Asia-Pacific
Economic Cooperation

Advancing Free Trade
for Asia-Pacific Prosperity

Innovation, Competitiveness and the Role of Fiscal Policies

ISSUES PAPER No. 7

APEC Policy Support Unit
November 2014

Prepared by:

Quynh Le and Tammy Hredzak (Consultant)
Asia-Pacific Economic Cooperation Policy Support Unit
Asia-Pacific Economic Cooperation Secretariat
35 Heng Mui Keng Terrace
Tel: (65) 6891-9600 │ Fax: (65) 6891-9690
Email: psugroup@apec.org │ Website: www.apec.org

Produced for:

Asia-Pacific Economic Cooperation
Finance Ministers' Process

APEC#214-SE-01.14

KEY FINDINGS

1. Supporting sustainable economic growth and prosperity in the Asia-Pacific region is one of APEC's primary goals. To achieve this, and to address the challenges facing the global economy, APEC members need to place greater emphasis on promoting research and development (R&D) and encouraging innovation as important pathways to strengthen the region's competitiveness, raise labour productivity and address the effects of changing demographics.

2. Promoting innovation has long been included in APEC's work agenda, as seen in the 2010 APEC Growth Strategy, the 2011 Honolulu Declaration, the 2012 Vladivostok Declaration and the 2013 Bali Declaration. As host of APEC 2014, China has also specified "promoting innovative development, economic reform and growth" as one of the priorities of the APEC agenda for this year, alongside "advancing regional economic integration" and "strengthening comprehensive connectivity and infrastructure development".

3. The APEC region was sharply impacted by the global financial and economic crisis that began in late 2008. Labor productivity growth was particularly hard hit, decelerating to around 82% the expansion rate seen in the previous six years. Despite some recovery since then, the pace of labor productivity growth in the APEC region over the past few years has continued to be below its pre-crisis peak. There is a need now for APEC to restore the rapid growth of labor productivity if the region desires to reach a higher level of sustainable economic progress.

4. One of the important lessons of the past two decades has been the pivotal role of productivity gains in the development of APEC economies. Labor productivity gains have and will become even more critical in many APEC economies, especially as some face challenging demographic issues. Improving the efficiency of capital and human resources is vitally important in order to sustainably improve APEC's labor productivity and output. Governments can play a critical role in promoting more efficiency in production by shaping policies to enable firms to continuously innovate.

5. Given the benefits of innovation in improving competitiveness and advancing economic growth, many economies have recently begun to more actively promote policies relating to innovation. Such policies range from immigration reform, so as to encourage greater mobility of highly-skilled workers, to providing strong legal recourse for patent infringements. There is also a range of fiscal policies that governments can use to help promote investments in innovation in their economies, including through direct spending to establish R&D or incubation centers.

6. Another way is through the use of subsidies and tax incentives to influence firms' decisions to invest in R&D. R&D subsidies and tax incentives can be used to narrow the gap between the private and social returns. Both types of fiscal policies raise the expected returns from innovation by reducing the marginal cost of R&D investment. R&D subsidies, mostly in the form of grants or loans, directly cover a portion of R&D costs on qualifying projects. R&D tax incentives, such as the deductibility of expenses relating to R&D from income or from taxes payable, lessen the tax burden for a

business. Tax incentives to support R&D can take many different forms, including tax allowances, tax deductions, super deductions, tax exemptions and tax credits.

7. From an administrative point of view, tax incentives are the least burdensome way of increasing business R&D and can be used to encourage an increase in R&D across the whole spectrum of firms. Therefore, if the government's objective is to increase R&D intensity among firms from a relatively low level, tax incentives may be the most sensible approach. Meanwhile, direct subsidies are better suited to encourage higher risk projects and to meet specific policy goals. If the government's objective is to enlarge the R&D capacity within certain fields or R&D milieus, in this case, subsidies would be the natural choice since it is more difficult to target specific fields or areas of R&D activities through tax incentives.

8. This report maps out the current R&D subsidies and tax incentives currently offered in the APEC region. All APEC members offer some type of direct subsidy in the form of grants or loans in order to help businesses finance R&D projects. Most also have a defined R&D tax incentive scheme in place. In some APEC economies, there are multiple R&D incentive packages available, while in others there may be one main incentive. In most APEC economies, the major tax incentive mechanism is usually a tax deduction or a tax credit. Some APEC economies do not have a defined R&D tax incentive scheme, but rely more on grant programs to promote business R&D.

9. Since fiscal support to business R&D is expensive, researchers have attempted to evaluate their effectiveness in promoting increased private R&D. The tax incentive scheme initiated in the United States in 1981 is among the most widely studied cases. The wide variations in the empirical estimations of private price elasticity of R&D – which measures the percentage change in R&D investment resulting from tax relief for every percentage change in its after-tax price – is one of the triggers for the debate on the effectiveness of R&D tax incentives.

10. A careful review of some key studies suggests that the results of empirical evaluations are sensitive to the methodologies used, the time period being examined, and the sources of the data. Early studies that were conducted less than five years since the initiation of the tax incentive scheme tend to report a small price elasticity of R&D, suggesting that the program has limited impact on firms to carry out extra R&D. On the other hand, results from later studies that took place more than 10 years after the program had been initiated found that tax incentives are not only effective in promoting private R&D spending, but also indicated that the benefits, as measured by increases in R&D, often outweigh the costs, as measured by foregone tax revenues.

11. The varying results of empirical studies, however, do not provide a justifiable ground for dismissing the effectiveness of R&D tax incentives. Indeed, the results of earlier studies were questioned on the basis of the methodological limitations in which the various studies faced. Additionally, the short time lag between the introduction of the incentive scheme and the evaluation exercises could also have resulted in lower estimates of price elasticity as firms often take time to adjust to new schemes. The results from later studies, which used more reliable and sophisticated evaluation techniques and which took into account the high adjustment costs, provide a better understanding of the effectiveness of R&D tax credits.

12. In the APEC region, there does indeed appear to be a positive correlation between government support to business R&D and BERD intensity, which is defined as the amount of business enterprise research and development as a share of GDP. Those APEC members that provide a greater amount of government support typically also have a higher level of BERD intensity.

13. Some APEC economies, however, provide a substantial amount of government support, but have a relatively low BERD intensity, underlining the importance of designing incentives and schemes that are targeted to achieving policy objectives as well as ensuring that the procedures for businesses to access the incentives are not too onerous. The effectiveness of R&D tax incentives also depends to a great extent on the broader regulatory environment and the stability of this environment over time. Factors include well-functioning financial markets as well as the overall tax system.

14. R&D fiscal incentives and subsidies, while being important, are not the sole factors influencing firms to undertake innovative activities. Tax regimes in general can also greatly impact investment decisions, including those involving investments in innovation, as R&D projects are evaluated for tax efficient outcomes. Although not a precise indicator, the World Economic Forum's Executive Opinion Survey suggests that tax systems in many APEC economies may reduce the incentive to invest in those economies. While the region includes some of the top performers globally, many APEC members are below the APEC average, indicating that there is significant room for improvement for many economies.

15. The limited availability of empirical studies evaluating the effectiveness of R&D subsidies and tax incentives in many APEC economies is a call for further research in this area. Developing APEC economies are at different stages of technological development and they possess different institutions and policy frameworks. Future studies should therefore be fine-tuned to the economic context of developing economies. APEC can stimulate this shift in research agenda and foster the links between leading researchers, research institutions, policy makers and research managers.

16. Despite the plethora of studies on the impact of R&D tax incentives, most of these studies refer to programs that took place in the 1980s and early 1990s. As such, our knowledge on recently introduced and redesigned fiscal incentive schemes remains limited. Further refinement to the methodologies is also important in order to derive more accurate estimations of the economic costs and benefits of tax incentives. For instance, the effectiveness of R&D tax incentives has long been evaluated against the price elasticity or input additionality. These approaches ignore some other benefits that are brought about by increased innovative activities, such as employment gains and enhanced social welfare.

TABLE OF CONTENTS

1. Introduction 1

2. APEC's Competitiveness and Economic Growth 4

3. Fiscal and Taxation Policies in Promoting Innovation: R&D Subsidies and R&D Tax Incentives in the APEC Region 9

A. The Rationale for R&D Subsidies and Tax Incentives 9

B. Fiscal Policies to Promote Innovation in the APEC Region 13

4. Assessing the Effectiveness of R&D Subsidies and R&D Tax Incentives 18

5. Conclusion 24

Annex: Fiscal and Taxation Policies Relating to R&D in APEC 27

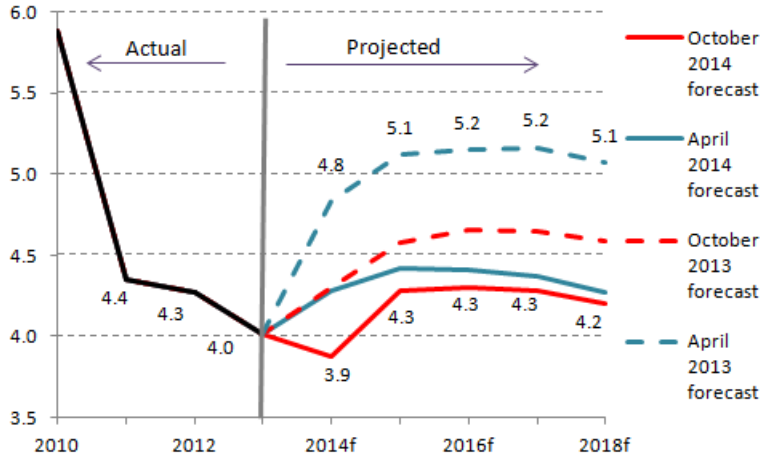
References 36

1. INTRODUCTION

It has been more than six years since the start of the 2008-09 Global Financial Crisis (GFC). However, its legacy continues to impact APEC economies. Between 2008 and 2013, APEC GDP expanded by less than three-fourths of the 4.7% growth rate seen in the six-year period immediately prior to the crisis. The region's economic recovery has remained unsteady. In the first half of this year, APEC output expanded at 3.8%, a touch lower than the 4.1% recorded in the second half of last year and much lower than had been expected.

This weaker than expected economic performance in the post-GFC period has effectively placed the APEC region on a lower projected medium-term growth path. Information gathered from the latest International Monetary Fund's (IMF) World Economic Outlook indicates that the APEC region is projected to grow at an average annual rate of 4.2% between 2014 and 2018 (Figure 1). This represents a marked downward shift in the growth forecasts of APEC output expansion. In particular, in early 2013, the IMF had forecast an average annual growth rate of 5.1% for the APEC region from 2014 to 2018. According to the latest forecast, APEC GDP over the 2014 through 2018 period will be around USD 5.5 trillion lower than the amount that had been projected earlier.

Figure 1. Evolution of the IMF forecasts for APEC GDP growth (%)

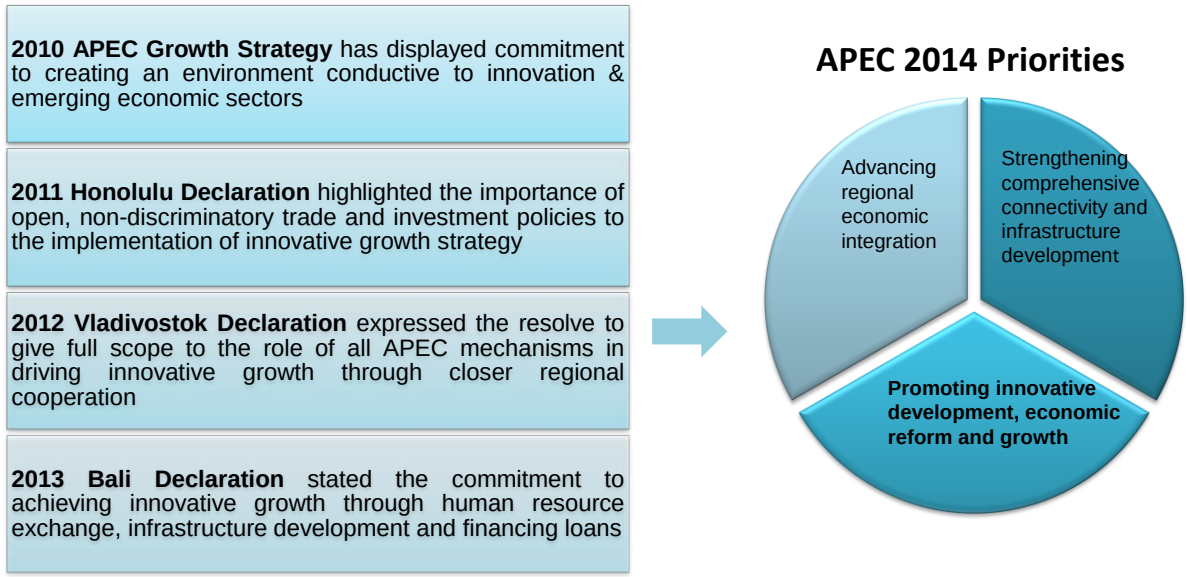


Note: Figures for 2010 through 2013 are actual growth rates; figures for 2014 through 2018 are projected growth rates. GDP growth for the APEC region is a weighted average based on purchasing power parity at constant 1980 prices.

Source: International Monetary Fund (IMF), World Economic Outlook and APEC Policy Support Unit (PSU) calculations.

APEC is now at a critical juncture in which new policies are needed to bring about sustainable, equitable and higher medium-term economic growth. APEC recognizes that enhancing the region's competitiveness is strategically important in order to achieve the primary goal of supporting sustainable economic growth and prosperity in the Asia-Pacific region. APEC economies have increasingly placed an emphasis on encouraging innovation as an important pathway to strengthen the region's competitiveness. Innovation has long been included in APEC's work agenda, as expressed in the 2010 APEC Growth Strategy, the 2011 Honolulu Declaration, the 2012 Vladivostok Declaration and the 2013 Bali Declaration (Figure 2). As host of APEC 2014, China has also specified "promoting innovative development, economic reform and growth" as one of the priorities of the APEC agenda for this year, alongside "advancing regional economic integration" and "strengthening comprehensive connectivity and infrastructure development".

Figure 2. Promoting innovation has been consistently reflected in APEC Leaders' Declarations



Source: APEC.

The significance of innovation in contributing to productivity gains and raising world living standards can be traced back to the Industrial Revolution. Discoveries such as electrification and the internal combustion engine radically transformed economies around the world. Many aspects of modern life, from communications to health, have intrinsically benefited from advances in technology. Theoretically, the link between innovation and economic growth was established at least as early as 1776 by Adam Smith. In his seminal book "*An Enquiry into the Nature and Causes of the Wealth of Nations*", he stated:

"*All the improvements in machinery, however, have by no means been the inventions of those who had occasion to use the machines. Many improvements have been made by the ingenuity of the makers of the machines, when to make them became the business of a peculiar trade; and some by that of those who are called philosophers of men of speculation, whose trade it is not to do anything but to observe everything; and who, upon that account, are often capable of combing together the powers of the most distant and dissimilar objects. And the progress of society, philosophy or speculation becomes, like every other employment, the principal and sole trade and occupation of a pajhrticular class of citizens … and the quantity of science is considerably increased by it.*"

Enabling an environment that is conducive to innovation requires a holistic approach, ranging from developing and maintaining an open economy that allows the flow of capital, people, ideas, goods and services across borders, to strengthening an institutional framework that provides effective protection and enforcement of intellectual and industrial property rights. Many aspects of innovation promotion have been covered by a wide variety of committees and sub-fora within APEC. Currently, the Economic Committee of APEC is examining best practices in regulatory reforms to promote innovation in the region. In recognition of the central role of innovation to the region's economic growth, APEC established the Policy Partnership on Science, Technology and Innovation (PPSTI) in 2012. The main role of the PPSTI is to support the development of science and technology cooperation and effective innovation policy in APEC economies. Some priority areas of the APEC PPSTI include:

- fostering an enabling environment for innovation;
- developing innovation policy frameworks;
- strengthening collaboration among APEC members;
- developing science, research and technology cooperation; and
- supporting infrastructure for the commercialization of ideas.

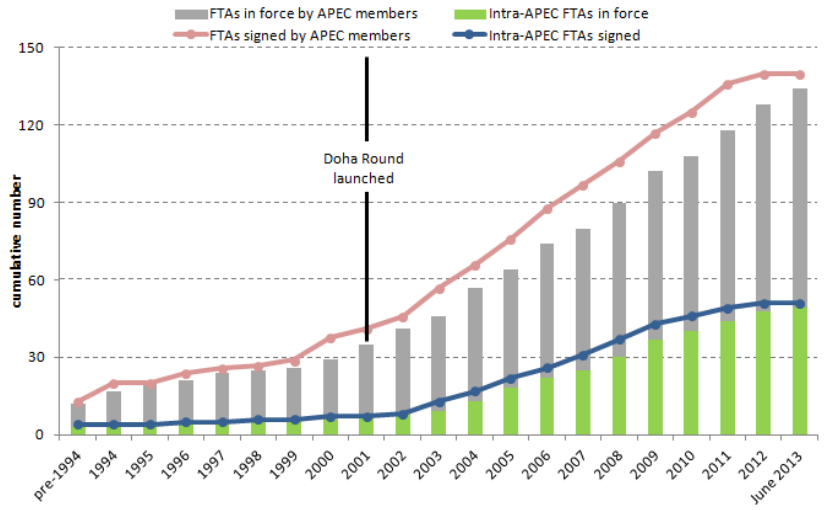
Aside from strengthening the environment to enable innovative activities, there is scope for public financial policies to influence firms undertaking research and development (R&D). R&D, which can be defined as "creative work undertaken on a systematic basis to increase the stock of scientific and technical knowledge, including knowledge of man, culture and social, and the use of this stock of knowledge to devise new applications" (OECD, 1993) is a crucial component of innovation and a key factor in developing new competitive advantages. China, as 2014 Chair of the APEC Finance Ministers' Process (FMP), has highlighted "Fiscal and Taxation Policies for Economic Restructuring" as one of the four working priorities for this year.

This issues paper aims to contribute to that priority by examining the role of fiscal and taxation policies that are related to R&D and the need to sharpen APEC economies' competitive edge and accelerate the economic restructuring process in the APEC region. The remainder of the paper is organized as follows. Chapter 2 discusses the role of productivity gains in APEC's economic progress. Chapter 3 maps out the current R&D subsidies and tax incentive schemes that are currently in place in APEC economies. Chapter 4 highlights the evidence on the effectiveness of R&D subsidies and tax incentives. Finally, chapter 5 provides a conclusion and suggests possible future work on the role of fiscal and taxation policies in the APEC region.

2. APEC'S COMPETITIVENESS AND ECONOMIC GROWTH

2014 marks the 25th anniversary of APEC's establishment. Over the past 25 years, APEC economies have worked together to enhance trade and investment liberalization and facilitation in the Asia-Pacific region and to promote greater regional integration. When APEC was first established, there were only three free trade agreements (FTAs) in the region. By mid-2013, APEC members had signed up to 140 FTAs as well as 800 bilateral investment treaties (Figure 3). In addition, industrial tariffs have become progressively lower, from an average rate of 16.9% in 1989 to 5.1% in 2011.

Figure 3. Free Trade Agreements (FTAs) in APEC (cumulative number)

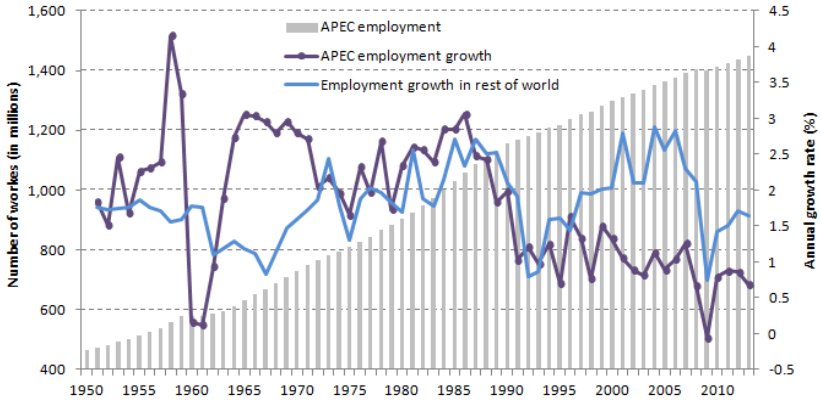


Source: APEC Policy Support Unit (PSU).

APEC has also brought about significant changes to global policy and the economic landscape. It has upheld the multilateral trading system and played an important role in concluding the Uruguay Round negotiations, the WTO's Trade in Information Technology Products Agreement (ITA), and early harvest talks of the Doha Round negotiations held in Bali, Indonesia at the end of 2013. Increased economic integration has facilitated cross-border technology and knowledge transfer which have helped to boost the region's competitiveness. As explained later in this chapter, enhanced APEC competitiveness had become the most critical source of economic gains in the region in recent years.

In the four decades from the 1950s through the 1980s, APEC economies enjoyed rapid expansion in the labor force, brought about from the baby boom following World War II. APEC employment grew strongly at a compound annual growth rate (CAGR) of 2.3% over this period, much higher than the CAGR of 1.8% seen in the rest of the world (Figure 4). This demographic development provided an important boost for APEC growth during this period, especially during the 1970s when the region's growth was badly

Figure 4. Employment from 1950 to 2013



Note: Data for Brunei Darussalam and Papua New Guinea are not available.
Source: The Conference Board, Total Economy Database and APEC Policy Support Unit (PSU) calculations.

Figure 5. Evolution of APEC GDP growth and the contributions from employment and labor productivity

Note: Labor productivity is defined as output per worker. Data for Brunei Darussalam and Papua New Guinea are not available. Aggregate data for the APEC region prior to 1973 also excludes Russia due to data unavailability.
Source: The Conference Board, Total Economy Database and APEC Policy Support Unit (PSU) calculations.

affected by two major oil price shocks in 1973 and 1979. On average over the period between 1973 and 1989, the rapid growth of employment accounted for almost 65% of APEC GDP expansion (Figure 5). Since 1990, there has been a sharp drop in the rate of APEC's labor quantity expansion, reflecting the steady decline in APEC's population growth rate since 1970. On average, APEC's employment in the 1990s was growing at half the pace seen in the previous four decades. Additionally, many APEC economies were affected by the 1997-1998 Asian Financial Crisis which scaled down the gains in labor productivity. As a result, the pace of output expansion in the 1990s was, on average, only three-quarters the rate achieved during the four previous decades.

The wide-ranging structural reforms and increased economic integration that gradually took place in the early 1990s brought about beneficial results to the APEC region in the 2000s. In some economies, there has been a gradual shift from land-intensive commodities to higher value-added goods. APEC's trade rose from 28% of GDP in 1992 to a peak of 50% of GDP in 2008. More exposure to global competition and global technology appears to have had an advantageous impact on APEC's competitiveness. From 2000 to 2007, APEC's output per worker rose by more than 31%, from USD 15,325 per worker/per annum to USD 20,103 per worker/ per annum. In comparison, over the 10-year period between 1990 and 2000, APEC's output per worker improved by only 25%. This improved labor productivity contributed to 80% of GDP growth in the APEC region between 2000 and 2007.

The impressive progress in advancing APEC's competitiveness has made APEC's performance clearly stand out from the rest of the world. Despite the fact that APEC's employment has been growing at a much slower rate than that of the rest of the world, larger gains in labor productivity have resulted in GDP growth in the region to consistently outperform the rest of the world (Figure 6). APEC GDP recorded a compound annual growth rate (CAGR) of 3.7% between 1980 and 2007, more than a full percentage point higher than the CAGR for the rest of the world over the same period. As a result, APEC's share of global GDP rose from under 48% in 1980 to 55% in 2007. Strong economic growth has also dramatically improved the region's economic welfare (Figure 7). APEC GDP per capita, in constant 2013 purchasing power parity (PPP) terms, doubled while that of the rest of the world improved by less than 30%.

GDP in APEC and rest of world since 1980 (in 2013 purchasing power parity prices)

Figure 6. GDP

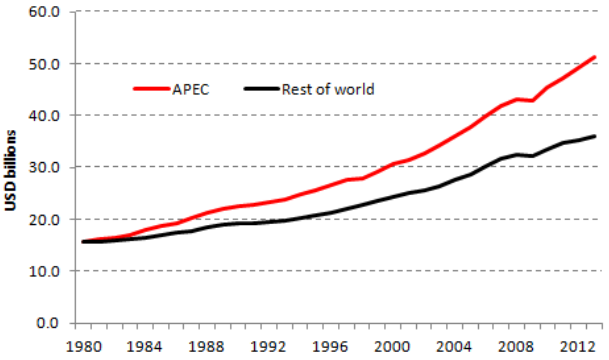
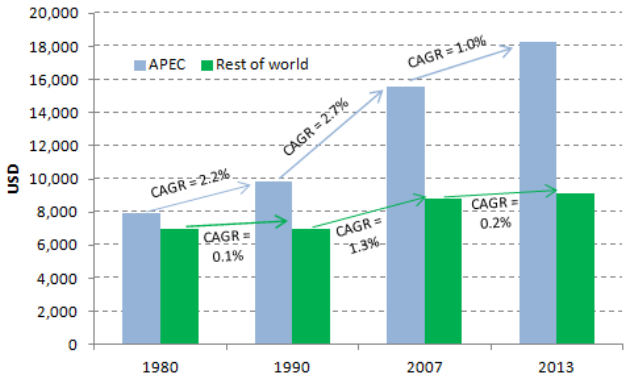


Figure 7. GDP per capita



Note: Data for Brunei Darussalam and Papua New Guinea are not available.
Source: The Conference Board, Total Economy Database and APEC Policy Support Unit (PSU) calculations.

However, the APEC region was sharply impacted by the 2008-09 Global Financial Crisis. APEC's labor productivity growth decelerated to around 82% of the expansion rate seen in the previous seven years. Despite some recovery since then, the pace of labor productivity growth in the APEC region over the past few years has continued to be below its pre-crisis peak. The deceleration in labor productivity growth occurred against the backdrop of a sharp slowdown in labor input growth. Indeed, the expansion rate of labor input over the period between 2008 and 2013 was, on average, the slowest since the 1950s.

The shifting performance of APEC labor productivity growth since 1990 can be explained using a growth accounting exercise. In particular, the factors contributing to APEC GDP growth can be decomposed into employment growth (labor utilization) and other immediate sources of labor productivity. The elements influencing productivity gains include:

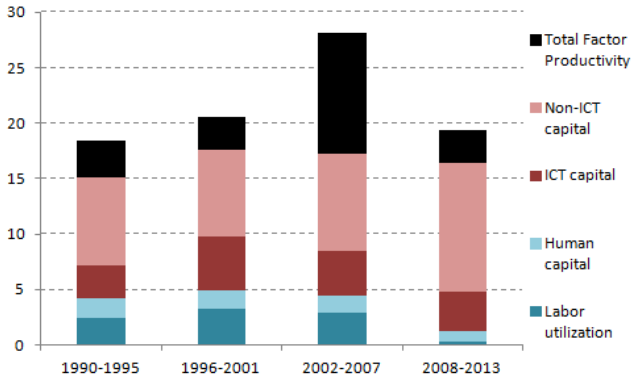
- changes in the quality of labor (human capital).
- changes in the rate of capital deepening. Capital deepening, which is the amount of capital per unit of labor input, measures the increase in capital intensity. In this analysis, capital services are divided into two broad types. The first is Information and Communications Technology (ICT) assets which encompass computer hardware, software and telecommunications equipment. The second classification of capital services – non-ICT assets – covers investments in dwellings, buildings and structures, transport equipment and machinery.
- changes in the rate of technological progress or Total Factor Productivity (TFP). TFP is sometimes referred to as multi-factor productivity or the Solow residual. It is often used as a measure of technological progress or the contribution from science or technology. However, in practice, TFP is often calculated as the portion of real output growth which is not accounted for by increases in inputs of labor (quantity and composition of labor) and capital (ICT and other capital). Therefore, TFP may capture progress not only in technology, but also through improvements in organization. Additionally, its measurement can be affected by other cyclical factors such as capacity utilization and business cycles.

Figure 8 provides a supply side perspective to understand the drivers of APEC's GDP growth and labor productivity growth. It shows that the labor productivity gains in the APEC region across the four 6-year periods since 1990 have been driven by different factors. Since 2000, improvements in human capital have played a lesser role in labor productivity gains vis-à-vis

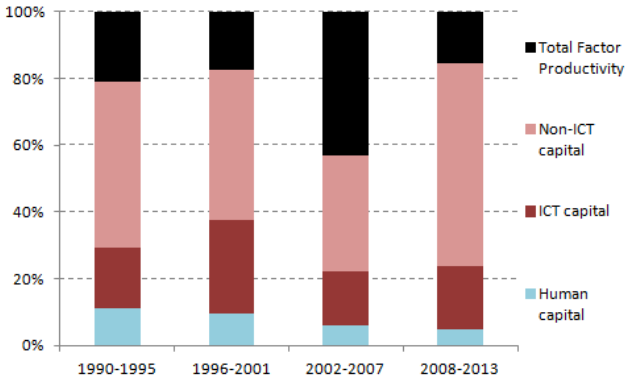
the contribution seen in the 1990s. Over the period between 2002 and 2007, when APEC recorded significant gains in labor productivity growth, improved production efficiency or technological progress accounted for more than 43% of this impressive achievement.

Figure 8. Supply side perspective to understand the drivers of APEC's labor productivity gains

Contributions to GDP growth
(percentage points, cumulative over a period)



Contributions to labor productivity gains
(proportional to total gains over each period)

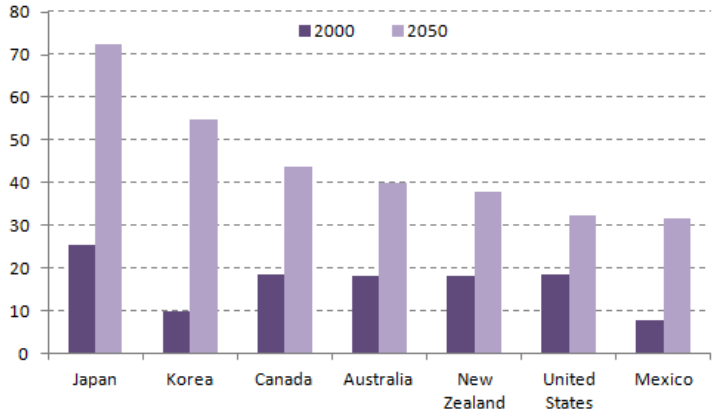


Note: Data for Brunei Darussalam and Papua New Guinea are not available.
Source: The Conference Board, Total Economy Database and APEC Policy Support Unit (PSU) calculations.

Despite a significant improvement in 2008, there has still been a marked decline in TFP growth. On a cumulative basis, TFP growth contributed 3.0 percentage points to APEC GDP in the six years between 2008 and 2013, less than one-third the contribution made between 2002 and 2007. With the contributions from labor inputs and improved production efficiencies on the decline, APEC growth has been more reliant on capital deepening since 2008. From 2008 through 2013, the contribution of non-ICT capital to APEC labor productivity growth was almost double its rate in the preceding six-year period. Investments in ICT capital, however, were marginally lower since 2008 in comparison with the two periods from 1996 to 2001 and from 2002 to 2007.

Growth decompositions based on a supply side perspective provide some insights into new policy challenges for the APEC region. Among these is the need for APEC to restore the rapid growth of labor productivity if the region is to reach a higher level of sustainable economic progress. Labor productivity gains will become even more critical in many APEC economies, especially as demographics will become less supportive and which may even become a drag on growth in some markets. This trend particularly holds true for the APEC region. According to OECD forecasts, by 2050 the number of people aged 65 and older compared to those aged 15-64 will be more than double the ratio recorded in 2000 in many APEC economies (Figure 9).

Figure 9. Population aged 65 and over relative to population aged 15-64 in 2000 and 2050 in selected APEC economies (ratio)



Source: OECD, 2006.

Since 2008, increased capital accumulation has helped to avert some of the decline in output per worker. Some new capital assets were brought about as a result of government fiscal stimulus measures that were implemented in response to the 2008-09 Global Financial Crisis and its aftermath. In many APEC economies, fiscal stimulus packages were unprecedented in terms of size and coverage. A substantial number of these were dedicated to infrastructure projects, which helped to increase capital stock. In China, for example, 86% of the fiscal stimulus package announced in November 2008 – equivalent to USD 586 billion or 13.3% of GDP – was allocated to infrastructure projects.

In today's tightening fiscal environment, the ability of governments to maneuver much of the capital deepening may be restrained. In the short- to medium-term, this momentum can only be sustained if APEC can mobilize private savings into productive capital investments. It should be noted that in the longer term, increases in capital input – without increasing its efficiency – will result in diminishing returns. Nor can the quantity of capital input be increased indefinitely. Therefore, improving the efficiency of capital and human resources is vitally important in order to sustainably improve APEC labor productivity and output. Governments can play a critical role in promoting more efficiency in production by shaping policies to enable firms to continuously innovate.

3. FISCAL AND TAXATION POLICIES IN PROMOTING INNOVATION: R&D SUBSIDIES AND R&D TAX INCENTIVES IN THE APEC REGION

A. THE RATIONALE FOR R&D SUBSIDIES AND TAX INCENTIVES

The APEC region is undergoing rapid change and becoming increasingly integrated into fast-evolving regional and global production and knowledge networks. Innovation provides the region with an additional means to take advantage of increased economic integration by deepening its capacity to move up the global value chain. The overall picture of improved labor productivity in the region as discussed in the previous chapter, however, masks an uneven pace of convergence across APEC economies. Generally, the gap in labor productivity vis-à-vis output per worker in the United States is larger among developing economies (Figure 10). Figure 11 suggests that TFP gaps account for the bulk of income and labor productivity differences across APEC economies. The lower TFP levels in many APEC economies, relative to that of the United States, suggests significant catch-up potential.

Figure 10. Labor productivity as a percentage of US labor productivity, 2008

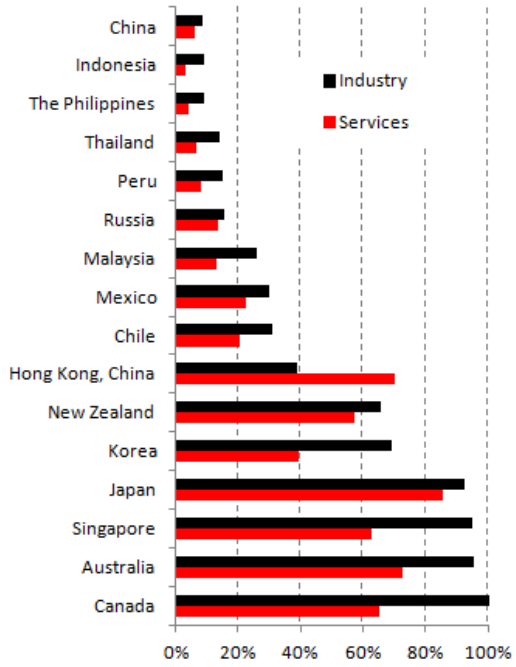
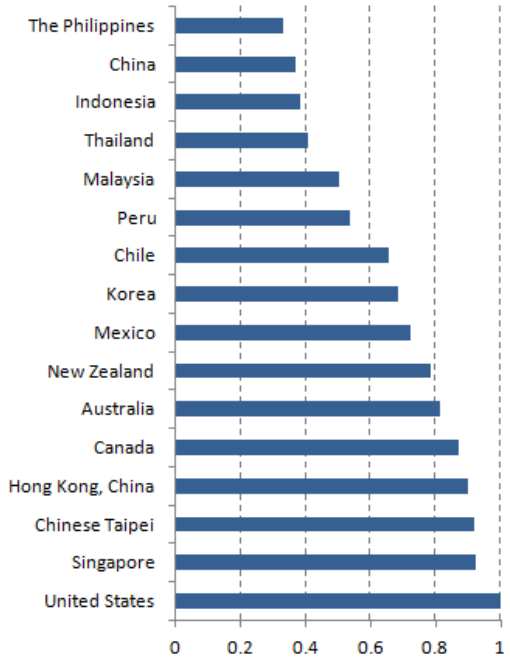


Figure 11. Level of Total Factor Productivity (TFP), relative to the US in current PPP terms



Source: Penn World Table, Version 8.0.

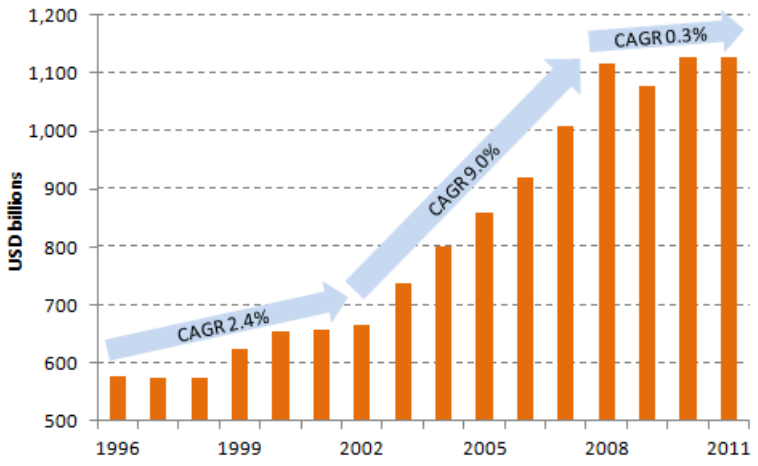
Given the benefits of innovation in improving competitiveness and advancing economic growth, many APEC economies have recently begun to more actively promote policies relating to innovation. Such policies range from immigration reform, so as encourage greater mobility of highly-skilled workers, to providing strong legal recourse for patent infringements. There is also a range of fiscal policies that governments can use to help promote investments in innovation in their economies, including through direct spending to establish R&D or incubation centers. Another way is through the use of tax subsidies and/or incentives so as to influence firms' decisions to invest in R&D. Contrary to direct R&D funding where a dollar increase in government expenditure equals a dollar increase in R&D

activity, the effect of tax subsidies and incentives on influencing private firms to undertake R&D is more ambiguous. The focus of this chapter is therefore limited to providing an analysis of subsidies and tax incentives relating to R&D activities across the APEC region.

There are numerous empirical studies supporting the view that R&D is a crucial input for product and process innovation and an essential investment for an economy's long-term growth and competitiveness. Verspagen (1995) estimated the contribution of R&D to economic growth in a broad sample of sectors and across multiple OECD economies using an R&D augmented production function. The author found that there is indeed a positive influence of R&D investment on output growth, especially in high-tech sectors. Another study by Griliches and Mairesse (1982) used firm-level data to explore the relationship between R&D and productivity in Japan and the United States. They identified a positive and substantial impact of R&D on productivity in science-related sectors (elasticity equal to 0.2). In Chinese Taipei, the productivity of 156 firms over the period between 1994 and 2000 was studied by Wang and Tsai (2004). They also observed a positive and significant R&D effect on productivity, with the impact of R&D on high-tech firms being the largest and most statistically significant.

The rationale for government intervention in promoting R&D is well established. Seminal studies by Nelson (1959) and Arrow (1962) attributed underinvestment in private R&D to the imperfect appropriability conditions of new knowledge generated from R&D activities. Newly discovered ideas, products and knowledge, which are the primary outputs of the innovation process, have the classic aspect of non-rivalrous goods. The non-rivalry suggests that once created, innovative output can be beneficial for others without the creator being able to appropriate it fully. The presence of positive externalities induces a divergence between the social and private returns of R&D activities. Griliches (1992) empirically computed the social and private rates of return of R&D investments and found that the social rates were significantly higher than the private ones. The difficulty in fully capitalizing on their innovation outputs leads to firms investing less in R&D than would be socially desirable. In addition to these classical justifications, there are other policy rationales for public support of private R&D. R&D investments often involve complex and soft information that is difficult to verify and the outcomes are also uncertain. Information asymmetries also make it difficult for external investors to correctly assess and efficiently monitor innovation projects. Therefore, external investors or financial institutions often impose higher risk premiums for innovation projects. R&D performing firms may be credit constrained as obtaining external bank funding for R&D can be difficult.

Figure 12. R&D expenditure in high-income economies



Source: World Bank, World Development Indicators.

The impact on performance in research and innovation in the aftermath of the 2008-09 Global Financial Crisis provides another call for government support in R&D. There is a tendency for innovative firms to scale back their R&D expenditures and investments in risky projects during times of economic

turmoil, a trend confirmed by the OECD (2009). In addition, Archibugi (2013) showed that companies were decreasing their R&D efforts in the aftermath of the crisis. Meanwhile, Filippetti and Archibugi (2011) demonstrated that the number of firms that were able to expand their R&D had dramatically dropped. Figure 12 shows that R&D expenditure in high-income economies was indeed affected by the recent crisis. In 2011, the ratio of R&D expenditure to GDP in high-income economies fell by 8.5% from the peak witnessed in 2009.

R&D subsidies and tax incentives can be used to incentivise firms to undertake R&D projects by narrowing the gap between the private and social returns. Both types of fiscal policies raise the expected returns from innovation by reducing the marginal cost of R&D investments. R&D subsidies, mostly in the form of grants or loans, directly cover a portion of R&D costs on qualifying projects. R&D tax incentives, such as the deductibility of expenses relating to R&D from income or from taxes payable, lessen the tax burden for a business. Tax incentives to support R&D can take many different forms and are discussed in Box 1.

Box 1. Definitions of tax incentives commonly used to support R&D

Tax allowance – a sum to be deducted from gross income in the calculation of taxable income.

Tax deduction – a sum to be deducted from taxable income; usually expenses incurred to produce income and often subject to limitations or conditions.

Super deduction – a sum to be deducted from taxable income that is greater than the amount of qualifying expenses.

Tax exemption – reduces taxable income like a tax deduction, but often subject to fewer restrictions.

Tax credit – an amount that can be offset against a tax liability.

The key theoretical as well as practical difference between a subsidy as opposed to a tax incentive is that in the former, an informed government agency can maximize social benefits by selecting projects that would generate the highest social benefits. An advantage of direct R&D subsidies is that a public agency can have greater influence on the way R&D projects are conducted. In particular, in order to maximise knowledge spillovers and the overall benefit to society, the government can require firms that have received government grants or loans to collaborate and network within the project. However, a drawback of a direct subsidy is that its effectiveness depends on who qualifies. In practice, the costs associated with applying and fulfilling administrative burdens as well as other requirements may prevent many eligible firms from applying.

In comparison with subsidies, R&D tax incentives are often considered to be more neutral and market oriented as the decision of allocating R&D investment is placed more firmly on private companies (Atkinson, 2007). From the firm's perspective, tax incentives are often more transparent and predictable. This transparency, combined with lower application and compliance costs relative to subsidies, makes R&D tax incentives more attractive to a wider group of firms. A caveat of R&D tax incentives is that private firms would typically choose projects that generate the highest expected private returns. Only in those cases where the social and private returns are aligned will R&D tax incentives induce the most socially optimal projects.

R&D tax incentives are increasingly used throughout the world, including by emerging and developing economies as they seek to promote R&D investment by both domestic and foreign companies in their economies. Tax incentives are relatively easy to administer

through the existing tax system and can also be easily altered in terms of size and scope. R&D tax incentive schemes can therefore be designed according to policy objectives. The most commonly used incentives are tax deductions or allowances and/or tax credits, although the structure and implementation of these incentives often varies significantly between economies. Some of the main considerations when examining the R&D tax incentive scheme of an economy include the following:

1. *eligible industries and/or enterprises*: Under most R&D tax incentive schemes, all businesses in all industries are eligible to claim the incentives, provided that they are conducting qualifying R&D. However, some economies may wish to promote R&D investment in targeted industries or areas, such as biotechnology or energy efficiency, and therefore allow only businesses conducting R&D in those industries to claim the incentives. Similarly, governments may wish to target specific geographical regions with incentives offered to businesses establishing themselves in specially designated zones. Some schemes may also offer enhanced R&D tax incentives with more generous benefits that can be claimed only by SMEs. Governments may also require pre-approval before businesses can claim the incentives. This can range from simply stating their intent to relevant tax authorities in advance, to requiring that businesses go through an approval process before being eligible to claim the incentives.
2. *eligible R&D activities and expenses*: Although the definition of R&D differs across economies, eligible R&D activities generally include those which are systematically conducted for the purpose of acquiring or applying new scientific and technical knowledge, thereby developing or improving technologies, techniques, or products and services. Most tax incentive schemes allow businesses to deduct current expenses only, such as salary expenditure and materials costs that are directly related to qualifying R&D activities. Capital expenses such as facilities and buildings and machinery and equipment used in R&D usually do not qualify for the tax incentives, although some schemes may allow for accelerated depreciation of some capital expenses. Additionally, some tax incentive schemes allow companies to claim expenses incurred through offshore R&D activities.
3. *volume basis or incremental basis*: Volume-based tax incentives typically allow income to be reduced by the total amount of qualifying R&D spending in the current tax year. Some schemes also offer super deductions, under which businesses can deduct an amount that is even greater than their actual R&D expenses. Governments may elect to limit the amount of expenses that can be deducted by applying a cap (the amount credited cannot be greater than a percentage of the company's total tax liability, for example). Alternatively, some schemes offer tax incentives on an incremental basis, under which the amount of R&D expenses that can be deducted is based on an increase in research expenditures above a baseline amount, which could be a percentage of average R&D expenses in the prior three years, for example.
4. *refund or carry forward provisions*: For businesses that receive no income or experience losses in a given tax year, the tax incentive scheme may allow for either a full or partial refund of the eligible expenses and/or allow that amount to be carried forward and claimed in tax filings in future years.

B. FISCAL POLICIES TO PROMOTE INNOVATION IN THE APEC REGION

Since financing for R&D is a vital component to achieving innovation, we have limited our analysis in this section to a review of the tax incentives and other fiscal policies relating to R&D across the APEC region. Annex 1 provides an overview of the major fiscal policies relating to R&D at the federal or central level in each APEC economy, while Table 1 summarizes some of the more common R&D incentives that are currently used in the APEC region. While all APEC members offer some type of direct subsidy in the form of grants or loans in order to help businesses finance R&D projects, most also have a defined R&D tax incentive scheme in place. In some APEC economies, there are multiple R&D incentive packages available, while in others, there may be one main incentive in the form of a tax deduction or credit.

Table 1. R&D tax incentives and project financing relating to R&D in APEC, 2014

Economy	Tax deductions and allowances	Super deductions	Tax credits	Tax exemptions	Reduced corporate tax rates	Project financing (grants or loans)
Australia			✓			✓
Brunei Darussalam	✓			✓		✓
Canada			✓			✓
Chile	✓		✓			✓
China	✓	✓		✓	✓	✓
Hong Kong, China	✓					✓
Indonesia	✓					✓
Japan	✓		✓			✓
Korea			✓			✓
Malaysia	✓	✓		✓		✓
Mexico						✓
New Zealand						✓
Papua New Guinea	✓	✓				✓
Peru	✓					✓
The Philippines	✓			✓		✓
Russia	✓	✓		✓		✓
Singapore	✓	✓				✓
Chinese Taipei			✓			✓
Thailand	✓	✓		✓		✓
United States	✓		✓			✓
Viet Nam				✓	✓	✓

Source: Compiled by the APEC Policy Support Unit (PSU) using publicly available sources, including domestic tax authorities and other government agencies as well as information made publicly available by Deloitte, EY and KPMG.

Some APEC members have recently scaled-back their R&D tax incentive schemes. Although remaining as one of the most generous schemes globally, Canada recently curtailed its R&D tax incentive scheme by decreasing the federal tax credit from 20% to 15% and excluding certain qualifying R&D assets from immediate deduction for tax years ending after 2013. Australia's 2014-15 Federal Budget, currently under legislation, also reduces the tax credit rate by 1.5 percentage points. There is also a proposal currently being legislated in Australia to exempt very large companies (those with aggregate assessable income of AUD 20 billion or more) from claiming the incentive.

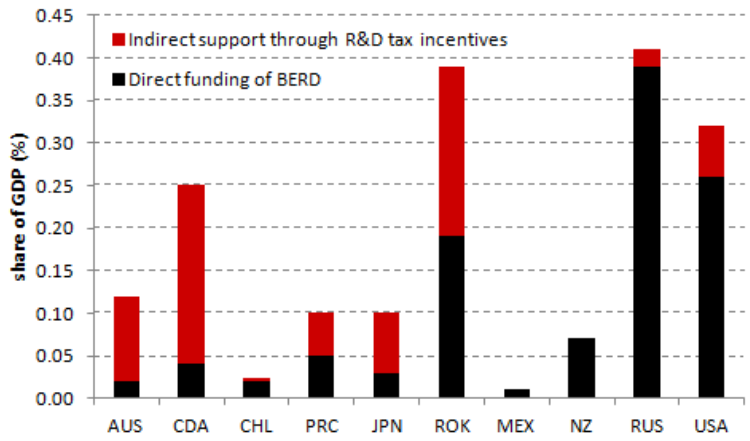
Meanwhile, other APEC members have recently expanded their R&D tax incentive schemes. Japan, which already has a mature R&D tax incentive scheme providing extensive benefits to firms conducting R&D, introduced the Asian Business Location Law in 2012. This incentive allows Japanese subsidiaries of qualifying multinational companies that establish R&D

operations in Japan to deduct up to 20% of income that is attributable to its R&D activities for the first five years. There are also several emerging APEC economies, such as Chile and Russia, that view increasing investment in innovation as the key to promoting competitiveness in their economies. In the past few years, both Chile and Russia have progressively introduced a wide range of incentives to promote R&D activities in their economies and to develop hubs of innovation and entrepreneurship.

There are also some APEC members that do not have a defined R&D tax incentive scheme, namely Indonesia; Mexico; and New Zealand. However, these economies still offer a number of other incentives in order to promote business investment in R&D. In Indonesia, although not specifically designed as an R&D tax incentive, businesses conducting R&D are eligible for various tax incentives under the general tax law as well as under schemes to promote investment more generally. Meanwhile, Mexico and New Zealand both offer direct subsidies in the form of grants and other funding schemes for qualifying R&D projects in order to support the development and commercialization of innovative technologies.

Governments often use a combination of direct spending and tax incentives in order to support business R&D in their economies. Data from the OECD shows the breakdown in government spending between direct spending on business enterprise research and development (BERD) and the amount of indirect support provided through R&D tax incentives in selected APEC economies in 2011 (Figure 13)[1]. The total amount of government support to business R&D, measured as a share of GDP, as well as the composition of that support, varies significantly across APEC members. Some economies, such as Russia and the United States, spend considerably more on direct funding of BERD than they do on providing indirect support through R&D tax incentives. In other economies, such as Australia; Canada; and Japan, the amount of indirect support provided through R&D tax incentives is considerably higher than that which is directly funded.

Figure 13. Government support to business R&D in selected APEC economies, 2011



Note: Data for Australia and Chile are from 2010; data for China are from 2009. The OECD states that this is an experimental indicator and that international comparability may be limited.
Source: OECD, Directorate for Science, Technology and Industry, Measuring R&D Tax Incentives online data.

As discussed earlier, the structure and implementation of tax incentives can also vary significantly between economies. Table 2 describes some of the main features of the major R&D tax incentive in each APEC economy, allowing for a closer examination of the schemes across the region. In most APEC economies, the major tax incentive mechanism is usually a

[1] It is important to note that the R&D incentives offered in an economy, and therefore the amount and composition of government spending, may have changed since 2011 in order to reflect current policy priorities. For instance, Russia has gradually reduced direct spending on R&D since 2011 in favor of providing indirect support through R&D tax incentives.

Table 2. Features of the major R&D tax incentives in APEC, 2014

Economy	Do the incentives apply to specific industries only?	Are there enhanced incentives available for SMEs or smaller enterprises?	Is pre-approval or advance notification necessary to claim the incentives?	Do the incentives include capital R&D expenditures (e.g., machinery)?	Do the incentives include offshore R&D expenditures?	Are the incentives based on volume (V) or incremental (I) amounts?	Is there a limit or cap to the amount that can be deducted or credited?	Can the incentives be refunded (R) or carried forward (CF) into future years?
Australia	no	yes	yes (advance notification)	some capital expenses	some offshore expenses (requires pre-approval)	V	proposed (very large companies to be exempted)	R (small companies) CF (large companies)
Brunei Darussalam	yes (wide range of industries)	no	yes (pre-approval)	yes (Pioneer Status)	no	V	no	---
Canada	no	yes	no	no	no	V	no	R (small companies) CF (large companies)
Chile	no	no	yes (pre-approval)	some capital expenses	yes (up to 50%)	V	yes	CF
China	yes (for most incentives)	no	yes (pre-approval)	some capital expenses	yes (up to 40%)	V	no	CF (for super deduction)
Hong Kong, China	no	no	no	yes	no	V	no	no
Indonesia	yes (52 sectors)	no	yes (pre-approval)	some capital expenses	no	V	no	CF
Japan	no	yes	no	depreciation allowance	yes	both	yes	CF (base credit amount over cap)
Korea	no	yes	no	yes	yes	both	yes (for large companies)	CF
Malaysia	no	no	yes (pre-approval)	yes	no	V	no	CF
Mexico	no	yes	yes (pre-approval)	some capital expenses	no	V	yes (maximum grant)	---
New Zealand	no	yes	yes (pre-approval)	some capital expenses	no	V	yes (maximum grant)	---
Papua New Guinea	no	no	yes (pre-approval)	some capital expenses	no	V	no	no
Peru	no	no	yes (pre-approval)	some capital expenses	no	V	yes	no
The Philippines	yes (for some incentives)	no	varies (some incentives require pre-approval)	yes	no	V	no	yes (deferred capital expenses)
Russia	yes (for some incentives)	no	varies (most incentives require pre-approval)	yes	no	V	yes (for some incentives)	CF
Singapore	no	yes	no	some capital expenses	yes (with limitations)	V	yes (for some schemes)	R & CF
Chinese Taipei	no	no	yes	no	unclear	V	yes	no
Thailand	no	no	varies (some incentives require pre-approval)	accelerated depreciation	no	V	no	CF (for BOI incentives)
United States	no	no	no	no	no	I	yes	CF
Viet Nam	no	no	yes (certification)	yes	no	V	no	CF

Source: Compiled by the APEC Policy Support Unit (PSU) using publicly available sources, including domestic tax authorities and other government agencies as well as information made publicly available by Deloitte, EY and KPMG.

tax deduction or a tax credit[2]. However, in some economies where there is more than one major incentive offered, an attempt has been made to consolidate the features of the various incentives for the purpose of this analysis. Additionally, in those economies without a defined R&D tax incentive scheme, the major fiscal package to promote business R&D, such as a grant program, is referenced instead.

In nearly all APEC economies, businesses in any industry that are conducting qualifying R&D activities are eligible to claim the main incentives that are offered. Some economies also offer additional incentives to businesses operating in targeted industries in order to strategically develop specific sectors of their economy (e.g., Chinese Taipei). In only a few

[2] Please see Annex 1 for more details about the R&D incentives offered in each APEC economy.

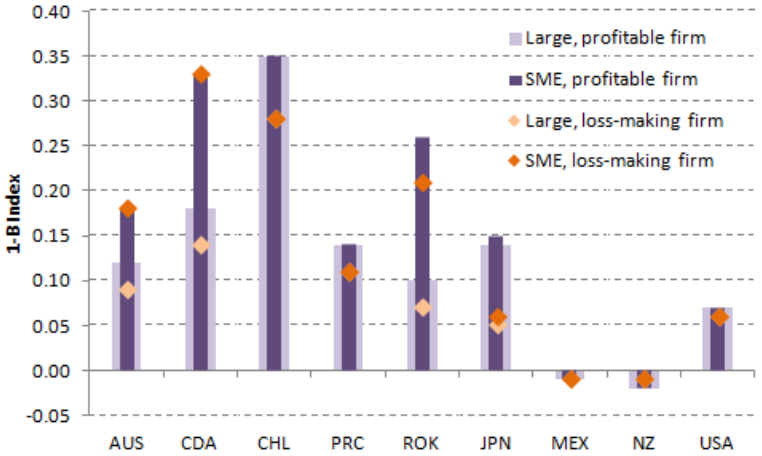
APEC economies is the eligibility to claim the main R&D tax incentive limited to businesses operating in certain industries. Most APEC members also require some form of prior notification or approval process before businesses can claim the incentives. In general, it is important that the procedures to apply for R&D funding or to become eligible for an R&D tax incentive are not too onerous. Otherwise, businesses may be limited in their use of the incentives if accessing them is too burdensome, particularly SMEs which may often lack the necessary resources to comply (OECD, 2000).

Examining the structure of major R&D incentives across the APEC region also allows for a better understanding of the differing levels of generosity of the schemes as well as the policy objectives behind the incentives. For example, several APEC members, such as Australia; Canada; Japan; and Korea provide more generous R&D incentives for smaller companies (e.g., higher tax credit rates than those offered to larger companies) in an effort to promote R&D investment and innovation by smaller firms. Also, although off-shore expenses relating to R&D activities conducted abroad are excluded from the incentives in most APEC economies, some, including Chile; China; Japan; Korea; and Singapore, allow such expenses to be claimed in an attempt to attract foreign R&D investment in their economies as well as to build international R&D networks.

Nearly all of the R&D tax incentives offered in the APEC region are based on volume amounts of qualified expenditure, with six economies offering super deductions and most also providing relief for some capital expenses. The United States is the only APEC member with an R&D tax incentive scheme that is based on incremental amounts of spending, while the incentive schemes offered in Japan and Korea are based on a combination of both volume and incremental amounts. About half of the APEC members apply some form of a cap to the amount that can be deducted or credited (or granted in direct funding schemes) in order to limit the cost of the incentive scheme.

In addition, most APEC members with an R&D tax incentive scheme allow businesses to carry-forward the allowance if they are in a loss position in a given tax year. Although some economies allow the amounts to be carried forward indefinitely or until fully utilized (Australia; Chile; Malaysia; Singapore), other APEC members usually set a limit of 5 years up to 20 years (Canada and the United States). Canada and the United States also offer a carry-back provision, while Australia and Canada allow small businesses to claim a refund of the tax credit. Given these provisions, data calculated by OECD indicates the implied tax

Figure 14. Implied tax subsidy rates on R&D expenditures in selected APEC economies, by firm size and profit scenario, 2013



Note: The implied tax subsidy rate is calculated as 1 minus the B-index, which is defined as the minimum present value of before-tax income necessary to pay the cost of R&D and to pay the corporate income taxes so that it becomes profitable for the firm to conduct R&D. The OECD states that this is an experimental indicator and that international comparability may be limited.
Source: OECD, Directorate for Science, Technology and Industry, Measuring R&D Tax Incentives online data.

subsidy rate on R&D based on firm size and profit scenario for several APEC economies in 2013 and illustrates the more generous treatment of SMEs in Australia; Canada; and Korea (Figure 14) [3].

[3] According to the OECD, the implied tax subsidy rate is calculated as 1 minus the B-index, which is the present value of before-tax income that a firm must generate in order to cover the cost of an R&D investment and pay the applicable corporate income taxes. Taking into account provisions in the tax system that allow for special treatment of R&D expenditures, it therefore reveals the impact of a tax system on private sector decisions to invest in R&D. It is customary to present this indicator in the form of an implied subsidy rate, or 1 minus the B Index (1-B Index). More generous R&D tax incentives imply a lower breakeven point for R&D expenditures and therefore a higher implied subsidy. For example, there is an implied tax subsidy rate of 12% for R&D expenditures incurred by large, profitable firms in Australia and 18% for those incurred by profitable SMEs.

4. ASSESSING THE EFFECTIVENESS OF R&D SUBSIDIES AND R&D TAX INCENTIVES

While it is generally agreed that markets may fail to provide the socially optimal quantity of R&D as it has some characteristics of a public good, there is also much debate over whether governments should in fact provide tax support for business R&D, and if so, to what extent. One of the considerations in providing R&D support is the fiscal cost. Figures 15 through 18 provide stylized presentations on the rationale for R&D support and the costs that accrue to the government through different fiscal policies. Among the three instruments being analysed, project-based R&D support is the most cost-efficient. However, criticism of direct government spending on R&D includes that it may "crowd out" investment from the private sector. In addition, with direct spending programs it can be difficult to determine whether the most beneficial projects are actually the ones that receive funding. Due to the intrinsic uncertainty of knowledge creation, subsidies may not actually be granted to those projects with the highest spillover gap.

Figure 15. Rate of private R&D investment with and without R&D subsidies or incentives

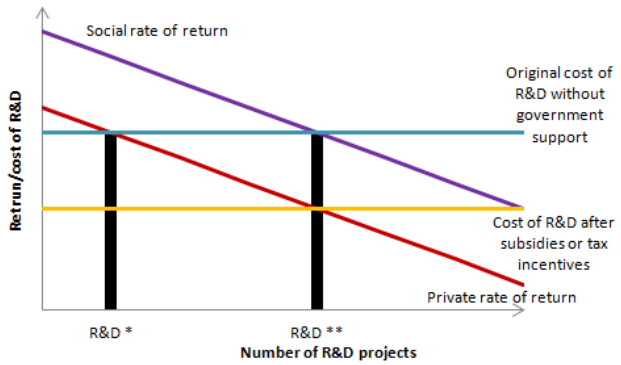


Figure 16. Cost of volume-based tax incentives to the government

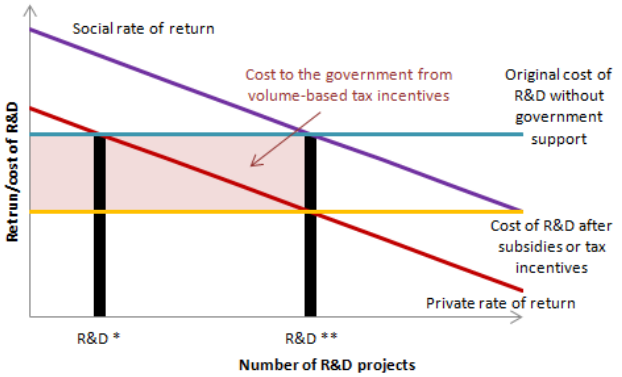


Figure 17. Cost of incremental tax incentives to the government

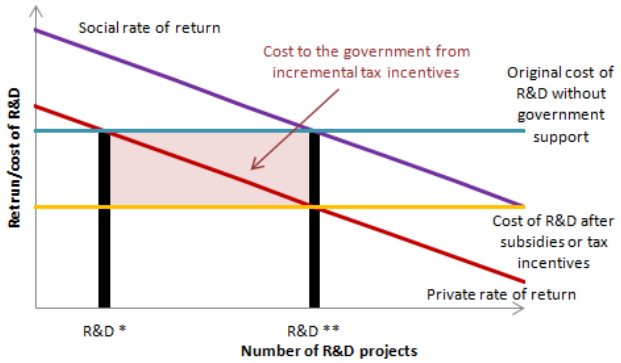
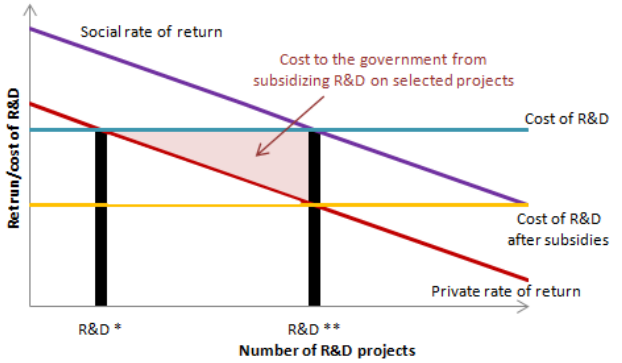


Figure 18. Cost of project-based R&D support to the government



Note: R&D* denotes the number of projects undertaken by the private sector without any subsides or tax incentives, while R&D** denotes the number of R&D projects that is socially optimal.
Source: APEC Policy Support Unit, adapted from producer tax subsidy theory.

Worldwide, there has been a trend towards R&D tax incentives. Critics of R&D tax incentives, however, argue that they create distortions in tax policy and that such schemes can be expensive for governments. As seen in Figure 16, the costs of providing volume-based tax incentives are comparably expensive. These programs may transfer a large cost from the

private sector to the government by supporting pre-existing R&D which would have been carried out even in the absence of R&D tax credits. Theoretically, incremental R&D tax incentive schemes, which only subsidize R&D that exceeds a base level, reduces the cost to governments, provided that the base is defined so as to avoid disincentive effects. However, the sheer complexity of an incremental R&D tax incentive scheme makes it difficult and costly to administer. Incremental schemes may also potentially lead to market distortions and uncertainty among firms. Some studies (Hollander et al, 1987) have found that such schemes encourage firms to exhibit recycling behaviour in order to maximize the benefits of the tax incentives.

Given the higher cost of tax incentives to the government, questions are raised as to whether they are effective in promoting increased private R&D expenditure. One of the most widely studied fiscal incentive mechanisms is the R&D tax credit scheme in the United States, which was introduced in 1981. Many researchers have attempted to estimate the tax price elasticity of total R&D spending, but with disparate results. Table 3 presents a summary of the results of some of the key studies. At a glance, it appears that empirical evidence concerning the effectiveness of R&D tax incentives is mixed. Estimations of private "R&D price elasticity" – which measures the percentage change in R&D investment resulting from tax relief for every percentage change in its after-tax price – vary significantly.

Table 3. Overview of the literature on the effectiveness of fiscal incentives for R&D

Study	Economy	Period	Industries	Method	R&D price elasticity	Input additionality
Einser et al. (1983)	USA	1980-1982	600 firms	Estimation of R&D price elasticities using dummy	Insignificant	n/a
Mansfield (1986)	USA; Canada	1981-1983	110 firms in the US 40 firms in Canada	Survey, asked if R&D tax incentives increased spending	Small	n/a
Berger (1993)	USA	1975-1988	Manufacturing (publicly listed enterprises only)	R&D demand estimation with tax credit shift parameter (pooled OLS with fixed effects)	1.0 to 1.5	USD 1.74
Hall (1993)	USA	1981-1991	Manufacturing (publicly listed enterprises only)	Estimation of R&D price elasticities using generalized method of moments	0.84 to 2.7	USD 2.00
Hines (1991)	USA	1984-1989	Manufacturing (publicly listed enterprises only)	Estimation of R&D price elasticities using generalized method of moments	1.2 to 1.6	n/a
Klassen et al. (2004)	USA; Canada	1991-1997	n/a	n/a	n/a	USD 3.0 for USA CAD 1.3 for Canada
McCutchen (1993)	USA	1975-1985	Pharmaceutical industry	R&D demand estimation with tax credit shift parameter (pooled OLS)	0.28	USD 0.29 to 0.35
Bloom et al. (2002)	8 OECD members (Canada; France; Germany; Italy; Japan; Spain; UK; USA)	1979-1997	Manufacturing	Estimation of R&D price elasticities using pooled OLS and instrumental variables	1.2 to 1.6	n/a
McKenzie and Sershun (2010)	9 OECD members (Australia; Canada; France; Germany; Italy; Japan; Spain; UK; USA)	1979-1998	Manufacturing	Estimation of R&D price elasticities using dynamic panel models (OLS, feasible GLS, Panel corrected standard errors Arellano-Bond)	0.46 to 0.77 (long-term)	n/a

Note: Input additionality refers to the change in R&D spending by per one unit of forgone tax revenue.
Source: Compiled by the APEC Policy Support Unit (PSU).

Einser et al. (1984) concluded that the 1981 tax credit program in the United States had a limited potential for stimulating R&D expenditure. Their conclusion was echoed by Mansfield (1986) who assessed the relevance of tax incentives to R&D spending in over 200 firms in Canada, Sweden and the United States using a survey approach. The results showed

that less than 2% of firms reported increases in R&D as a result of tax incentives. These early studies are at odds with later work by Berger (1993), Hall (1993) and Hines (1991) which found that the tax price elasticity of total R&D spending during the 1980s in the United States is on the order of unity or higher. In other words, these later studies found that the 1981 tax incentive scheme in the US effectively produced roughly a dollar-for-dollar increase in reported R&D spending. These studies also estimated the additionality effect and suggested that the benefits to society could, in some cases, be two or three times larger than the cost of R&D[4]. Hall (1993), for example, used data from over 1,000 manufacturing firms in the United States between 1981 and 1991 and found that tax credits had been successful in increasing private R&D investment. It was also estimated that firms increased their R&D spending by around USD 2 billion at an annual cost of around USD 1 billion in forgone tax revenue, a ratio of 2 to 1.

The disparate findings on the effectiveness of the R&D tax credit scheme in the United States can be attributed to many factors, including differences in methodologies and different data sets and sample sizes. One common thread among the evaluations in the 1990s is that the data from US firms was extracted from Compustat, a relatively comprehensive dataset. In contrast, earlier studies that were conducted in the 1980s had limited data sources available, e.g. internal tax data, surveys and interviews. Additionally, there are doubts about the robustness in the methodologies used in some studies. For example, the results obtained by Eisner were questioned on the ground that the R&D equation appeared to be mis-specified and that it did not contain any variable to capture the effect of the tax credit. Similar critiques were also raised on McCutchen's study of large pharmaceutical firms in the United States (1993), which also found a low tax price elasticity of R&D.

Finally, estimation results appear to be highly sensitive to the time lag between the implementation of a policy measure and the evaluation of its impact, with the earlier studies having been conducted following a rather short period of time. It might be the case that it takes some time for firms to adjust their R&D spending to the new tax incentive scheme due to the presence of adjustment costs that firms incur when increasing their investment in R&D (e.g., the hiring of scientists and engineers). Therefore, in the initial years following the introduction of a new or enhanced tax incentive scheme, the response from firms can be weak. Evidence from a wide range of econometric studies confirms that the responsiveness of investment to prices is lower in the short run than in the long run (Rao, 2013).

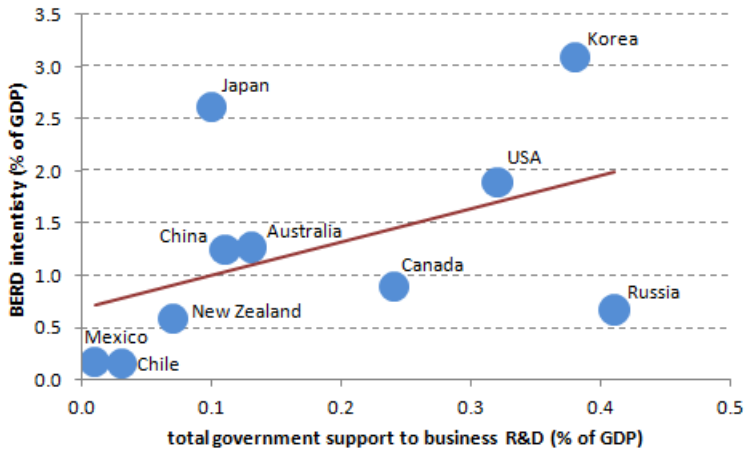
One should be cautious in interpreting the large estimates of price elasticity of R&D, however. There is a tendency that once firms learn about the tax incentives, they will shift expenses around in their accounting in order to maximize the portion of R&D that can qualify for the tax reduction. Whereas prior to the preferential treatment, firms may be indifferent about labelling expenditures as R&D or classifying them as any other outlays. This phenomenon, which is known as "relabelling", may lead to a spurious increase in reported R&D. Some studies, including Hall (1995) and Mansfield (1986), however, suggest that the incidence of this is relatively small, particularly in the long-term.

Outside of the United States, empirical studies on the impact of R&D tax incentives on other APEC members are limited to a few advanced economies. Czarnitzki et al. (1999)

[4] The input additionality of R&D tax incentives refers to the amount of R&D investment increases for every dollar foregone in tax revenues. It is measured by dividing the amount of R&D generated by the R&D tax incentives by the net tax revenue loss. An estimation of input additionality larger than one implies that tax incentives boost private R&D expenditure at an amount larger than the foregone tax revenues.

investigated the effectiveness of the tax incentive scheme in Canada, but from a different angle. The authors looked at the impact of R&D tax incentives on the innovation success of firms in terms of the frequency of new product development, the introduction of new-to-the-market products and the sales share of new products. They found a positive impact from the Canadian R&D tax credit on innovation success.

Figure 19. Government support to business R&D & business R&D intensity in selected APEC economies, 2011



Note: Data for Australia and Chile are from 2010; data for China are from 2009. Fitted trend line is a linear regression of changes in total government support to business R&D against changes in BERD intensity for the 10 economies shown. The OECD states that this is an experimental indicator and that international comparability may be limited.

Source: OECD, Directorate for Science, Technology and Industry, Measuring R&D Tax Incentives online data.

While the US and Canada demonstrate good cases for the use of R&D tax credits, it is not possible to make a broad assessment as to the impact that fiscal policies may have on increasing investment in R&D in other economies. This is due to variations in the incentive schemes across economies as well as the time lag between the implementation of a policy measure and the evaluation of its impact, particularly since tax incentive schemes may be frequently adjusted. On the surface, there does indeed appear to be a positive correlation between government support to business R&D and BERD intensity, which is defined as the amount of business enterprise research and development as a share of GDP, in the APEC region (Figure 19). Although it is only one contributing factor, those APEC members that provide a greater amount of government support typically also have a higher level of BERD intensity. Korea, for example, provides one of the highest levels of government support (as a share of its GDP) among the APEC members, but also has one of the highest levels of BERD intensity. Russia, however, also provides a substantial amount of government support, but has a relatively low BERD intensity, underlining the importance of designing incentives and schemes that are targeted to achieving policy objectives as well as ensuring that the procedures for businesses to access the incentives are not too onerous[5]. On the other hand, Japan has been quite successful in achieving a high level of BERD intensity while providing one of the lower levels of government support (as a share of its GDP) among the APEC members.

Empirically, studies that examine the effectiveness of R&D tax incentives in multiple economies offer inconclusive evidence. Bloom et al. (2003) used data from nine OECD members to estimate the correlation between aggregate R&D expenditure and the user cost of R&D, taking into account economy-specific effects. The results suggested that fiscal R&D incentives have a significant impact, but it varies over time: a 10% fall in the cost of R&D

[5] It is important to note that the R&D incentives offered in an economy, and therefore the amount and type of government support as well as its impact on BERD intensity, may have changed since 2011. For instance, Russia has substantially changed its R&D incentives scheme since 2011.

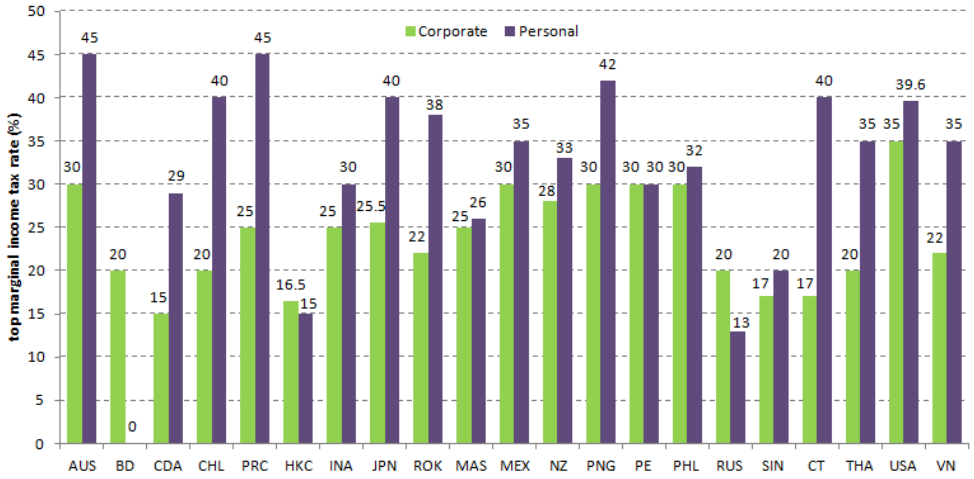
would stimulate an approximately 10% rise in the R&D level in the long run and just over a 1% rise in the short run.

McKenzie and Sershun used a similar data set, but yielded different results. In their study, the value of R&D price elasticity was half the amount found in Bloom et al.'s report. An essential difference between the two studies is that McKenzie and Sershun also took into account the economy-wide tax system. The authors argued that while tax subsidies may lower the cost of R&D, high taxes on production – or the fruit of R&D (new products and processes) – may punish success. As a result, the positive effect from R&D incentives may be countervailed by a high tax level in general. Their findings confirmed the decisive role of the general tax system in the extent of R&D activities. In this vein, Box 2 provides a brief examination of the overall tax systems in the APEC economies and their impact on the incentives for firms to invest.

Box 2. Assessment of the general tax systems on investment incentives in APEC

In a progressive tax regime – a system where different levels of income are taxed at different rates according to income brackets, as opposed to a flat tax system – the top marginal rate is the rate applied to each additional unit of taxable income above the highest income threshold. It differs from other rates, such as the average tax rate, which is the ratio of total taxes paid to total taxable income (taxes paid/taxable income), and the effective tax rate, which is the ratio of total taxes paid to total income (taxes paid/total income). The top marginal tax rate applied by the federal or central government to individuals and corporations resident in an economy is typically used to analyse how changes in income will impact tax obligations. For this reason, it is a useful measure in order to evaluate the difference in tax obligations between two different scenarios or strategies.

Figure 20. Top marginal tax rates on corporate and personal income, 2014



Note: Rates shown are the top marginal tax rates applied at the federal or central level to resident corporations and individuals as at 25 June 2014. Taxes applied at the state or provincial level are not included.

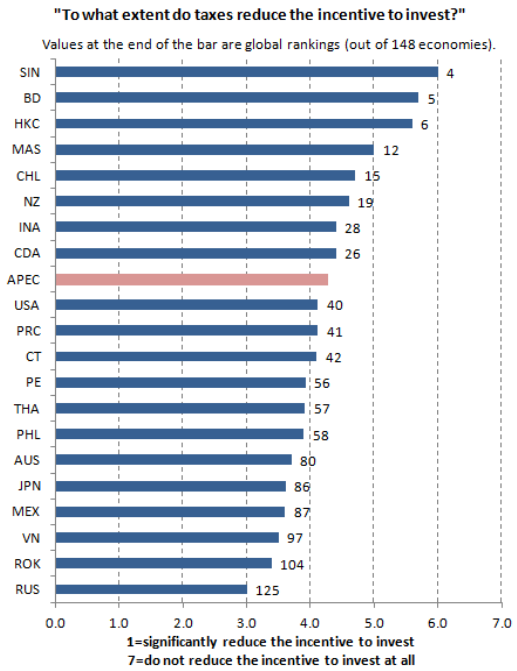
Source: APEC Policy Support Unit (PSU) based on publicly provided information from domestic tax authorities .

In most APEC economies, central governments apply a marginal income tax rate of at least 20% to corporations and a marginal income tax rate of at least 30% to individuals (Figure 20). It is very important to note that these rates do not include taxes that are applied at the state or provincial level, which can vary between states or provinces and which can also

substantially add to the overall tax burden in an economy. In addition, the thresholds upon which these tax rates are applied can vary significantly, particularly for personal income. For example, the top marginal rate of 39.6% is applied to personal taxable income above USD 406,750 for single taxpayers in the United States, while the top marginal rate of 45% is applied to personal taxable income above AUD 180,000 in Australia (approximately USD 170,000). Nevertheless, the top marginal corporate and personal income tax rates applied by federal or central governments allows for a useful comparison of tax rates across the region.

The effect of tax policies on incentives to invest varies greatly across the APEC region. Although not a precise indicator, the World Economic Forum's Executive Opinion Survey suggests that tax systems in the region may reduce the incentive to invest in many APEC economies (Figure 21). While the region includes some of the top performers globally (Singapore; Brunei Darussalam; and Hong Kong, China), many APEC members are below the APEC average, indicating that there is significant room for improvement in this regard for many economies. A tax regime that is more conducive to investment will help to unleash the potential for innovation across the region.

Figure 21. Effect of taxation on incentives to invest, 2013



Note: APEC average is a simple average. Data for Papua New Guinea are not available.
Source: World Economic Forum, Global Competitiveness Report 2013-2014 (Executive Opinion Survey).

5. CONCLUSION

As host of APEC 2014, China has specified "promoting innovative development, economic reform and growth" as one of the three priorities of the APEC agenda for this year, emphasizing the importance of innovation in APEC growth strategies. Indeed, innovation has long been a focus for APEC, as reflected consistently in APEC Leaders' Declarations since 2010. The analysis of the drivers of APEC growth since 1950 in this paper highlights the fundamental role played by innovation and technological capabilities in supporting economic progress in the region.

Over the past few decades, APEC has achieved impressive economic gains vis-à-vis the rest of the world. GDP growth in the region has outperformed the rest of the world, notwithstanding the diminishing trend of APEC's labor force expansion. Since 2000, the APEC region has reaped the benefits of earlier economic reforms and increased economic integration. Labor productivity gains have become the engine of APEC growth, contributing to 80% of APEC GDP growth between 2000 and 2007. The differences in economic growth between the APEC region and the rest of the world can be largely explained by the differences in the ability to generate and adapt to new technologies. The results of the growth accounting exercise conducted in this paper indicate that the single most significant factor driving APEC's labor productivity gains between 2002 and 2007 was enhanced production efficiencies, which were captured in the rapid rise of Total Factor Productivity growth.

Two emerging trends in recent years underscore the need for APEC's continued focus on promoting innovation. First, the 2008-09 Global Financial Crisis continues to impact APEC's competitiveness, with the contribution of TFP growth to the region's economic progress being reduced to one-third the contribution seen between 2002 and 2007. Going forward, with the APEC labor force being forecast to grow at a progressively slower rate, further boosting the region's productive efficiencies by expanding technological capacity is critical for the region to sustainably enhance economic welfare. Second, there exists a wide gap in the output produced per worker among APEC economies. The difference in TFP levels accounts for the bulk of labor productivity gaps across APEC economies. The lower TFP levels in many APEC economies, relative to that of the US, suggest a significant catch-up potential. Promoting innovative capability in firms should therefore become the cornerstone of economic development policies.

The focus of this paper has been on the role of fiscal and taxation policies in promoting R&D investment, which is viewed as one of the important inputs of innovative outcomes. In many economies, fiscal subsidies and tax incentives have become an integral part of a broader strategy to increase investment in R&D and promote innovation. Businesses have long considered tax incentives to be an important and sometimes necessary relief given the typically high costs of conducting R&D. However, a successful R&D fiscal incentive strategy depends to a large degree on understanding the different advantages and costs of the various instruments and designing them to best suit the government's overall economic growth policies. Tax incentives and direct subsidies, for example, have different roles within a policy mix for business R&D and are complementary to each other.

From an administrative point of view, tax incentives are the least burdensome way of increasing business R&D and can therefore be used to encourage an increase in R&D across the whole spectrum of firms. Therefore, if the government's objective is to increase R&D

intensity among firms from a relatively low level, tax incentives may be the most sensible approach. Meanwhile, direct subsidies are better suited to encourage higher risk projects and to meet specific policy goals. If the government's objective is to enlarge the R&D capacity within certain fields, subsidies would be the natural choice since it is more difficult to target specific fields or areas of R&D activities through tax incentives.

In recent years, APEC members have increasingly implemented fiscal incentives to encourage firms to undertake R&D, with all members offering some type of direct subsidy in the form of grants or loans in order to help businesses finance R&D projects. However, APEC economies differ widely in the use of R&D tax incentives. In some APEC economies, there are multiple R&D incentive packages available, while in others there may be one main incentive in the form of a tax deduction or credit. Some APEC economies, including Indonesia; Mexico; and New Zealand do not have a defined R&D tax incentive scheme. Therefore, the total amount of government support to business R&D varies significantly across the APEC members.

While it is generally agreed that markets may fail to provide a socially optimal quantity of R&D on the basis that it has some characteristics of a public good, R&D tax incentives are expensive. Volume-based R&D tax incentives may transfer a large cost from the private sector to the government by supporting pre-existing R&D which would have been carried out even in the absence of R&D tax incentives. Given their high costs, the dynamics of R&D subsidies and tax incentives have been widely debated, underscoring the need to better assess firms' reaction to the policies and the potential efficiency effects.

Among the APEC economies, the R&D tax credit scheme introduced in the United States in 1981 provides a good empirical base for evaluating the effectiveness of this instrument. This report summarises the findings of key econometric studies. At first glance, it appears that the empirical studies are inconclusive in terms of determining the effectiveness of R&D tax incentives. However, a careful review of some key studies suggests that the variations in the results are due to the methodological limitations which the various studies faced. In some studies that were conducted in the early 1980s, estimations of price elasticity of R&D – which measures the percentage change in R&D investment resulting from tax relief for every percentage change in its after-tax price – were generally lower. However, these studies were either conducted using a less robust data set or the R&D equation was not well specified. Additionally, the short time lag between the introduction of the incentive scheme and the evaluation exercises could also have resulted in lower estimates of price elasticity as firms often take time to adjust to new schemes.

Since 1990, evaluation techniques have become more reliable and sophisticated. The longer time lag since the introduction of the US tax credit in 1981 has also allowed for a longer time frame in order to evaluate its impact to a fuller extent. As a result, later studies found a statistically significant relationship between R&D tax incentives and increased levels of R&D investment. Many of these later studies not only concluded that R&D tax incentives have been effective in encouraging firms to undertake more R&D, but also suggested that the increases in private R&D often outweigh the fiscal costs of the tax incentives. In some studies, the estimated input additionality effects are larger than two, indicating that for every dollar forgone in tax revenue due to the tax credits, firms raise their R&D investment by 2 dollars. One can conclude that R&D tax incentives have been a useful tool to stimulate private R&D and raise the level of business R&D expenditure to a higher level in the United States.

The findings for the United States, however, cannot be generalised for other APEC economies due to the variations in incentive schemes across the region. Studies on the effects of the Canadian R&D tax credit scheme on the innovation success of firms found that the program had a positive impact on the frequency of new product development, the introduction of new-to-the-market products and the sales share of new products. Outside the United States and a few advanced APEC economies, empirical literature evaluating the effectiveness of R&D tax incentives is limited. Additionally, there are very few studies assessing incentive schemes across multiple economies, making it challenging to understand the economy-specific conditions and policy design features that determine the success or failure of an R&D tax incentive scheme. An examination of the data on the amount of government support to business R&D and BERD intensity across selected APEC economies reveals that there does indeed appear to be a positive correlation between the generosity of the R&D scheme and private R&D investment. Although it is only one contributing factor, those APEC members that provide a greater amount of government support typically also have a higher level of BERD intensity.

The limited availability of empirical studies evaluating the effectiveness of R&D subsidies and tax incentives in many APEC economies is a call for further research in this area. Developing APEC economies are at different stages of technological development and they possess different institutions and policy frameworks. Future studies in this area should therefore be fine-tuned to the economic context of developing economies. APEC can stimulate this shift in research agenda and foster the links between leading research institutions and policy makers. APEC's Finance Ministers' Process is an ideal platform to bring together tax policy experts and tax officials to share policy successes and failures and to engage in mutual learning.

Another observation is that despite the plethora of studies on the impact of R&D tax incentives, most of these studies refer to programs that took place in the 1980s and early 1990s, with only a few exceptions. As such, our knowledge on recently introduced and redesigned fiscal incentive schemes remains limited. Further refinement to the methodologies is also important in order to derive more accurate estimations of the economic costs and benefits of tax incentives. For instance, the effectiveness of R&D tax incentives has long been evaluated against the price elasticity or input additionality. Future approaches should take into account some other benefits that are brought about by increased innovative activities, such as employment gains and enhanced social welfare.

The effectiveness of R&D tax incentives depends to a great extent on their design and on the broader regulatory environment and its stability over time. Factors include well-functioning financial markets as well as the overall tax system. These factors can enhance the returns to investing in knowledge-based assets, thereby making R&D investment more attractive to private investors. R&D policies should also be transparent and consistent. OECD analysis suggests that the impact of R&D credits on private R&D expenditure will generally diminish in economies that have experienced a large number of R&D tax policy reversals (OECD, 2013a). It is therefore important that governments minimize policy uncertainty for firms by maintaining the continuity of R&D policies as long as possible.

ANNEX: FISCAL AND TAXATION POLICIES RELATING TO R&D IN APEC

The following table provides an overview of the major R&D incentives that are currently in place at the federal or central level in each APEC economy as at September 2014.

Economy	Fiscal and taxation policies relating to R&D
Australia	• R&D Tax Incentive: Tax credit scheme open to firms in all sectors who are conducting eligible R&D in Australia and who have registered their R&D activities by lodging an application annually with AusIndustry. There is a 45% refundable tax credit (equivalent to a 150% deduction) to eligible entities with aggregated turnover of less than AUD 20 million per annum and a 40% non-refundable tax credit (equivalent to a 133% deduction) to all other eligible entities. (The non-refundable tax offset can be carried forward indefinitely.) Most current and some capital expenses directly incurred while conducting either "core" or "supporting" R&D activities are eligible. Some offshore R&D expenses may also qualify subject to approval. The 2014-15 Federal Budget will reduce the tax credit rates to 43.5% and 38.5%, respectively, following the passage of legislation. Additionally, there is a proposal currently being legislated that would exempt companies with aggregate assessable income of AUD 20 billion or more from claiming the incentive. • Australia also has a number of grants and other incentives available to encourage innovation, including the recently announced Entrepreneurs' Infrastructure Programme with funding of AUD 484.2 million to support eligible businesses to develop and commercialize new ideas.
Brunei Darussalam	• Investment Incentives Order 2001: An enterprise operating in a designated pioneer industry can apply for Pioneer Status and be eligible for a corporate income tax exemption period of 5 years (businesses with fixed capital expenditure less than BND 2.5 million) or 8 years (businesses with fixed capital expenditure of BND 2.5 million or more). The tax exemption period can be extended for an additional 3 years, but cannot exceed 11 years in total. Those businesses located in a Hi Tech Park are eligible for a tax exemption period of 11 years, which can be extended for an additional 5 years, but cannot exceed 20 years in total. In addition, businesses with Pioneer Status are exempt from import duties on machinery, equipment, component parts, accessories, as well as raw materials not available or produced in Brunei Darussalam and intended for the production of pioneer products. The scheme also allows for carry-forward of loss and allowance. • Income Tax Act: Qualifying R&D expenditure (excluding capital expenditure) is allowed as a deduction in deriving chargeable income. • Brunei Research Incentive Scheme (BRISc): Government funding to finance research projects in the energy, environment, health

Economy	Fiscal and taxation policies relating to R&D
	care/health sciences, food security, and ICT sectors with up to BND 5 million available per project (an additional BND 5 million available on a case-by-case basis). Local companies are eligible for 80% funding; foreign firms who undertake research with the Institute of Higher Learning or a local government agency are eligible for 70% funding; foreign firms who undertake research independently are eligible for 50% funding.
Canada	• Scientific Research and Experimental Development (SR&ED) Program: Tax credit scheme open to businesses in all sectors conducting eligible R&D work in Canada. There is a tax credit of 15% on qualified SR&ED expenditures carried out in Canada, which can be carried forward for 20 years and carried back for 3 years. For small Canadian-controlled private corporations, this credit is increased to 35% on the first CDA 3 million of qualified SR&ED expenditures (subject to reductions). The 35% tax credit is 100% refundable for non-capital-related expenditures and 40% refundable for capital expenditures. • Starting in 2014, capital expenditures will no longer be eligible under the SR&ED tax credit scheme. However, under Canada's general corporate tax system, these R&D assets may qualify to be depreciated over a 3 year period. (Certain R&D assets, such as computer hardware, may be eligible for other accelerated depreciation schemes.) They may also qualify for manufacturing or processing investment tax credits ranging from about 5% to 10% of the qualifying expenditures. • Canada also has a large number of grant programs available to help fund R&D in Canada, including those to conduct applied research, those to develop R&D networks between academia and the private sector, and those to encourage international R&D partnerships.
Chile	• Research and Development Investment Tax Incentive: Foreign and domestic businesses in all sectors conducting R&D are required to seek pre-approval in order to claim the incentives. The scheme offers a tax credit of up to 35% of expenses incurred in certified in-house R&D projects or up to 35% of payments associated with certified R&D contracts entered into with research centers accredited by the Chilean Economic Development Agency (CORFO). For international companies, up to 50% of R&D activity conducted outside of Chile can be claimed as eligible expenses. The amount of the tax credit is limited to UTM 15,000 (approximately USD 1.1 million) and may be carried forward until fully utilized. The remaining 65% of R&D expenditures can be taken as a tax deduction. Uncertified R&D projects or uncertified R&D contracts are eligible for the 65% tax deduction, but not for the 35% tax credit. • CORFO also offers a large number of programs that provide grants and financing in order to fund R&D projects and support their commercialization and to attract international companies and institutions to establish R&D centers of excellence in Chile.
China	• Companies in encouraged industries that are granted High and New Technology Enterprise (HNTE) status pay a reduced corporate income

Economy	Fiscal and taxation policies relating to R&D
	tax rate of 15% instead of 25% for three consecutive years. • IT outsourcing, business process outsourcing, and knowledge process outsourcing companies in designated cities that are granted Advanced and New Technology Service Enterprise (ATSE) status pay a reduced corporate income tax rate of 15% instead of 25%. Staff education expenses of up to 8% of total salaries can be deducted from corporate income tax. Business tax exemption on revenue derived from off-shore outsourcing services. • A 150% super deduction for qualifying R&D expenditures when calculating taxable income, which can be carried forward for up to 5 years. • Specified R&D equipment imported by qualified foreign-invested R&D centers is exempt from customs duty, value-added tax (VAT), and consumption tax; input VAT on domestically manufactured equipment purchased by qualified domestic R&D institutes and foreign-invested R&D centers is refundable. • Business tax exemption on revenue derived from the transfer of qualified technology; the first RMB 5 million of profit is exempted from corporate income tax, while profit above RMB 5 million is eligible for a 50% reduction.
Hong Kong, China	• A 100% deduction is available for direct R&D expenditure conducted in-house, payments to approved research institutes, and capital expenditure on plant or machinery that is used for R&D purposes. • Innovation and Technology Fund (ITF): Provides funding through four schemes to support mainly applied R&D projects. The ITF will support up to 90% of the total project cost for platform research projects (those which are conducted by R&D centres or designated local public research institutes and which aim to benefit the entire industrial sector or a large segment of the sector) and up to 50% for collaborative research projects (those between R&D centres or designated local public research institutes and private companies).
Indonesia	• There is currently no defined R&D-based tax incentive scheme in Indonesia. However, under the tax law, expenses from conducting R&D activities in Indonesia may be claimed as a tax deduction in calculating taxable income. In addition, under the Tax Allowance Incentive Scheme, which is available for new investments or investments for the purpose of expansion, businesses conducting eligible R&D may qualify to carry forward and claim tax losses for an additional year (following the standard 5 years) if the proportion of the R&D investment is at least 5% of the total investment within 5 years. This scheme also allows for accelerated depreciation and amortization of capital assets. • Indonesia does provide grants for R&D; however, the funding is limited and often short-term only.
Japan	• R&D Tax Credit: A tax credit of 8-10% of total qualifying R&D expenses is available for large companies, while a tax credit of 12% of total qualifying R&D expenses is available for SMEs (defined as companies whose capital does not exceed JPY 100 million). The tax credit

Economy	Fiscal and taxation policies relating to R&D
	is limited to 20% of the company's corporate income tax liability amount, with the excess portion allowed to be carried forward for 1 year. For fiscal years beginning 1 April 2013 through 31 March 2015, the tax credit limit is increased to 30% of the company's corporate income tax liability amount. • Additional R&D Tax Credit: When a company's qualifying R&D expenses exceed certain benchmarks set in previous years, an additional tax credit of up to 10% of the company's corporate income tax liability is available. Companies may be able to claim either the Incremental R&D Tax Credit (5% of incremental qualifying R&D expenses) or the Excess R&D Tax Credit (qualifying R&D expenses in excess of an amount equivalent to 10% of average sales, multiplied by a certain percentage). • Asian Business Location Law: Japanese subsidiaries of qualifying multinational companies which start R&D operations in Japan can deduct up to 20% of income that is attributable to its R&D activities for the first 5 years. (Companies are required to submit an R&D business plan and obtain pre-approval before claiming the incentive. This incentive cannot be claimed in conjunction with the R&D Tax Credit.)
Korea	• R&D Tax Credit: For large corporations, the credit equals the greater of either (1) 40% of eligible current-year R&D expenses exceeding the average of R&D expenditures in the 2 prior years, or (2) 3% of eligible current-year R&D expenses plus an additional rate defined as 50% of the R&D expense ratio (capped at 6%). For SMEs, the credit equals the greater of either (1) 50% of eligible current-year R&D expenses exceeding the average of R&D expenditures in the 2 prior years, or (2) 25% of eligible current-year R&D expenses. For R&D current-year expenditure incurred by new, high growth companies with original technology, the credit is increased to 20% for large corporations and 30% for SMEs. Unutilized R&D tax credits can be carried forward for up to 5 years. • R&D Facility Tax Credit: An additional tax credit of 10% of the cost of developing a new R&D facility may also be available in the year that the facility is completed. • Korea also has a number of incentives available in order to promote domestic R&D centers as well as foreign investment in R&D in Korea, including additional tax credits, tax exemptions, and subsidies and cash grants. For instance, an R&D center registered in a designated R&D special zone and performing specified R&D activities is fully exempted from corporate tax for the first three years with a 50% exemption granted for the subsequent two years.
Malaysia	• Investment Tax Allowance (ITA): Companies performing in-house R&D may qualify for an ITA of 50% on the qualifying capital expenditure incurred within 10 years, while R&D service providers may qualify for an ITA of 100% on the qualifying capital expenditure incurred within 10 years. The company can offset the ITA against 70% of its statutory income for each year of assessment, with any

Economy	Fiscal and taxation policies relating to R&D
	unutilized allowances carried forward to subsequent years until fully realized. • Super deduction: Companies performing in-house R&D may be eligible for a 200% super deduction for qualifying non-capital expenditures incurred in qualifying R&D, subject to approval. This super deduction can also be claimed for cash contributions or donations made to approved research institutes and for payments for the use of services of approved research institutes, approved research companies, R&D companies, or contract R&D companies. • Pioneer Status Income Tax Exemption: The Ministry of Finance may grant "Pioneer Status" to companies deriving income from certain activities and products that benefit the Malaysian economy such as R&D companies, high-tech companies, software development companies, and manufacturing companies producing world-class products. Statutory income earned by an R&D company granted Pioneer Status is eligible for a 70% to 100% income tax exemption for a period of 5years, which can be extended for another 5 years upon approval. • Under the Special Incentive Package, R&D grants are made available on a reimbursement basis for qualifying R&D expenditures under approved projects. Applicants may also be able to negotiate income tax exemptions for a specific period and and/or an ITA on qualifying capital expenditures incurred for a specific period.
Mexico	• High Added Value Technological Innovation for Technological Research, Development, and Innovation (INNOVAPYME): Provides cash grants to technologically innovative Mexican SMEs that provide high levels of added value of up to USD 1.6 million per company for eligible R&D expenses paid by the company. Benefits include (1) 30% of the current year's R&D expenditure on an individual project and (2) 35% of the current year's expenditure and 75% of research centers' and universities' expenditure on linked projects incurred during the current year. • Development and Innovation of Precursor Technologies for Technological Research, Development, and Innovation (PROINNOVA): Provides cash grants to Mexican companies engaged in the development and innovation of initial technologies of up to USD 2.08 million per company for eligible R&D expenses paid by the company. Benefits include 35% of the current year's expenditures (increased to 50% for SMEs) and 75% of the research centers' and universities' expenditure incurred in the current year. • Technological Innovation to Enhance Competitiveness for Technological Research, Development, and Innovation (INNOVATEC): Provides cash grants to Mexican companies engaged in technological innovation for competitiveness of up to USD 2.77 million per company for eligible R&D expenses paid by the company. Benefits include: (1) 25% of the current year's R&D expenditure on an individual project and (2) 30% of the current year's expenditure and 75% of research centers' and universities' expenditure on linked projects incurred during the current year.

Economy	Fiscal and taxation policies relating to R&D
New Zealand	• New Zealand has various grant funding initiatives to support the creation and commercialization of innovative technologies. For instance, the R&D Growth Grant provides funding equal to 20% of the qualifying firm's eligible R&D expenditure for a period of 3 years, up to a maximum of NZD 5 million per year. (After 2 years of funding, firms can apply for a 2-year extension.) For smaller firms, the government offers an R&D Project Grant, which typically provide support of 30% to 50% of eligible R&D costs.
Papua New Guinea	• A 150% tax deduction is available for scientific R&D expenditure carried out under an R&D plan that has been approved by a committee chaired by the Internal Revenue Commission (IRC).
Peru	• Qualifying expenditure incurred to undertake R&D activities in Peru is deductible subject to a limit of 10% of net revenue per year, with a maximum limit of 300 UIT (approximately PEN 1.14 million). • Funding for Innovation Projects (FINCyT): Peru, together with the Inter-American Development Bank (IDB), has made USD 100 million available for the financing of innovation projects, scientific research, and postgraduate scholarships.
The Philippines	• Companies can deduct 100% of current R&D expenditures from gross income (as ordinary and necessary expenses) and can also chose to defer qualifying R&D expenditures on capital over a period of at least 60 months. • Investment Priorities Plan (IPP): Enterprises engaged in R&D activities such as the establishment of research or testing laboratories may apply to the Board of Investments (BOI) to be entitled to a four-year income tax holiday on income derived from the registered R&D activity as well as other fiscal and non-fiscal incentives. • IT Zones: An enterprise engaged in IT service activities such as IT R&D and located inside a registered IT zone may register with the Philippine Economic Zone Authority (PEZA) to be eligible for various incentives, including an extended income tax holiday and an exemption from import duties and taxes on imported machinery and equipment and raw materials. • Cash gifts or donations made to an accredited research institution or organization shall be exempt from the donor's tax provided that no more than 30% of the gift is used for administration purposes. Donations made to an accredited NGO operating exclusively for scientific, research and educational purposes shall be deductible in full from the taxable business income of the donor provided that no more than 30% of the gift is used for administration purposes.
Russia	• Companies can apply for a 150% super deduction of qualifying R&D expenses incurred for eligible activities to reduce profit tax. Unutilized expenses may be carried forward for up to 10 years.

Economy	Fiscal and taxation policies relating to R&D
	• Special Economic Zones (SEZs): There are currently 26 SEZs established across Russia under one of four categories: Manufacturing, Technology & Innovation, Tourism, and Port. Companies registered within one of the four Technology & Innovation SEZs can benefit from a profit tax exemption, a property tax exemption (normally 2.2%), a free customs zone, reduced social security rate of 14% (normally 30%) on annual remuneration up to a cap of RUB 568,000 with remuneration exceeding the cap exempt. • Skolkovo Innovation Centre: Companies resident in the Skolkovo Innovation Centre receive a profit tax exemption, a VAT exemption (normally 18%), a property tax exemption, and a reduced social security contribution rate of 14% on annual remuneration up to a cap of RUB 568,000 with remuneration exceeding the cap exempt, as well as cash grants. • Russia also has a number of other R&D tax incentives available, including accelerated depreciation that can be applied to fixed assets used in R&D activities; reduced social security contributions for companies involved in developing software; an import VAT exemption for qualifying technological equipment that has no equivalent produced in Russia; direct grants of USD 1-5 million for a qualifying R&D project in a strategic area such as energy efficiency; as well as a wide range of regional tax incentives.
Singapore	• A 100% deduction is available for qualifying R&D project, regardless of whether the R&D activities are conducted in Singapore or overseas. Unutilized losses may be carried forward indefinitely. • An additional 50% deduction is available on certain expenditure on R&D activities performed in Singapore. • To encourage businesses to invest in innovation and productivity, the additional deduction has been increased to 300% on the first SGD 400,000 of eligible R&D expenditure for the years of assessment ("YA") 2011 to 2018, with a combined expenditure cap of SGD 800,000 for the YAs 2011 to 2012, SGD 1.2 million for the YAs 2013 to 2015, and SGD 1.2 million for the YAs 2015 to 2018. This additional deduction also applies to eligible R&D expenditure incurred overseas. • Eligible businesses also have the option to convert up to SGD 100,000 of qualifying expenses into cash in each year of assessment, at a 60% conversion rate for the YAs 2013 to 2018. • An additional 100% deduction (capped at a maximum of 200%) is available on R&D expenditure incurred on projects approved by the Economic Development Board (EDB) on and before 31 March 2015. Unutilized losses may be carried forward indefinitely. • Research Incentive Scheme for Companies (RISC): Cash grants are available for approved R&D projects to assist companies in setting up R&D centers in Singapore and to develop their R&D capabilities. Qualifying manpower-related costs receive 50% support, while qualifying equipment, materials/consumables and software costs, professional services, and intellectual property rights receive 30% support.

Economy	Fiscal and taxation policies relating to R&D
Chinese Taipei	• Statute for Industry Innovation: A tax credit of 15% of total R&D expenditure can be claimed against total corporate tax payable in the year it is incurred. The credit amount is capped at 30% of the total corporate tax payable and cannot be carried forward. Businesses in all industry sectors conducting qualifying R&D must seek approval in order to claim the credit. Currently, it is unclear whether offshore R&D expenditure is eligible for the tax credit. • There are also various tax incentives available for businesses conducting qualifying R&D activities in specific industries. For instance, companies operating in the biotechnology and new pharmaceutical industry are entitled to a tax credit of 35% on qualifying R&D activities, which may be carried forward for up to 5 years. • Chinese Taipei also has a number of grant programs available to encourage innovation. For instance, SMEs can apply to the Small Business Innovation Research (SBIR) program for subsidies covering up to 50% of the total cost of R&D.
Thailand	• Revenue Department Incentives: A 200% deduction is available for eligible expenditure incurred on R&D activities carried out in Thailand by R&D Service Providers (companies or government entities that have been approved by the Revenue Department). In addition, there is an accelerated depreciation rate of 40% available for qualifying machinery and equipment used in R&D. • Board of Investment (BOI) Incentives: Companies which have been granted an investment incentive by the BOI to conduct R&D are entitled to a corporate income tax exemption on the net profit derived from the R&D activity for 8 years (biotechnology companies located in a science and technology park are entitled to a 50% reduction of corporate income tax for an additional 5 years), and an import duty exemption on machinery for use in R&D. Tax losses during the exemption period can be used to offset net taxable profit for up to 5 years after the exemption period.
United States	• Tax Credit: A non-refundable tax credit to reduce a business's federal tax liability is available for qualified research expenses incurred in the US that exceed one of two computed base amounts. In general, the credit is limited to a maximum of 25% of the regular tax liability and unutilized credit may be carried back for one year (five years for SMEs) and carried forward for 20 years. The Regular Credit is computed by measuring R&D spending as a percentage of the business's gross receipts; a business will likely be eligible for this credit if it is increasing its qualified research expenses as a percentage of gross receipts measured against a historical period. After computational adjustments, including a minimum base amount equal to 50% of current qualified research expenses, the maximum value of the Regular Credit is 6.5% of the business's qualified research expenses. The Alternative Simplified Credit is equal to 9.1% of the business's increase in qualified research expenses in the current year over 50% of the average qualified research expenses for the prior three years. If there are no qualified research expenses in the prior three years, then the credit is equal to 6% of qualified research expenses in the current tax period.

Economy	Fiscal and taxation policies relating to R&D
	• Tax Deduction: A 100% deduction of direct costs of R&D is allowed and can be claimed retroactively for three years. (Costs associated with overhead and the acquisition of depreciable property are excluded.) However, taxpayers must reduce the current deduction by the amount of the tax credit; otherwise, they can elect to take the Regular Credit at a reduced rate of 13% or 9.1% for the Alternative Simplified Credit.
Viet Nam	• High Technology Incentives: Qualifying enterprises conducting high-tech R&D are entitled to the following incentives: (1) corporate income tax rate reduction to 10% applicable for 15 years (receiving a 4-year exemption and a 50% deduction on the applicable tax rate for 9 years), which can be extended to 30 years subject to approval; (2) VAT exemption on transfers of technology; (3) a 5-year exemption from import duties on imported goods that are not yet able to be produced domestically to create fixed assets used in a qualifying R&D project, including raw materials, materials and component parts; (4) preferential land lease fees; and (5) funding schemes through the federal high-tech development program are available for training, R&D, or pilot production costs. Tax losses can be carried forward for up to 5 years. • Science Research and Technology Development Incentives: Qualifying enterprises conducting R&D in scientific research and technology development are entitled to the following incentives: (1) corporate income tax rate reduction to 10% applicable for 15 years (receiving a 4-year exemption and a 50% deduction on the applicable tax rate for 9 years), which can be extended to 30 years subject to approval; (2) 1-year corporate income tax exemption on income earned from the performance of contracts for scientific research and technological development, from the sale of products during their test production, and from products made from new technology applied for the first time in Viet Nam; (3) profits before tax may be used to establish a fund for scientific and technology development within the enterprise, subject to a limit of 10% of total taxable income; (4) a reduced 5% VAT rate may be applied to eligible activities and services, while machinery, equipment and material imported for scientific research and technology development are exempt from VAT at the import stage; and (5) various import duty exemptions, including an exemption on imported goods directly used for scientific research and technology development and a 5 year exemption on imported goods that are not yet able to be produced domestically to create fixed assets used in a qualifying R&D project. Tax losses can be carried forward for up to 5 years.

Source: Compiled by the APEC Policy Support Unit (PSU) using publicly available sources, including domestic tax authorities and other government agencies as well as information made publicly available by Deloitte, EY, and KPMG.

REFERENCES

Andrews, Dan and Chiara Criscuolo (2013). "Knowledge-based Capital, Innovation and Resource Allocation: A Going for Growth Report", *OECD Economic Policy Papers*, No. 4, OECD Publishing, May 2013.

Archibugi, Daniele, Andrea Filippetti, and Marion Frenz (2013). "The Impact of the Economic Crisis on Innovation: Evidence from Europe", *Technological Forecasting & Social Change*, Vol. 80, Issue 7, September 2013, pp. 1247-1260.

Arrow, Kenneth (1962). "*Economic Welfare and the Allocation of Resources for Invention*", Princeton University Press, New Jersey.

Atkinson, Robert D. (2007). "Expanding the R&D Tax Credit to Drive Innovation, Competitiveness and Prosperity", *The Journal of Technology Transfer*, Vol. 32, Issue 6, pp. 617-628.

Berger, Philip G. (1993). "Explicit and Implicit Tax Effects of the R&D Tax Credit", Journal of Accounting Research, Vol. 31, Issue 2, Autumn 1993, pp. 131-171.

Bloom, Nicholas, Rachel Griffith, and John Van Reenen (2007). "Do R&D Tax Credits Work? Evidence from a Panel of Countries 1979-1997", Stanford Institute for Economic Policy Research, SIEPR Discussion Paper No. 07-20, November 2007.

Busom, Isabel, Beatriz Corchuelo, and Ester Martinez Ros (2012). "Tax Incentives or Subsidies for R&D?", UNU-MERIT Working Paper Series #2012-056, July 2012.

The Conference Board, Total Economy Database, January 2014.

Correa, Paulo, Luis Andrés, and Christian Borja-Vega (2013). "The Impact of Government Support on Firm R&D Investments: A Meta-Analysis", Policy Research Working Paper No. WPS 6532, The World Bank, July 2013.

Czarnitzki, Dirk, Petr Hanel, and Julio Miguel Rosa (2011). "Evaluating the impact of R&D tax credits on innovation: A microeconometric study on Canadian Firms", *Research Policy*, Vol. 40, pp. 217-229.

Deloitte (2013). "2013 Global Survey of R&D Tax Incentives", March 2013.

Eisner, Robert, Steven H. Albert, and Martin A. Sullivan (1984). "The New Incremental Tax Credit for R&D: Incentive or Disincentive?", *National Tax Journal*, Vol. 37, No. 2, June 1984.

EY (2013a). "2013 Asia-Pacific R&D Incentives".

EY (2013b). "Worldwide R&D incentives reference guide 2013-2014".

Feenstra, Robert C., Robert Inklaar, and Marcel P. Timmer (2013). "The Next Generation of the Penn World Table".

Filippetti, Andrea and Daniele Archibugi (2011). "Is the Economic Crisis Impairing Convergence in Innovation Performance across Europe", *Journal of Common Market Studies*, Vol. 49, Issue 6, pp. 1153-1182, November 2011.

Griliches, Zvi (1991). "The Search for R&D Spillovers", NBER Working Paper No. 3768, July 1991.

Hall, Bronwyn H. (1992). "R&D Tax Policy During the Eighties: Success or Failure?", NBER Working Paper No. 4240, December 1992.

Hall, Bronwyn H. (1995). "Effectiveness of Research and Experimentation in Tax Credits: Critical Literature Review and Research Design", Report to Office of Technology Assessment, Congress of the United States.

Hall, Bronwyn H. and John van Reenen (1999). "How Effective are Fiscal Incentives for R&D? A Review of the Evidence", NBER Working Paper No. 7098, April 1999.

Hines, James (1991). "On the Sensitivity of R&D to Delicate Tax Changes: The Behavior of U.S. Multinationals in the 1980s", NBER Working Paper No. 3930, December 1991.

Hollander, Abraham, Alain Haurie, and Pierre L'Ecuyer (1987). "Ratchet effects and the cost of incremental incentive schemes", *Journal of Economic Dynamics and Control*, Vol. 11, Issue 3, pp. 373-389, September 1987.

Kasahara, Hiroyuki, Katsumi Shimotsu, and Michio Suzuki (2013). "Does an R&D Tax Credit Affect R&D Expenditure? The Japanese R&D Tax Credit Reform in 2003", CES Working Paper No. 4451, October 2013.

Köhler, Christian, Philippe Laredo, and Christian Rammer (2012). "The Impact and Effectiveness of Fiscal Incentives for R&D", NESTA Working Paper 12/01, January 2012.

Mansfield, Edwin (1986). "The R&D Tax Credit and Other Technology Policy Issues", *The American Economic Review*, Vol. 76, No. 2, pp. 190-194, May 1986.

McKenzie, Kenneth J. and Natalia Sershun (2010). "Taxation and R&D: An Investigation of the Push and Pull Effects", *Canadian Public Policy*, Vol. 36, Issue 3, pp. 307-324, September 2010.

Nelson, Richard (1959). "The Simple Economics of Basic Scientific Research", *The Journal of Political Economy*, Vol. 67, pp. 297-306.

OECD, Directorate for Science, Technology and Industry, Measuring R&D Tax Incentives online data.

OECD (1993). "*The Measurement of Scientific and Technical Activities: Proposed Standard Practice for Surveys of Research and Experimental Development*", OECD Publishing.

OECD (2000). "*Reducing the Risk of Policy Failure: Challenges for Regulatory Compliance*", OECD Publishing.

OECD (2006). "*Live Longer, Work Longer: A synthesis report*", OECD Publishing.

OECD (2013a). "Raising the Returns to Innovation: Structural Policies for a Knowledge-based Economy", *OECD Economics Department Policy Notes*, No. 17, May 2013.

OECD (2013b). *OECD Science, Technology and Industry Scoreboard 2013*, OECD Publishing.

Palazzi, Pamela (2011). "Taxation and Innovation", *OECD Taxation Working Papers*, No. 9, OECD Publishing, November 2011.

Rao, Nirupama (2013). "Do Tax Credits Stimulate R&D Spending? The Effect of the R&D Tax Credit in its First Decade", New York University Wagner Research Paper No. 2272174, April 2013.

Thomson, Russell (2013). "The Effectiveness of R&D Tax Credits: Cross-Industry Evidence", Melbourne Institute of Applied Economic and Social Research, Working Paper No. 18/13, The University of Melbourne, May 2013.

Verspagen, Bart (1995). "R&D and Productivity: A Broad Cross-Section Cross-Country Look", *The Journal of Productivity Analysis*, Vol. 6, pp. 117-135.

Wang, Jiann-Chyuan and Kuen-Hung Tsai (2003). "Productivity Growth and R&D Expenditure in [Chinese Taipei]'s Manufacturing Firms", NBER Working Paper No. 9724, May 2003.

World Bank, World Development Indicators online database.

World Economic Forum (2013). "*The Global Competitiveness Report 2013-2014*", Geneva.

Tax Authorities in the APEC Region

Australia: Australian Taxation Office

Brunei Darussalam: Ministry of Finance, Revenue Division

Canada: Canada Revenue Agency

Chile: Chilean Tax Administration (Servicio de Impuestos Internos)

China: State Administration of Taxation

Hong Kong, China: Inland Revenue Department

Indonesia: Indonesia Tax Office (Direktorat Jenderal Pajak)

Japan: National Tax Agency

Korea: National Tax Service

Malaysia: Inland Revenue Board of Malaysia (Lembaga Hasil Dalam Negeri Malaysia)

Mexico: Tax Administration Service (Servicio de Administración Tributaria)

New Zealand: Inland Revenue Department

Papua New Guinea: Internal Revenue Commission

Peru: Superintendencia Nacional de Administración Tributaria (SUNAT)

Philippines: Bureau of Internal Revenue

Russia: Federal Tax Service of Russia

Singapore: Inland Revenue Authority of Singapore

Chinese Taipei: Taxation Administration

Thailand: Revenue Department

United States: Internal Revenue Service

Viet Nam: General Department of Taxation