital and advice to start-ups and that less investment and engagement by VC firms results in reduced innovation by start-ups.

Gentry and Hubbard (2000) evaluate the link between taxes and entrepreneurship by examining the relationship between personal income tax rates and the rates of self-employment of individuals and individual

[19] Akcigit and Stantcheva (2020) argue that tax decreases will have a smaller effect on innovation than tax increases in part because lower taxes will only matter for firms that have some significant actual or anticipated market share.

[20] The estimated elasticity of patents to changes in the capital gains tax for VC firms is -0.45 to -0.75. This means that a 10 percent increase in the capital gains tax results in a decrease in patenting of between 4.5 and 7.5 percent.

households. Specifically, they focus on the tax schedules that individuals face from 1978 to 1993. They do not find general support for the hypothesis that the average level of the personal income tax rate affects entry into self-employment. However, they find that progressive marginal tax rates do discourage entry into self-employment and into business ownership. They rationalize the finding on the grounds that with progressive tax rates, the government claims a larger share of payoffs from successful entrepreneurs than it does from less successful entrepreneurs. This asymmetric treatment of outcomes from taking risk discourages entrepreneurial ventures at the margin.

Block (2021) identifies a negative relationship between entrepreneurship entry rates measured as the number of newly registered firms relative to the number of incumbents and the effective corporate tax rate for a sample of 34 countries. He also provides a review of several other studies that examine the relationship between different measures of corporate taxes and entrepreneurship. He summarizes these studies as identifying a negative and statistically significant relationship between a higher corporate tax burden and entrepreneurship, although the economic effect of a higher corporate tax burden on entrepreneurship is modest. However, a higher top corporate tax rate has a more substantial quantitative effect on entrepreneurship than a higher average tax rate. Block also notes that high levels of corporate income taxes are particularly related in a negative fashion to the entry of relatively innovative start-up firms. In another review of recent academic research, Hedlund (2019) summarizes the research as showing that higher income tax rates adversely influence innovation generally and entrepreneurship specifically. In contrast, Bruce, Gurley-Calvez, and Norwood (2020) summarize the empirical literature linking tax rates to small business activity as inconclusive with some studies finding a negative relationship and others finding a positive relationship.[21]

In summary, the available evidence broadly supports the conclusion that higher general taxes, particularly corporate taxes, discourage innovation measured in various ways. Most of the studies listed in Figure 1 make comparisons between the corporate tax rates in different geographical locations and patenting activity and patent quality by companies in the various locations. The negative relationship between corporate taxes and innovation reflects, in part, reduced investment in risky activities at various stages of the innovation process. It can also reflect the movement of

[21] Time (2019) also concludes that the precise effect of raising or lowering tax rates remains nebulous when it comes to entrepreneurship, although he argues that most observers agree a simpler tax code would be beneficial for entrepreneurship by reducing costs associated with understanding a complex tax system.

Figure 2: Summary of Literature Linking Taxes to Mobility of Star Scientists

Authors	Innovation Measure(s)	Tax Measure(s)	Unit	Impact
Akcigit, et.al.	Location of star scientists	Top personal marginal tax rate	US and Europe	Negative impact of top rate on share of stars
Moretti and Wilson (2014)	Location of biotech scientists	R&D tax incentives	US states	Positive impact on location
Moretti and Wilson (2015)	Location of star scientists	Personal and corporate taxes; investment tax credit	US states	Negative impact of general taxes; positive impact of tax credit
Moretti and Wilson (2017)	Location of star scientists	Personal and business ttax differentials	US states	Migration from high to low tax states
Moretti and Wilson (2017)	Location of star scientists	Investment and R&D tax ccredits	US states	Positive effects on location

Source: See References.

companies from higher to lower tax jurisdictions. In this regard, another margin along which taxes can affect innovation is by causing a reduced supply of inventors in a given location. In particular, relatively high personal income tax rates can contribute to a "brain drain" of highly skilled scientists and engineers.

Figure 2 summarizes several studies that examine the relationship between personal income tax rates and the geographical mobility of scientists and engineers. Some of the effect of taxes on innovation identified in the studies summarized in figure 1 reflects the direct or indirect relocation of scientific personnel related to higher personal or corporate taxes. The studies that figure 2 summarizes explicitly identify the impact of personal and corporate taxes, as well as R&D and investment tax credits on the location choices of "star" scientists. The latter are typically identified as the top 1 percent in terms of patent citations. The returns to inventors are highly skewed with the top 1 percent of inventors collecting more than 22 percent of total inventors' income (Bell et al., 2019). Hence, the most relevant personal tax rate is the highest marginal rate given the relatively large incomes that star scientists earn.

Given the small number of relevant studies and the focus of those studies on the mobility of star scientists between US states, one must obviously be cautious in drawing conclusions for other jurisdictions, including Canada. Notwithstanding those cautions, the available studies identify the significant effect of relatively high marginal personal income tax rates on the location decisions of star scientists. That is, there is a significant amount of migration among top scientists from jurisdictions with relatively high top marginal personal income tax rates to jurisdictions with lower top marginal tax rates. Relatively high corporate tax rates are also linked to the outmigration of top scientists, while relatively generous investment tax credits attract star scientists.[22]

The small number of relevant studies, as well as the differences in model specifications, data sources, and estimation techniques make it difficult to summarize the estimated tax elasticities for the location decisions of top scientists. There is some consensus that the tax elasticity is higher for foreign-born inventors than for domestic inventors. For example, Akcigit et al. (2016) find that the baseline elasticity of the number of star domestic inventors to the top net of tax rate is small (around 0.3). This translates on average into an increase of 1 percent in domestic top 1 percent inventors at home for a 10 percentage-point decrease in the top marginal rate from a starting level of 60 percent. By contrast, the elasticity of the number of star 1 percent foreign inventors to the top net of tax rate is around 1, which translates into a 26 percent increase in foreign top 1 percent inventors for the same 10 percentage point decrease in the top tax rates.

There are certainly other factors besides taxes and tax credits that influence the location decisions of top scientists. In particular, participation in technology clusters, such as Silicon Valley, contributes to higher productivity among research scientists, which can offset the influence of higher personal tax rates in such clusters. Location in technology clusters can also increase the productivity and profitability of research-intensive companies which can offset the negative effect of higher corporate taxes on decisions of firms to locate research activities in relatively highly taxed clusters. In this regard, Bell et al. (2019) argue that exposure to innovation activity draws individuals who produce high-impact innovations into the innovation pipeline, while top income tax reductions have limited poten-

[22] The empirical evidence is less consistent regarding the effect of R&D tax credits on the mobility of star scientists. Moretti and Wilson (2014) identify a positive and statistically significant effect on the location decisions of biotech scientists, while Moretti and Wilson (2017) find no statistically significant relationship for a broader sample of star scientists.

tial to increase aggregate innovation because they only affect individuals who have already been exposed to innovation.[23]

Moretti and Wilson (2015) provide some evidence that the long-run elasticity of mobility of star scientists relative to taxes is smaller for scientists located in technology hubs, which gives some indirect empirical support to the thesis advanced by Bell et al. (2019). However, the effect of the migration of even relatively small numbers of star scientists into new geographical jurisdictions is amplified by the "magnet" effect of those scientists. Simply put, the arrival of star scientists in a location attracts new technology-intensive firms to that location, and those new companies will either hire additional scientists to work in the location or transfer scientists already employed to the new location. In this regard, Zucker and Darby (2014) follow the careers of 5,401 top nanoscale scientists working in 5 major areas of science and technology from 1981 to 2004. They find that the number of stars in a US region or in one of the top 25 science and technology countries generally has a consistently significant and qualitatively large positive effect on the probability of new firm entry in the same area of science and technology.

It is not a surprising empirical finding that higher personal and corporate tax rates, especially higher marginal tax rates, discourage innovation activity. What is more controversial is whether it is better to reduce—or at least not increase—general taxes in order to promote innovation rather than implement R&D tax credits or investment tax credits. Mohnen (2022) notes that in 2018, 30 out of 36 OECD countries provided some kind of tax support for business R&D expenditures. The typology of R&D tax incentives includes tax credits based on R&D and innovation and tax measures that are not based on R&D tax expenditures. Innovation expenditure includes acquisition of capital goods for innovation, design work, and the acquisition of rights to use patents and other intellectual property products (IPP).

The conceptual case for tax credits is that they can be targeted at specific activities such as R&D or specific categories of companies that might be more likely candidates to innovate given a lower effective tax rate. For this reason, some economists argue that tax credits can be a more efficient policy instrument to promote innovation than reductions in general taxes. This issue is relevant for Canada since, as Lester (2021) details, governments in Canada subsidize R&D performed by small firms at a much higher rate than R&D performed by large firms.[24] Specifically, the

[23] It should be noted that Bell et al. (2019) base their conclusion on a calibrated stylized model and not on direct evidence.

[24] Hall (2020) cites data for 42 countries with some type of tax scheme that reduces

federal government provides a 15 percent tax credit for R&D performed by large firms, while all small and medium-sized, Canadian-controlled private firms performing R&D receive a 35 percent subsidy in the form of a refundable tax credit. After accounting for provincial government programs, the average small-firm statutory subsidy rate on eligible R&D spending increases to 42 percent for small firms but only to 20 percent for large firms.

Lichter et al. (2021) compare the efficiency of general business taxes in Germany to affect firm-level R&D with targeted R&D policies. Their estimates imply that R&D expenses decrease by around €0.34 for a tax increase worth €1 in business tax revenues. Equivalent measures of targeted R&D tax incentives for the UK are much higher—between £1.0 and £1.7 of increased R&D spending for each £1.0 decrease in revenue. In short, Lichter et al. document more bang for the R&D tax credit buck than for the general tax buck.

Mohnen (2022) provides an extensive review of the relationship between R&D tax credits and R&D performance. For Mohnen, R&D tax expenditures include R&D allowances, tax credits, and R&D cost reductions. His study raises at least three issues. One is whether the tax subsidies encourage an overall increase in R&D expenditures or whether they simply replace some or all of the R&D expenditures that firms would have made from their own funds.[25] He concludes that most studies find a ratio equal to 1 or even below 1, in other words showing hardly any signs of additionality.[26] Nevertheless, he concludes that R&D tax incentives lead to more R&D and indirectly to more innovation. Likewise, he concludes that changes in general taxes affect innovation and R&D, although he notes that not as many studies have found as much of an effect with tax reductions as with tax increases.

A second and related issue is whether changes in general taxes to promote innovation could be made more efficient by targeting general tax reductions or tax increases to firms that are more or less likely to contribute to the innovation process. For example, Akcigit and Stantchova (2020) suggest that small firms find it more beneficial to engage in "external" research, which leads them to produce disproportionately many more

the cost of doing R&D. She reports that, in general, loss-making firms receive a slightly smaller subsidy, while small and medium-sized firms get a slightly larger subsidy.

25 This issue is referred to as additionality.

26 Mohnen (2022) does note that most studies find higher elasticities for small than for large firms. Hall (2020) reads the empirical evidence as suggesting that R&D tax credits are generally effective at increasing overall business R&D. Howell (2017) provides evidence that direct R&D funding from the US Department of Energy had large, positive effects on the patenting activity of firms receiving the grants.

radical, important innovations. Preferential tax rates and tax breaks for small firms can foster this phenomenon further and improve the quality of innovation and the prevalence of breakthrough innovations.[27]

The primary argument in favour of relying on general tax policies to promote innovation is that it leaves the choice of innovation activities, including R&D projects, up to the private sector instead of allowing the government to pick winning innovation strategies.[28] The historical experience of the Canadian government's past innovation initiatives leave little room for optimism about the success of top-down innovation strategies.[29] In particular, more favourable tax treatment that small and medium-sized firms enjoy may have harmed Canada's innovation performance. In this regard, Lester (2021) cites research showing that small firms generate much smaller knowledge spillovers from R&D per dollar of tax benefit than do larger firms.[30]

A third issue is whether tax measures targeted specifically at R&D expenditures are as effective in promoting the introduction and diffusion of innovations as general tax reductions, particularly at the high end of the personal income tax structure. As Jones (2022) notes, basic research uncovers fundamental truths about the world and is readily subsidized with government funding. Applied research turns those fundamental truths into consumer products or firm-level process innovations. The latter is the realm of entrepreneurs and may not be readily subsidized as formal R&D. Indeed, formal R&D is a small part of what economists would like to measure as innovative activity. Jones therefore concludes that the innovation that occurs beyond formal R&D is primarily influenced by the general tax system. High incomes are a prize that partly motivates entrepreneurs to turn basic insights into a product or process that ultimately benefits consumers. High marginal tax rates deter this effort and therefore reduce overall innovation.

In summary, higher general taxes, especially higher top marginal personal tax rates, contribute to decreases in the quantity and quality of

[27] A focus on small firms might be more appropriately assigned to new start-up firms. To be sure, the latter are typically small firms.

[28] In this regard, the Tax Foundation, which ranks the tax regimes of countries as more or less favourable to economic growth, considers R&D tax subsidies as an unfavourable feature. It argues that good tax policy treats economic decisions neutrally, neither encouraging nor discouraging one activity over another (see Bunn, 2022).

[29] See Globerman and Emes (2019) and Cross (2021) for discussions of this issue.

[30] Knowledge spillovers can be thought of as knowledge generated by the R&D carried out by specific firms that is used by third parties who do not financially compensate the R&D performers.

innovation, which, in turn, promote decreases in TFP and standards of living. Whether or not higher tax rates ultimately lead to lower tax revenues over time as a consequence of slower economic growth obviously depends upon the starting tax rate and the magnitude and time profile of the relevant tax changes.[31] If higher tax rates lead to higher tax revenues, there could be an offset to the negative impact of higher tax rates on innovation. Namely, more revenue would be available to governments to fund innovation-promoting activities of a general nature, such as increased funding of basic research and public education. However, revenues for those activities could be raised through consumption-related taxes that would be less damaging to private sector innovation or by reducing government spending on activities that do not contribute to improved economic growth.

[31] Slower economic growth shrinks the growth rate of the tax base.

Canada's Innovation Performance and Tax Competitiveness: Evidence from League Tables

The preceding review of empirical evidence supports the importance of relatively low corporate and personal tax rates to innovation performance. In particular, it underscores the negative effect of relatively high marginal personal tax rates on upper-income scientific and technical workers. In this section, we review evidence on Canada's international tax competitiveness. Before doing so, it is useful to review Canada's innovation performance in an international context.

As noted earlier, the Global Competitiveness Index provides one overall measure of the innovation performance of OECD countries. Table 1 reports the rankings of the top 15 countries in 2014 and the rankings of those countries in 2022.[32] What is particularly notable from table 1 is Canada's decline in ranking between the two years. This decline occurred despite the federal government's emphasis, especially since 2017, to improve Canada's environment for innovation.[33]

As discussed earlier in this study, there are numerous determinants of innovation besides a country's tax structure. Nevertheless, it would be consistent with the empirical literature to observe that Canada's tax environment became relatively less favourable to innovation from 2014 to 2022 consistent with its relative decline in innovation performance.[34]

The Tax Foundation provides one league table comparison of tax systems in OECD countries. The foundation's International Tax Competi-

[32] There were 34 countries in the OECD in 2014 and 36 countries in 2022.

[33] For a discussion of the Canadian government's recent initiatives to promote domestic innovation, see Globerman and Emes (2019).

[34] While this is a relatively short time period, studies have identified a relatively short lag between changes in taxes and changes in innovation measures. For example, Atanassov and Liu (2019) find that tax increases can measurably affect innovation as soon as two years after the increases, while Moretti and Wilson (2017) find changes in personal income tax rates can influence the location decisions of star scientists as soon as a year after the changes are implemented. To be sure, the full effect of a tax change accumulates over time.

Table 1: Innovation Rankings from the Global Innovation Index

	2014	2022
Switzerland	1	1
United Kingdom	2	4
Sweden	3	3
Finland	4	8
Netherlands	5	5
United States	6	2
Denmark	7	9
Luxembourg	8	16
Ireland	9	19
Canada	10	12
Germany	11	7
Norway	12	18
Israel	13	13
Korea	14	6
Australia	15	21

Sources: Dutta, Lanvin, and Wunsch-Vincent (2014; 2022).

tiveness Index looks at more than 40 tax policy variables encompassing five broad types of taxes: corporate, individual, consumption, property, and cross-border. Since the identified linkages between taxes and innovation are particularly relevant for corporate and individual taxes, we focus on the league table information it provides for those two categories of taxation.

The corporate tax league table reports an overall rank and numerical score for countries as well as ranks and scores for several subcategories including the corporate tax rate, rules for cost recovery including the depreciation of capital assets, and the complexity of the corporate tax code.[35] In fact, there is a relatively high rank order correlation between the various measures. For example, the Spearman Rank Order correlation coefficient between the overall country ranking and the ranking for the corporate tax rate in 2022 is .93.[36] This is almost a perfect relationship between the two

[35] See Bunn (2022) for a full discussion of the construction of the various league tables.

[36] The Spearman Rank Order correlation coefficient measures the correspondence in the ordinal rankings of the variables of interest. A value of 1 identifies a perfect

Table 2: Corporate Tax Overall Ranking and Ranking for Corporate Tax Rate

	2014		2022	
	Overall ranking for corporate taxes	Ranking for the corporate tax rate	Overall ranking for corporate taxes	Ranking for the corporate tax rate
Switzerland	3	4	5	3
United States	15	15	9	11
Sweden	2	5	2	5
United Kingdom	10	3	4	2
Netherlands	7	8	10	10
Korea	5	6	15	13
Germany	12	14	14	14
Finland	4	2	3	4
Denmark	6	7	8	6
Canada	8	9	12	12
Israel	13	10	7	8
Luxembourg	14	12	11	9
Norway	9	11	6	7
Ireland	1	1	1	1
Australia	11	13	13	15

Sources: Pomerleau and Lundeen (2014) and Bunn (2022)

measures. Hence, for simplicity, table 2 reports the rank orders for the overall country ranking for corporate taxes and the ranking for the corporate tax rate for 2014 and 2022. Countries that rank poorly overall on corporate taxes typically levy relatively high tax rates on corporate income or have multiple layers of tax rules that contribute to complexity.

The countries listed in table 2 are those that ranked in the top 15 OECD countries in terms of innovation in 2014 as reported in table 1. The first column in table 2 reports the overall ranking for corporate taxes in

correspondence in the rank orders. A value of zero indicates that there is no correspondence in the rank orders. Hence, the estimated correlation coefficient of .93 indicates that the overall ranking of the corporate tax system for the sample of countries almost perfectly matches the ranking by corporate tax rate. There is a weaker correlation between the corporate tax system overall and the complexity of the corporate tax system. Specifically, the Spearman Rank Order correlation coefficient between the two variables for 2022 is .38.

2014, while the second reports the rankings for the corporate tax rate in 2014. Columns 3 and 4 report similar information for 2022. Of particular interest is the decline in Canada's ranking between 2014 and 2022 for both measures.[37] To be sure, a number of countries dropped in the league table rankings between those two years. However, the US improved its comparative position quite markedly from 2014 to 2022 undoubtedly reflecting in part the corporate tax reductions implemented by the Trump Administration. The US improvement is particularly relevant for Canada given the relatively large volume of cross-border migration between the US and Canada for highly educated scientists and engineers, many of whom work in the corporate sector. In this regard, Akcigit et al. (2016) report that among inventors who migrate within this corridor, very few also migrate to another country. Specifically, among 863,406 US-born inventors, 640 were resident in Canada at some point in their careers, while only 35 resided in both Canada and some other country sometime in their careers. Among 44,321 Canadian-born inventors, 946 were resident only in the US at some point in their careers, while only 18 resided in both in the US and a third country.

The Tax Foundation's International Tax Competitiveness Index also reports a league table for the personal income tax. A country's overall score for its individual income tax is determined by three subcategories: the rate and progressivity of wage taxation, the extent to which a country's income tax system "double taxes" corporate income by taxing capital gains and dividend income, and by the complexity of the personal tax system. In broad terms, countries with high ratios of marginal tax rates to average tax rates are given lower overall scores than countries with flatter tax schedules. A country receives a better score for lower capital gains and dividend taxes. Complexity is measured by surtaxes on personal income and by the amount of social security contributions other than those collected through employer or employee payroll taxes (Bunn, 2022).

Columns 1 and 2 in table 3 report the overall personal income tax rankings for 2014 and 2022 for the top 15 innovating countries listed in tables 1 and 2. Columns 3 through 6 report rankings for two of the three subcategories that are of greatest relevance to innovation performance based on the earlier literature review. The latter are rankings for the income tax rate structure and the taxation of capital gains and dividends.[38]

[37] Chen and Mintz (2012) discuss improvements in the international competitiveness of Canada's corporate tax system from 2000 to 2012, although Canada had only the 20th most competitive corporate tax system in the 34 member OECD in 2012. More recently, Mintz (2022) has outlined Canada's need for major corporate tax reform along with specific suggested changes.

[38] The Spearman Rank Order correlation coefficient between the overall ranking for a

Table 3: Personal Income Tax: Scores for Overall Ranking, Income Tax Rate, and Capital Gains Rate

	Overall personal income tax rankings		Income tax rate structure		Taxation of capital gains and dividends	
	2014	2022	2014	2022	2014	2022
Switzerland	1	1	1	4	2	1
United States	12	4	13	9	13	7
Sweden	9	3	10	7	14	9
United Kingdom	7	8	8	8	12	8
Netherlands	2	6	9	10	1	6
Korea	4	10	5	15	4	4
Germany	15	9	15	1	8	5
Finland	10	11	12	12	11	11
Denmark	14	14	11	5	7	14
Canada	11	13	14	13	10	12
Israel	13	12	7	14	6	10
Luxembourg	6	2	4	2	3	2
Norway	5	7	6	3	9	13
Ireland	8	15	2	6	15	15
Australia	3	5	3	11	5	3

Sources: Pomerlau and Lundeen (2014) and Bunn (2022).

Two observations from table 3 seem particularly worth highlighting. One is Canada's relatively unfavourable performance in both sample years across the three income tax assessments. On both the overall ranking for personal taxes and the two subcategories, Canada ranks towards the bottom of the sample of countries. Furthermore, between 2014 and 2022 Canada's performance on the overall ranking and on the ranking for taxation of capital gains and dividends declined, although there was a slight improvement in its ranking for income tax rates.

A second observation is the marked improvement in rankings for the United States between 2014 and 2022. As this paper discussed earlier, the US is the most likely migration destination for top-ranked Canadian

country's personal income tax and the ranking for income tax rate score is a relatively modest .33. The correlation coefficient for the rank order correspondence between the overall personal income tax and the capital gains and dividend subcategory is a more robust .77. The majority of the sample countries tied in their 2022 rank for complexity.

scientists. Hence, the improvement in the personal income tax environment in the US relative to that in Canada represents an additional significant challenge to improving Canada's innovation performance beyond Canada's relatively and increasingly uncompetitive tax environment.

Concluding Comments

Technological change underlies increases in productivity, while improved productivity is the basis for enhanced standards of living. In turn, innovation, broadly defined, is the main determinant of technological change. Hence, the development, introduction, and spread of new production processes, new organizational and management practices, and new products, particularly when the latter take the form of capital inputs, should be an important focus of public policy.

While various factors influence the innovation process as it is broadly defined, the incentive effects of a nation's tax system are clearly important. In this regard, numerous empirical studies document the negative impact that relatively high corporate and personal income tax rates have on innovation, holding other relevant influences constant. The negative effect is magnified with increases in the highest marginal tax rates. Thus, broad-based taxes featuring low rates are more likely to foster a healthy ecosystem of innovation than are tax regimes built on high rates and a large array of exemptions and targeted tax credits that shrink the tax base.

Among advanced economies, Canada's innovation performance has been unimpressive to say the least, notwithstanding recent government initiatives to promote Canadian innovation. Moreover, Canada's overall innovation ranking as reported by one well-known rating service worsened between 2014 and 2022. Specifically, over that period Canada slipped from the tenth highest ranked country to the twelfth highest ranked country among the top 15 innovating OECD countries as identified in 2014.

From 2014 to 2022 Canada's relative ranking on corporate and personal income taxes also worsened significantly. With regard to the overall corporate tax system, in 2014 Canada ranked as the eight most favourable country among the top 15 countries ranked on the basis of innovation performance, while it ranked twelfth in 2022. With regard to the overall personal income tax system, Canada ranked eleventh in 2014 among the 15 top innovating countries, whereas it ranked thirteenth in 2022. In short, from the perspective of promoting innovation, Canada currently has one of the least favourable corporate and personal income tax regimes among advanced economies, particularly based on high marginal tax rates and the multiple taxation of corporate profits.

While the design of a nation's tax system must consider multiple objectives, not the least of which is to generate revenue to pay for government-provided services, the impact of specific features of the tax system on innovation activities clearly should not be ignored or minimized. In this regard, Canada's tax system is uncompetitive compared to those of most other advanced economies, including the United States, when it comes to encouraging innovation-related activities.

References

Akcigit, Ufuk, Salome Baslandze, and Stefanie Stantcheva (2016). Taxation and the International Mobility of Inventors. *American Economic Review* 106, 10: 2930-2981.

Akcigit, Ufuk, and Stefanie Stantcheva (2020). *Taxation and Innovation: What Do We Know?* Working Paper 27109. National Bureau of Economic Research <https://www.nber.org/papers/w27109>, as of November 30, 2022.

Akcigit, Ufuk, John Grigsby, Tom Nichols, and Stefanie Stantcheva (2022). Taxation and Innovation in the 20th Century. *Quarterly Journal of Economics* 137, 1: 329-383.

Atanassov, Julian, and Xiaoding Liu (2019). Can Corporate Tax Cuts Stimulate Innovation? *Journal of Financial and Quantitative Analysis* 55, 5: 1415-1465.

Balsalobre-Lorente, Daniel, Ayoub Zeraibi, Khurram Shehzad, and Juan Maria Cantos-Cantos (2021). Taxes, R&D Expenditures and Open Innovation: Analyzing OECD Countries. *Journal of Open Innovation*, volume 7: 1-12.

Bell, Alexander, Raj Chetty, Xavier Jaravel, Neviana Petkova, and John Van Reenan (2019). *Do Tax Cuts Produce More Einsteins? The Impacts of Financial Incentives vs. Exposure to Innovation on the Supply of Inventors*. Working Paper 25493. National Bureau of Economic Research. <https://www.nber.org/papers/w25493>, as of November 30, 2022.

Block, Jörn (2021). *Corporate Income Taxes nd Entrepreneurship.* IZA World of Labor. <https://wol.iza.org/uploads/articles/574/pdfs/corporate-income-taxes-and-entrepreneurship.pdf>, as of November 30, 2022.

Bruce, Donald, Tami J. Gurley-Calvez, and Alex Norwood (2020). Taxes and Entrepreneurship: A Literature Review and Research Agenda. *Foundations and Trends in Entrepreneurship* 16, 5: 393-443.

Bunn, Daniel. 2022. *International Tax Competitiveness Index 2022.* The Tax Foundation. <https://taxfoundation.org/2022-international-tax-competitiveness-index/>, as of December 5, 2022.

Chen, Duanjie, and Jack Mintz (2012). *2012 Annual Global Tax Competitiveness Ranking- A Canadian Good News Story*. SPP Research Papers, Vol. 5, Issue 28. University of Calgary. <https://www.policyschool.ca/wp-content/uploads/2016/03/2012-tax-competitiveness-chen-mintz.pdf>, as of December 5, 2022.

Cross, Philip. 2021. *Canada's Faltering Business Dynamism and Lagging Innovation.* The Fraser Institute. <https://www.fraserinstitute.org/studies/canadas-faltering-business-dynamism-and-lagging-innovation>, as of December 5, 2022.

Dimitrova, Lora, and Sapnoti Eswar (2022). Capital Gains Tax, Venture Capital, and Innovation in Start-Ups. *Review of Finance* (September). <https://academic.oup.com/rof/advance-article/doi/10.1093/rof/rfac057/6694058>, as of December 5, 2022.

Durante, Alex (2021, May 21). Reviewing Recent Evidence of the Effects of Taxation on Economic Growth. Blog post. Tax Foundation. <https://taxfoundation.org/reviewing-recent-evidence-effect-taxes-economic-growth/>, as of December 5, 2022.

Dutta, Soumitra, Bruno Lanvin, and Sacha Wunsch-Vincent (eds.) (2014). *The Global Innovation Index 2014: The Human Factor in Innovation.* World Intellectual Property Organization. <https://www.wipo.int/edocs/pubdocs/en/economics/gii/gii_2014.pdf>, as of December 5, 2022.

Dutta, Soumitra, Bruno Lanvin and Sacha Wunsch-Vincent (2022). *Global Innovation Index 2022: What is the Future of Innovation-Driven Growth?* World Intellectual Property Organization. <https://www.wipo.int/edocs/pubdocs/en/wipo-pub-2000-2022-section1-en-gii-2022-at-a-glance-global-innovation-*index-2022-15th-edition.pdf*>, as of December 5, 2022.

Ettinger, Michael, and Michael Linden (2012). The Failure of Supply-Side Economics. Center for American Progress. <https://www.american-

progress.org/article/the-failure-of-supply-side-economics/>, as of December 5, 2022.

Gentry, William, and Robert Glenn Hubbard (2000). Tax Policy and Entrepreneurial Entry. *American Economic Review* 90, 2: 283-287.

Globerman, Steven, and Joel Emes (2019). *Innovation in Canada: An Assessment of Recent Experience.* The Fraser Institute. <https://www.fraserinstitute.org/studies/innovation-in-canada-an-assessment-of-recent-experience>, as of December 5, 2022.

Hall, Bronwyn H. (2020). *Tax Policy for Innovation.* Research Working Paper 25773. National Bureau of Economic. <https://www.nber.org/system/files/working_papers/w25773/w25773.pdf>, as of December 5, 2022.

Hall, Robert, and Dale Jorgenson (1967). Tax Policy and Investment Behavior. *American Economic Review* 57: 391-414.

Hall, Robert, and Charles Jones (1999). Why Do Some Countries Produce So Much More Output Per Worker Than Others? *Quarterly Journal of Economics* 114, 1: 83-116.

Hedlund, Aaron (2019). *How Do Taxes Affect Entrepreneurship, Innovation and Productivity?* The Center for Growth and Opportunity. <https://www.thecgo.org/wp-content/uploads/2020/04/rif-2019.006.pdf>, as of December 5, 2022.

Hope, David, and Julian Limberg (2020). *The Economic Consequences of Major Tax Cuts for the Rich*. Working Paper 55. London School of Economics and Political Science. <https://eprints.lse.ac.uk/107919/1/Hope_economic_consequences_of_major_tax_cuts_published.pdf>, as of December 5, 2022.

Howell, Sabrina 2017. Financing Innovation: Evidence from R&D Grants. *American Economic Review* 107, 4: 1136-1164.

Jones, Charles (2022). Taxing Top Incomes in a World of Ideas. *Quarterly Journal of Economics* 130, 9): 2227-2274.

Isaksson, Anders (2007). *Determinants of Total Factor Productivity: A Literature Review*. Staff Working Paper 02/2007. United Nations Industrial Development Organization. <https://open.unido.org/api/docu-

ments/4812034/download/UNIDO-Publication-2007-4812034>, as of December 5, 2022.

Kim, Young Eun, and Norman V. Loayza (2019). *Productivity Growth: Patterns and Determinants Across the World.* Policy Research Working Paper No. 8852. World Bank. <https://openknowledge.worldbank.org/handle/10986/31710>, as of December 5, 2022.

Lester, John (2021). *Benefit-Cost Analysis of Federal and Provincial SR&ED Investment Tax Credits.* SPP Research Paper 141: 1. University of Calgary. <https://www.policyschool.ca/publications/benefit-cost-analysis-of-federal-and-provincial-sred-investment-tax-credits/>, as of December 5, 2022.

Lichter, Andreas, Max Loffler, Ingo Isphording, Thu-Van Nguyen, Felix Page and Sebastian Siegloch (2021). *Profit, Taxation, R&D Spending, and Innovation.* Discussion Paper No. 14830. IZA Institute for Labor Economics. <https://docs.iza.org/dp14830.pdf>, as of December 5, 2022.

Mintz, Jack (2022). *A Proposal for a "Big Bang" Corporate Tax Reform*. SPP Research Paper 15: 7 (February). University of Calgary. <https://journalhosting.ucalgary.ca/index.php/sppp/article/download/73545/55635/226050>, as of December 5, 2022.

Mohnen, Pierre (2022). *Taxation and Innovation*. Technical Note No. IDB-TN-2480. Inter-American Development Bank. <https://publications.iadb.org/en/taxation-and-innovation >, as of December 5, 2022..

Moretti, Enrico, and Daniel Wilson (2014). State Incentives for Innovation, Star Scientists and Jobs: Evidence from Biotech. *Journal of Urban Economics* 79, issue C: 20-38.

Moretti, Enrico, and Daniel Wilson (2015). *The Effect of State Taxes on the Geographical Location of Top Earners: Evidence from Star Scientists.* Working Paper Series 2015-6. Federal Reserve Bank of San Francisco. <https://eml.berkeley.edu/~moretti/taxes.pdf>, as of December 5, 2022.

Moretti, Enrico, and Daniel Wilson (2017). Geographical Location of Top Earners: Evidence from Star Scientists. *American Economic Review* 107, 7: 1858-1903.

Mukherjee, Abhiroop, Manpreet Singh, and Alminas Zaldokas (2017). Do Corporate Taxes Hinder Innovation? *Journal of Financial Economics* 124, 1: 195-221.

Pomerleau, Kyle, and Andrew Lundeen (2014). *International Tax Competitiveness Index.* The Tax Foundation. <https://taxfoundation.org/2014-international-tax-competitiveness-index/>, as of December 5, 2022.

Reid, Jenni (2022, September 29). UK PM Liz Truss Defends Tax Cuts, Vows to Press On. CNBC. <https://www.cnbc.com/2022/09/29/uk-pm-liz-truss-defends-tax-cuts-vows-to-press-on.html>, as of December 5, 2022.

Saleem, Hummera, Malik Shahzad, Muhammed Bilal Khan, and Bashir Ahmad Khilji (2019). Innovation, Total Factor Productivity and Economic Growth in Pakistan: A Policy Perspective. *Journal of Economic Structures* 8, 7. <https://journalofeconomicstructures.springeropen.com/articles/10.1186/s40008-019-0134-6>, as of December 5, 2022.

Joseph Schumpeter (1942). *Capitalism, Socialism and Democracy.* Harper.

Time, Forest (2019). How Do Tax Rates Affect Entrepreneurship? *CHRON.* <https://smallbusiness.chron.com/tax-rates-affect-entrepreneurship-39006.html>, as of December 5, 2022.

Trostel, Philip (1993). The Effect of Taxation on Human Capital. *Journal of Political Economy* 101, 2: 327-350.

Watson, Garrett, and Nicole Kaeding (2019). *Tax Policy and Entrepreneurship: A Framework for Analysis.* Fiscal Fact No. 647. Tax Foundation. <https://files.taxfoundation.org/20190403131203/Tax-Policy-and-Entrepreneurship-A-Framework-for-Analysis1.pdf>, as of December 5, 2022.

Whelan, Karl (2021). Determinants of Total Factor Productivity. Notes. University College Dublin. <https://www.karlwhelan.com/Macro2/Notes10.pdf>, as of December 5, 2022.

Zucker, Lynne G., and Michael R. Darby (2014). Movement of Star Scientists and Engineers and High-Tech Firm Entry. *Annals of Economics and Statistics*, Issue 115-116: 125-175.

About the author

Steven Globerman

Steven Globerman is Resident Scholar and Addington Chair in Measurement at the Fraser Institute as well as Professor Emeritus at Western Washington University. Previously, he held tenured appointments at Simon Fraser University and York University and has been a visiting professor at the University of California, University of British Columbia, Stockholm School of Economics, Copenhagen School of Business, and the Helsinki School of Economics. He has published more than 150 articles and monographs and is the author of the book *The Impacts of 9/11 on Canada-U.S. Trade* as well as a textbook on international business management. In the early 1990s, he was responsible for coordinating Fraser Institute research on the North American Free Trade Agreement. He earned his BA in economics from Brooklyn College, his MA from the University of California, Los Angeles, and his PhD from New York University.

Acknowledgments

The author thanks two external reviewers for helpful comments and suggestions on an earlier draft. Any remaining errors are the sole responsibility of the author. As the researcher has worked independently, the views and conclusions expressed in this paper do not necessarily reflect those of the Board of Directors of the Fraser Institute, the staff, or supporters.

Publishing information

Distribution

These publications are available from <http://www.fraserinstitute.org> in Portable Document Format (PDF) and can be read with Adobe Acrobat® or Adobe Reader®, versions 8 or later. Adobe Reader® DC, the most recent version, is available free of charge from Adobe Systems Inc. at <http://get.adobe.com/reader/>. Readers having trouble viewing or printing our PDF files using applications from other manufacturers (e.g., Apple's Preview) should use Reader® or Acrobat®.

Ordering publications

To order printed publications from the Fraser Institute, please contact:

- e-mail: sales@fraserinstitute.org
- telephone: 604.688.0221 ext. 580 or, toll free, 1.800.665.3558 ext. 580
- fax: 604.688.8539.

Media

For media enquiries, please contact our Communications Department:

- 604.714.4582
- e-mail: communications@fraserinstitute.org.

Copyright

Date of issue

February 2023

ISBN

978-0-88975-721-9

Citation

Steven Globerman (2023). *Taxes, Innovation, and Productivity Growth.* Fraser Institute. <http://www.fraserinstitute.org>.

Supporting the Fraser Institute

To learn how to support the Fraser Institute, please contact

- Development Department, Fraser Institute
  Fourth Floor, 1770 Burrard Street
  Vancouver, British Columbia, V6J 3G7 Canada
- telephone, toll-free: 1.800.665.3558 ext. 548
- e-mail: development@fraserinstitute.org
- website: <http://www.fraserinstitute.org/donate>

Purpose, funding, and independence

The Fraser Institute provides a useful public service. We report objective information about the economic and social effects of current public policies, and we offer evidence-based research and education about policy options that can improve the quality of life.

The Institute is a non-profit organization. Our activities are funded by charitable donations, unrestricted grants, ticket sales, and sponsorships from events, the licensing of products for public distribution, and the sale of publications.

All research is subject to rigorous review by external experts, and is conducted and published separately from the Institute's Board of Trustees and its donors.

The opinions expressed by authors are their own, and do not necessarily reflect those of the Institute, its Board of Trustees, its donors and supporters, or its staff. This publication in no way implies that the Fraser Institute, its trustees, or staff are in favour of, or oppose the passage of, any bill; or that they support or oppose any particular political party or candidate.

As a healthy part of public discussion among fellow citizens who desire to improve the lives of people through better public policy, the Institute welcomes evidence-focused scrutiny of the research we publish, including verification of data sources, replication of analytical methods, and intelligent debate about the practical effects of policy recommendations.

About the Fraser Institute

Our mission is to improve the quality of life for Canadians, their families, and future generations by studying, measuring, and broadly communicating the effects of government policies, entrepreneurship, and choice on their well-being.

Notre mission consiste à améliorer la qualité de vie des Canadiens et des générations à venir en étudiant, en mesurant et en diffusant les effets des politiques gouvernementales, de l'entrepreneuriat et des choix sur leur bien-être.

Peer review—validating the accuracy of our research

The Fraser Institute maintains a rigorous peer review process for its research. New research, major research projects, and substantively modified research conducted by the Fraser Institute are reviewed by experts with a recognized expertise in the topic area being addressed. Whenever possible, external review is a blind process. Updates to previously reviewed research or new editions of previously reviewed research are not reviewed unless the update includes substantive or material changes in the methodology.

The review process is overseen by the directors of the Institute's research departments who are responsible for ensuring all research published by the Institute passes through the appropriate peer review. If a dispute about the recommendations of the reviewers should arise during the Institute's peer review process, the Institute has an Editorial Advisory Board, a panel of scholars from Canada, the United States, and Europe to whom it can turn for help in resolving the dispute.

Editorial Advisory Board