Chapter 1. Impact of taxation in agriculture: Literature review

This chapter examines relevant findings from the literature on taxation and agriculture, focusing on four areas: the impact of income tax on income levels and variability; the impact of property taxes on farm transfers and structural adjustment; the impact of taxation on investment and innovation; and the performance of tax instruments for improving environmental sustainability.

The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

1.1. Background

Previous OECD work in this area concluded that, while tax policies as they relate to agriculture can take different forms depending upon the country, they can generally be classified according to the following typology: taxes on income, profits and capital gains; social security contributions[1] (which are a mixture of tax, duty and insurance); taxes on payroll and workforce which concern farm operators as employers; taxes on property (including taxes on property transfer); and taxes on goods and services (including sales tax and VAT) (OECD, 2005[1]). While the sector is certainly affected by the levying of different tax provisions in these areas, it also benefits relative to other sectors through the granting of tax concessions. A given tax measure is considered to be a "tax concession" to agriculture if it results in differential treatment to the sector in such a way that agriculture is favoured, resulting in some foregone tax revenue, or "tax expenditure". Furthermore, any given tax measure is only considered as an agricultural tax concession in the OECD framework to measure agricultural support if the policy mainly benefits the agricultural sector and not other sectors to which they may also apply [e.g. fisheries, small and medium-sized enterprises (SMEs)]. Some commonly utilised concessions include special tax rates applied to farmer income; allowing income tax averaging to smooth income across years given that income from agriculture is more volatile than income in most other sectors; special treatment for depreciation (in particular through accelerated write-offs) to encourage investment; preferential treatment on property taxes applied at transfer by sale, gift or death to facilitate farm transition with minimal disruption to producing activities; and preferential treatment on taxes on inputs, outputs, or VAT (including fuel tax exemptions).[2] Previous OECD work on taxation in agriculture emphasised that tax concessions are used as a vehicle to achieve a wide variety of objectives in the sector (OECD, 2005[1]). However, a comparative analysis of these regimes is complicated by the fact that some of the observed measures are not viewed as agricultural concessions in some countries, as the same treatment is available for non-farm households.

Given the ubiquity of agricultural tax concessions, it would be rational to anticipate that a substantial body of scholarship would have analysed the effects of these concessions. Instead, only a handful of studies devoted to these mechanisms within the sector were identified, with much of the evidence base covered in this review drawn from more generic, economy-wide analyses. This gap is a consequence of various factors, including the lack of uniformity in national tax structures that complicates cross-country analysis efforts; the reduced public scrutiny on these policies since they result in foregone revenue rather than direct budget outlays; the necessity of sifting through multiple layers of tax regulation (national, regional, local) in any comprehensive analytical framework; and the political sensitivity of analysing agricultural taxation provisions (OECD, 2005[1]; Hill and Blandford, 2007[2]). Nevertheless, tax provisions, whether concessional or not, can have substantial repercussions for farm income, input use, transfer arrangements, and investment decisions. The current analysis picks up where previous work left off, focusing on what the literature in the wake of the report has concluded regarding four primary areas of interest related to taxation in agriculture:

- The impact of income taxes on income levels and variability
- The impact of property taxes on farm transfers and structural adjustments
- The impact of taxation on investment and innovation
- The performance of tax instruments for improving environmental sustainability.

This literature review focuses on specifically providing evidence on the extent and the efficiency implications of taxation in these areas. Although taxation analysis raises additional questions surrounding policy effectiveness with respect to revenue-raising objectives and equity considerations, those topics are considered to be outside the scope of the current review.

Although the literature review focuses on these four areas, there is also a recognition that it can be difficult to fully disentangle the various means through which taxation affects agriculture. In the first place, there are undoubtedly many tax provisions that either do not target or are not specific to agriculture that can have an effect on farm income, farm transfer, innovation, and sustainability, although their effect is rarely assessed. At the same time, given the difficulty of adequately targeting tax concession provisions, it is likely that tax concessions originally intended for a specific purpose may have unintended consequences for other areas. For example, tax concessions that succeed in spurring innovation may lead to higher farm incomes once said innovation is adopted. Nevertheless, this review largely concentrates on examining the evidence base in these four key areas in an effort to identify some tangible mechanisms through which the tax system has aided in fostering growth, investment, innovation, and improved sustainability outcomes in agriculture. With a view toward being as comprehensive as possible, this review examines both *ex ante* academic analyses, as well as *ex post* evaluations of policies actually implemented by countries. Additionally, while this review aims to examine the existing literature specifically related to taxation in agriculture, some more general findings on tax policy issues are also included in areas where the findings are likely to have implications for the agricultural sector.

1.2. Impact of income tax on income levels and variability

The literature review identified several studies on the impact of income tax on farm income levels and variability, where "income tax" can include both personal income tax (for farm households) and corporate income tax (for farm enterprises), although the former is more common in OECD countries. However, most analyses collectively considered the effect of changes in the whole tax regime on level of income, rather than merely the income tax provisions. The works can largely be divided along thematic lines, with several comparing how tax regimes affect competitive position (*vis-à-vis* the agricultural tax systems of other countries), while other studies analysed the potential effects of changes to an individual country's tax code in an empirical framework. Literature in the latter category is focused on the United States, as that country recently underwent a major overhaul of its tax system.

From an economy-wide point of view, general work on the usage of income taxes in overall tax structures provides some insights that are relevant to the agricultural sector. Previous OECD work on how tax structures can best support growth established that taxes on corporate and personal income are the tax categories that most distort economic incentives for production, and are therefore the most harmful for a country's overall economic growth (OECD, 2010[3]). The authors of this study stressed that tax systems should "avoid encouraging economic behaviour that could influence market activity adversely" – in other words, policymakers should ensure that the tax system does not penalise the very activities that are most conducive to growth (OECD, 2010[3]). In lieu of taxing income, the review instead suggested that countries rely more heavily on less distortionary taxes, such as property taxes and, to some extent, consumption taxes. At the same time, given the importance of land as a factor of production in the agricultural sector, the more detailed implications of this ranking of taxes from most to least distortive with respect to the agricultural sector deserves further study.

Specific work related to taxation in agriculture largely took a more comparative approach to analysing diverse tax systems. Work from Norway comparing the tax regimes of nine different countries (Australia, Canada, France, Germany, Ireland, Italy, Switzerland, the United Kingdom, and the United States) served as the basis for previous OECD work on taxation in agriculture. While that analysis made no direct quantitative comparisons between countries, it did conclude that every country analysed had some form of tax expenditure for farmers (where a "tax expenditure" is defined as "a fiscal advantage [that] is conferred on a group of individuals, or a particular activity, by reducing tax liability rather than by direct cash subsidy") (Andersen et al., 2002[4]). The authors found that the focus countries differed in the "volume and shaping" of tax expenditure benefits, including which expenditures were offered, the applied tax rates under similar provisions across countries, and how the countries have designed their tax bases (Andersen et al., 2002[4]). These expenditures included special systems for valuing income, tax averaging systems, special property tax valuations, inheritance tax reductions and farm transfer provisions. Previous OECD work on farm income extended upon this conclusion, providing some quantitative evidence that OECD taxation regimes very often provide relative benefits to farm households. The analysis found that in several member countries, the economic position improved for farm households compared to non-farm households when after-tax income was considered (OECD, 2003[5]). It also found that income taxation reduced the frequency of low incomes among farm households.

Two articles from Europe compared the tax system of different Member States in an effort to assess how the different tax regimes might affect the competitive position of their respective agricultural sectors. In a 2007 analysis, authors compared the agricultural tax systems of Belgium, the Czech Republic, Denmark, France, Germany, Hungary, the Netherlands, Poland, Spain, and the United Kingdom. After considering various provisions in the different countries – including income smoothing, depreciation, investment, and overall tax rates – the authors concluded that in aggregate, the tax systems in Belgium, France, the Netherlands, and the United Kingdom were the most supportive, in that they resulted in a lower overall tax burden for the agricultural sector (compared to the other countries examined), supported innovation and investment, allowed larger farms to develop efficiencies of scale, and facilitated farm transfers (Van Der Veen et al., 2007[6]). For example, the authors noted that the availability of income averaging in France, the Netherlands and the United Kingdom allowed farmers the flexibility to smooth their variable taxable incomes, which helped to reduce their tax burden.[3] A subsequent analysis from 2012 compared only the tax systems of Belgium, Denmark, France, Germany, and the Netherlands. The results of this analysis indicated that specific components of each tax system (including provisions for social security contributions or depreciation) could have a large impact on overall tax burden and income in a given year (Boullet et al., 2012[7]).

Turning to the empirical analyses, two recent studies looked at the likely effects of the 2017 US Tax Cuts and Jobs Act (TCJA).[4] Both research teams considered the multi-dimensional mechanisms through which the law would affect farm household tax burdens, but using different analytical frameworks. First, Williamson and Bawa (2018[8]) considered how the law would affect farm income using data from the US Internal Revenue Service and Agricultural Resource Management Survey (ARMS) in a tax simulation model. Their results suggested that, had the law been in place in 2016, farm households would have seen their average effective income tax rate fall by 3.3 percentage points to 13.9%. The authors estimated that tax rates would have declined for farms of all sizes and types, although the magnitude of these effects varied (Williamson and Bawa, 2018[8]). In contrast, Beckman, Gopinath and Tsigas (2018[9]) analysed the impacts of the law using a CGE framework, arguing that the implications of the tax reform are such that a whole economy analysis is needed to estimate the law's likely effects. They found that TCJA will likely lead to a decline in agricultural production as resources are allocated to other sectors, but farm household income is likely to rise because of higher income from non-farm activities (Beckman, Gopinath and Tsigas, 2018[9]).

Independent of the 2017 tax bill, an additional analysis from the United States looked at the role of various factors in farm household economic returns, including tax-loss benefits. The authors reported that tax allowances for depreciation expenses (in this case, immediate expensing through accelerated depreciation provisions) reduced farm income variability, as investments in depreciable assets typically occurred in high income years, thus allowing households to reduce their tax burden (Prager, Tulman and Durst, 2018[10]). Overall, the authors estimated that farm households reporting negative income for tax purposes in 2015 received an average economic benefit of USD 2 178 per household from those losses (Prager, Tulman and Durst, 2018[10]).

In addition to discussing the impact of taxation on income levels, various authors also highlighted the potential benefit of tax averaging to smooth income variability (although none attempted to specifically quantify those benefits). In one example, an analysis of the Australian agricultural tax system found tax averaging to be a useful tool to help farmers manage fluctuations in primary income (Boyce Chartered Accountants and McCluskey, 2016[11]). Similarly, an analysis from the European Union highlighted the potential tax benefits of averaging – particularly for industries like horticulture that are associated with high income volatility (Van Der Veen et al., 2007[6]).

1.3. Impact of property taxes on farm transfers and structural adjustment

Another lever through which taxation can affect farm operations is through allowances or incentives that either facilitate or discourage farm transfers. Much of the focus on tax policy in this area is related to taxes on inherited property (also referred to as estate taxes) and farm succession incentives. Previous OECD work indicated that special provisions for agriculture in the area of land transfer may be necessary due to equity concerns, as a farm businesses typically need to be refinanced every generation, such that the levying of high taxes on inherited property may put an undue burden on the successor, requiring the partial liquidation of the farm unit (OECD, 2005[1]). Outside of farm succession, some countries have utilised tax policy to facilitate agricultural land rental arrangements, helping to ensure that farmland can be put to productive uses in cases where the owner does not wish to engage in farming. One article analysing the impact of taxes on these types of arrangements was also reviewed.

With respect to estate taxes, much of the scholarship comes from the United States, where estate tax requirements have been relaxed in the past two decades. For example, the individual estate tax exclusion under US law has increased from USD 675 000 in 2001 to USD 11.18 million in 2018, while the tax rate on the taxable estate has fallen from 55% to 40% (Van Der Hoeven, 2013[12]; Williamson and Bawa, 2018[8]). With these changes, multiple sources assert that very few US farms are now subject to estate taxes. Furthermore, owners of farms that are subject to estate taxes should have sufficient resources to pay their tax bills without selling the farm property, motivating the authors to conclude that liquidity problems as a result of estate taxes do not hinder intergenerational family farm transfer in the United States (Durst, 2013[13]; Van Der Hoeven, 2013[12]; Gravelle, 2018[14]). However, this literature review was not able to identify any work that analysed exactly how these changes in tax provisions affected farm succession arrangements or transfer decisions.

Other countries have implemented succession tax incentive schemes that attempted to facilitate more predictable farm transfers by designating a successor well in advance of the current owner's retirement. With respect to the effectiveness of these programmes, the evidence is mixed. An analysis from Ireland using a hypothetical microsimulation model to investigate the economic factors motivating farm transfers suggested that an Irish programme that attempted to improve the facilitation of farm transfers did not provide sufficient economic incentive to encourage either land transfer before death or a phased land management approach (Leonard et al., 2017[15]). The authors indicated that this was partly due to the fact that inheritance tax thresholds were very high when the designated successor was a child of the farm owner, so there was little comparative benefit to either current owners or successors for choosing early succession. Interestingly, although the simulations indicated that tax incentives did not greatly affect farm income projections (and thus the incentive to make early transfer arrangements) under different transfer scenarios, farmers themselves were very concerned with how taxation might affect their transfer decisions – farmers listed taxation as one of the primary issues of concern that motivated them to attend government-sponsored workshops on family farm transfers. While farm transfer tax provisions seemed to have little effect in Ireland, work from Germany concluded that, for a subset of the country's producers who did transfer their farms to a successor before death, the country's tax regulations provided sufficient financial incentives to accelerate succession planning decisions (Glauben et al., 2009[16]). At the same time, the authors of this work noted that other factors – such as the age of the current manager and the profitability of the farming operation – also influenced succession decisions, leading to the conclusion that while farm households do seem to react to tax regulations during succession planning, many determinants of succession are beyond policymakers' control.

Outside of the realm of farm succession, one additional analysis investigated the role of property taxes on structural adjustment. In a study from Ireland, authors investigated the use of tax incentives to facilitate land leasing arrangements and improve farmland mobility by modelling and comparing four hypothetical farm management scenarios. They found that long-term leases to other farmers could be a more profitable option for cattle and tillage farmlandowners than farming the land themselves, while dairy farmers were likely to derive higher income through farming than through leasing (Geoghegan, Kinsella and O'Donoghue, 2017[17]). At the same time, the authors indicated that most Irish farms are too small to fully take advantage of the policy. Moreover, the authors noted that other policy factors (such as the desire to continue operations in order to maintain eligibility for other payments) may also have contributed to a reluctance to engage in long-term leases. The authors surmised, however, that redesigning the tax incentive to better take into account average Irish farm sizes may incentivise more landholders to take advantage of the policy (Geoghegan, Kinsella and O'Donoghue, 2017[17]). In fact, more recent data from Ireland's Office of Revenue Commissioners does indicate that in the wake of additional changes to the tax incentives, the number of long-term leases has increased (Office of Revenue Commissioners of Ireland, 2018[18]). However, a further analysis on the most likely motivation behind this rise in the number of leases has yet to be released.

1.4. Impact of taxation on investment and innovation

Taxation can affect investment and innovation through various pathways, most of which change the cost structure of firms to incentivise the investment [be it in capital goods or research and development (R&D)]. Specifically related to the agricultural sector, the evidence base on the effects of taxation on investment is mostly devoted to how tax code provisions for depreciation affect farm capital investment levels. With respect to innovation, much of the literature reviewed here is from a generic perspective, because the agriculture-specific evidence base is thin. However, several studies on how taxation can motivate innovation in sustainability and within specific agricultural sectors are also considered.

On the topic of depreciation, all reviewed analyses supported the hypothesis that accelerated depreciation in the United States (under US Internal Revenue Code Section 179[5]) was linked to higher investment levels (Ariyaratne and Featherstone, 2009[19]; Hadrich, Larsen and Olson, 2013[20]; Williamson and Stutzman, 2016[21]; Polzin, Wolf and Black, 2018[22]). However, the specific conclusions reached in each article varied based on the methodology, source data, and overall research objectives. An econometric analysis on farm-level data from the US state of Kansas found that the previous year's machinery and equipment depreciation was associated with large investments in farm machinery in the present year, but depreciation on buildings and structures was negatively related to investments in machinery (Ariyaratne and Featherstone, 2009[19]). The authors hypothesised that depreciation would ease liquidity constraints and permit agricultural firms to invest more, but they do not offer an explanation for why the investment responses differed for the two asset classes. Hadrich, Larsen and Olson (2013[20]) analysed the topic instead using farm data from the US state of North Dakota, concluding that use of accelerated depreciation provisions under Section 179 increased both the probability of purchasing machinery, and the value of the machinery that would be purchased. This led the authors to conclude that this accelerated depreciation programme was, "influencing decision-making processes, and possibly causing producers to have a larger machinery line than needed for their operations," (Hadrich, Larsen and Olson, 2013[20]). Subsequent work using panel data for the whole United States supported this conclusion, with Williamson and Stutzman (2016[21]) finding that for every 1 USD increase in the Section 179 expensing amount, farm investment increased by USD 0.32 from 1996-2012. At the same time, given that very few farms now exceed the annual Section 179 limits, further increases are not likely to have much effect on investment. Finally, Polzin, Wolf and Black (2018[22]) looked at the effects of accelerated depreciation (under both Section 179 and bonus depreciation provisions) on certain asset classes, since the various assets can be depreciated on different timetables. They found that Section 179 allowances led to increased investment in all asset classes, but the largest investment responses occurred in the 10-year[6] and 15-year[7] asset classes.

Aside from this recent literature on depreciation and investment, several reports were reviewed examining the relationship between taxation and innovation, though most were not specific to the agricultural sector.[8] Broadly speaking, the literature finds that different tax measures seem to have varying effects on both the level and type of innovation. Accordingly, key findings related to tax credits and reduced tax rates versus findings related to tax levies are explored separately below.

Tax credits or reduced tax rates (either on income or, in some cases, on labour costs) theoretically incentivise innovation by reducing the relative cost of that activity, but the extent to which this occurs is highly dependent upon the policy's design. Outside the realm of agriculture and environment, a broad review of the literature on the relationship between tax incentives and R&D funded by the European Commission concluded that R&D tax credits are effective in stimulating R&D investment (although the size of the effect varies widely), but there is only limited evidence that R&D tax credits have much of a positive impact on innovation itself (i.e. the actual development of new technologies) (CPB Netherlands Bureau for Econ. Policy Analysis et al., 2014[23]). Moreover, the review found that R&D tax credits have the drawback of incentivising companies to invest in projects with higher private returns rather than greater social returns. This outcome, combined with the finding that one euro of foregone revenue from the tax credits raised R&D expenditure by less than one euro, suggested that R&D credits may not be the most effective vehicle for resolving the innovation gap (CPB Netherlands Bureau for Econ. Policy Analysis et al., 2014[23]). Other authors offered a more mixed view of the quantitative impacts of R&D tax credits. One review of tax incentive programmes in different countries found that some programmes produced economic gains that more than offset the foregone tax revenue, while others did not. For example, the benefits of Canada's scientific research and experimental development (SR&ED) programme more than offset its costs, creating a net economic gain of 11 cents per CAD, while the Netherlands' R&D employee's wage tax reduction incentive resulted in a net loss since every EUR in lost tax revenue resulted in only EUR 0.72 in additional firm investment (KPMG Baltics AS, PRAXIS Center for Policy Studies and Staehr, 2009[24]). A 2016 review of Australia's R&D Tax Incentive found that although the programme did generate R&D spending by firms, it did not seem to achieve programme goals of additionality (further spending on R&D beyond what would have occurred even in the absence of the incentive) and spillovers (benefits to the wider sector or economy and not just to the innovating firm), but there was potential to better target the incentive to meet these objectives (Ferris, Finkel and Fraser, 2016[25]). Accordingly, the review made several recommendations on how to refine the tax incentive, including the introduction of a collaboration premium for R&D undertaken in conjunction with publicly-funded research organisations, as well as the use of an intensity threshold for large firms (that is, R&D spending only beyond a certain percentage of business expenses would be eligible for the concession).[9]

More recent work from the OECD echoed some of the findings of CPB et al. (2014[23]). Appelt et al. (2016[26]) concluded that R&D tax incentives typically do lead to additional investment. However, these authors stressed that the design of the tax instrument matters, and the benefits of these incentives are not uniform. For example, higher incentives tend to favour incumbent firms at the expensive of more dynamic newcomers. Additional research from the European Commission's Directorate-General for Research and Innovation (Ognyanova, 2017[27]) reinforced some of the findings of Appelt et al. (2016[26]). In addition to concluding that R&D tax incentives stimulate R&D investment (with the effects varying by firm and sector), the EC analysis noted that the effectiveness of these kinds of incentives is reduced if the incentive is unpredictable, unstable, or lagged (Ognyanova, 2017[27]). In contrast to Appelt et al. (2016[26]), however, this analysis found evidence that the impact of R&D incentives on innovation is typically stronger for younger firms and for SMEs (Ognyanova, 2017[27]).

One analysis instead focused on the relative advantages and drawbacks of tax incentives *vis-à-vis* other fiscal incentives as a means of generating innovation. Generally speaking, the authors concluded that tax incentives are the preferred instrument for innovations that can be brought to market quickly – if countries instead are seeking to promote more long-term research development, then research grants are a more effective policy tool (Neubig et al., 2016[28]). One final OECD analysis of R&D tax credits or reductions found that lower corporate taxes were associated with increased patent applications, with both the location of the research and the location of patent legal ownership affected by tax rates (Bieltvedt Skeie et al., 2017[29]).

Tax credits, however, are not the sole mechanism through which taxation and innovation are linked in practice. Taxes that are levied on firms can also affect innovation, albeit through different pathways – either by incentivising a change in firm behaviour by discouraging a "negative" activity (such as polluting), or by utilising the revenue raised by the tax to fund R&D activities. Much of the research relevant to the first case comes from the environment and sustainability literature. A 2010 OECD review on the intersection of taxation, innovation and the environment concluded that environmental taxes could both provide incentives for the adoption of new innovations, as well as effectively incentivise smaller, firm-level innovations (OECD, 2010[30]). The review emphasised that environmental taxes seemed to be most effective at accelerating innovations that are nearly market-ready, and do not generally lead to transformative changes. One striking example provided by this review came from Sweden, where the number of firms that had adopted existing abatement technology increased from 7% to 62% in the year following the introduction of a tax on NOx emissions (OECD, 2010[30]).

Other work in this area sought to gauge the relative effectiveness of environmental taxes compared with other policy instruments in increasing innovation. For example, Requate (2005[31]) concluded that emissions taxes generally seemed to provide stronger incentives for both higher investment in R&D and greater adoption of new mitigation technologies than tradeable permits. This finding was reinforced by OECD research, which indicated that emissions taxes would be more likely to incentivise investments in clean technologies compared to a system of free allocation of tradeable emissions permits if the tax was set at the same rate as the permit price (Flues and van Dender, 2017[32]). In a similar vein, numerical simulations carried out in a partial equilibrium model by Clancy and Moschini (2018[33]) indicated that carbon taxes were more effective at spurring breakthrough innovations than clean energy mandates that established targets for renewable energy production [somewhat in contrast to the general conclusions drawn by the earlier OECD (2010[30]) analysis]. Additionally, they found that the effectiveness of mandates in spurring innovation was more dependent upon the nature of the competition in innovation than were carbon taxes (Clancy and Moschini, 2018[33]).

Taxes can also incentivise innovation if the revenue raised by a given tax is specifically designated for research purposes.[10] The agriculture industry provides some unique examples of this arrangement, as specific sectors in many countries collect this type of revenue through so-called "producer levies" (sometimes called assessments or check-offs) for the purposes of research or market promotion (OECD, 2013[34]; OECD, 2019[35]). These levy schemes reflect a diversity of institutional arrangements (including a mixture of public and private administration, research, and priority-setting), and some are not "taxes" in a technical sense, as the revenue is not directly collected by the government. But levies collected under most programmes of this type are government-mandated – typically brought about under generic legislation that enables producers in a particular industry to vote to institute a system under which "funds from a hypothecated tax will be used to finance specific activities" (Alston, Gray and Bolek, 2012[36]). Levies are usually mandatory in order to eliminate the free-rider problem, but they are in some cases refundable. One OECD publication (2019[35]) notes that, through this mechanism, producer organisations fund R&D expenditures in Australia, Canada, Colombia, Sweden and the United States, and that this money remains within the given industry's value chain in all cases, except for Sweden.

As with other tax schemes covered in this review, the effectiveness of this mechanism as a vehicle for increasing innovation seems to depend upon the programme's design. For example, although many US check-off programmes are authorised for both R&D and market promotion purposes, in reality the bulk of the funds collected are funnelled into market promotion activities (Alston, Freebairn and James, 2003[37]). Nonetheless, some positive effects of check-offs on innovation were found. For example, Bessler (2009[38]) estimated that US soybean check-off research expenditures were responsible for a 0.95 bushel per acre increase in soybean yields over the period 1994 to 2007, translating to higher producer revenues on the order of USD 17 per acre. While innovation returns under the American system are perhaps less well-studied, the benefits of the Australian system of Rural Research and Development Corporations (RDCs) – which are co-financed through producer or industry levies and matching funds from the Australian government – have been well-documented. In their review of RDCs, the Australian Productivity Commission (2011[39]) noted numerous examples of how RDC-funded research led to productivity improvements or input cost savings, including the funding of new grain varieties, the implementation of new production practices that led to higher lobster yields, and the realisation of improved environmental outcomes in cotton production. In fact, the review noted that the average return for AUD 1 invested in research through the RDC system was AUD 2.36 after five years, AUD 5.56 after ten years, and AUD 10.51 after 25 years

(Productivity Commission, 2011[39]). While the system has generated new innovations, it also has its share of critiques, including that the system can crowd-out other public sources of funding (Alston, Gray and Bolek, 2012[36]), the system focuses narrowly on industry priorities and eschews research into broader rural issues with potentially larger spillover effects (Productivity Commission, 2011[39]), and the fact that it is unclear whether or not the party paying the levy (mostly producers) is also the party to whom the majority of benefits accrue (for example, food processors may capture the benefits) (Alston, Freebairn and James, 2003[37]).[11]

1.5. Performance of tax instruments for improving environmental sustainability

Given the increased political interest in reducing the negative environmental impacts of agriculture, including by mitigating greenhouse gas emissions, a growing body of scholarship is devoted to gauging the performance of various tax instruments for improving environmental sustainability. Many taxes can be related to sustainability, but those with the most obvious linkages are environmental taxes. These are defined as taxes whose "base is a physical unit (or a proxy of it) of something that has a proven, specific, negative impact on the environment" (OECD, 2014[40]). The UN System of Environmental-Economic Accounting (SEEA) framework classifies environmental taxes into four groups (OECD, 2014[40]):

- *Energy taxes:* Applied to energy products (including fuel oil, natural gas, coal, and electricity) used for transportation or stationary purposes, such as irrigation pumping. Carbon taxes are included under this category in the SEEA framework.
- *Transport taxes:* Applied to ownership or use of motor vehicles.
- *Pollution taxes:* Applied to emissions (either measured or estimated) to air and water, or to generation of solid waste.
- *Resource taxes:* Applied to extractions of natural resources, such as water or other minerals.

Because the mechanisms, incentives and response functions for said taxes differ somewhat, the literature specific to each of these areas is discussed separately below.

Energy taxes, including carbon taxes

Energy use emissions have various negative externalities, including environmental damage, negative health impacts, and climate change effects. Consequently, countries sometimes institute taxes on energy use as a means of charging for these damages, with the additional effects of reducing emissions and raising government revenues as well. Previous OECD work has noted that energy taxes make up the bulk of environmental tax revenue in agriculture (OECD, 2017[41]). Even so, a majority of emissions from the agricultural sector are either not taxed at all, or are taxed at a very low rate (5% or under) (OECD, 2018[42]), with many countries even offering tax concessions on fuel used for farming purposes (OECD, 2005[1]). These tax exemptions run counter to sustainability goals, disconnecting fuel demand from market signals and thereby encouraging overuse. In fact, the OECD's 2017 report stressed that "…the low tax rates and exemptions on fuel used in agriculture suggest that some of the lowest-cost opportunities to reduce carbon emissions are being foregone" (OECD, 2017[41]). At the same time, the political feasibility of eliminating these measures is often a challenge, with various authors noting that increased energy taxes are more conspicuous than changes in market prices alone (OECD, 2018[43]). In an economy-wide sense, recent OECD work on support to fossil fuels notes that most support to the fossil fuel sector is granted through tax expenditure mechanisms (OECD, 2018[44]). Moreover, although overall support is on the decline, there are still some important differences amongst countries, with new support mechanisms introduced every year (OECD, 2018[44]).

In general, the literature on energy taxes advocates for the use of Pigouvian taxes, where the tax rate on an externality is set at the level where the marginal social benefit equals the marginal social cost. These taxes are typically assessed on the polluters themselves (the "polluter pays" principle). Even a decade ago, the application of this principle was complicated by a lack of data on the impacts of emissions. However, the field is advancing, and it is now possible to estimate the negative impacts of certain activities with greater accuracy. In this environment, scholars advocate that energy taxes should be set to match the externalities of certain activities, differentiated by region. Such an approach could yield substantial benefits. For example, Parry (2014[45]) estimates that if corrective energy taxes were to be applied globally, energy-related CO_2 emissions would fall by 23% and raise 2.6% of global GDP in new revenues.

At an economy-wide level, carbon taxes are one form of energy taxes that have been utilised to achieve sustainability goals. Both *ex ante* and *ex post* analyses of carbon taxes have indicated that they can be an effective means of achieving reduced emissions. Two *ex ante* example studies used CGE frameworks to estimate the potential costs and benefits of a carbon tax in specific national contexts. The first investigated the likely effect of a carbon tax on the Chilean economy, concluding that a carbon tax of USD 26 per tonne would likely reduce the country's emissions by 20% (García Benavente, 2016[46]). A similar CGE analysis of Scotland concluded that a carbon tax of GBP 50 per tonne would be sufficient to attain Scottish emission targets, and that the tax could also stimulate additional economic activity if the revenues were recycled into the economy through income tax reductions (Allan et al., 2014[47]).

Two *ex post* analyses of carbon taxes confirmed that they are sometimes effective in reducing emissions, but that their effectiveness depends upon how the policy is implemented. First, a review of British Columbia's carbon tax on curbing greenhouse gas emissions estimated that the policy has reduced emissions by between 5% and 15%, with the authors indicating that the tax allowed only some minor exceptions (for example, for energy consumed by greenhouses, and fuel use in agriculture) (Murray and Rivers, 2015[48]). Next, the authors of a comparison of carbon tax applications in Denmark, Finland, the Netherlands, Norway and Sweden suggested that the design of the policy was crucial to its overall effectiveness, as they attributed the varied outcomes to both the applied rates and the exemptions permitted under the respective regimes (Lin and Li, 2011[49]).

Two forthcoming OECD studies drill down further to analyse specifically what effects carbon taxes would likely have on the agricultural sector. The first used data from four representative EU farm cases [based on data from the Common Agricultural Policy Regional Impact Analysis (CAPRI) database] in a detailed quantitative bioeconomic farm model to analyse the likely effects of six different GHG mitigation policies – an emission constraint, an emission tax, an abatement subsidy, an input tax on fertiliser, an input tax on ruminants, and carbon trading. The analysis concluded that the market-based instruments that target emissions more broadly (that is, the emission constraint, the emission tax, and the abatement subsidy) are most cost-effective at achieving emissions targets, such that the recommended approach is to target all emissions rather than a subset or proxy for emissions (OECD, 2019[50]). At the same time, these policies induce a reallocation of resources and income-generating activities at the farm level, causing production to shift away from high-emission activities like dairy production into lower-emission activities like crop production, but the magnitude of these shifts differs between the short- and the long-run, due largely to sunk investment costs and (lack of) access to off-farm income. The second analysis complements the findings of the first, analysing the comparative effects of a range of policies [a tax on GHG emissions, a tax on GHG emissions combined with a food consumption subsidy, a payment to producers to cover their costs of adopting abatement technologies, a tax on emission-intensive inputs (ruminant animals and nitrogen fertilisers), and a tax on emission-intensive consumer products (red meat and dairy), applied either globally or specifically to OECD countries] on the trade-offs between mitigation outcomes and agricultural income, competitiveness, food consumption and government finances. Echoing conclusions from the previous analysis, the results indicated that the policy with the widest base – the global tax on GHG emissions – would be most effective at reducing emissions (OECD, 2019[51]). At the same time, this policy would have large negative impacts on farm income and lead to large reductions in food consumption because of higher prices. However, the policy would also generate a large government revenues, which could be returned to consumers in the form of a food subsidy to maintain consumption levels. But this food subsidy would not resolve the loss of income to producers, with those in low-income countries being the most affected (OECD, 2019[51]).

It is worth noting that energy taxes could generate additional sustainability dividends based on how the revenues from the taxes are spent. For example, one 2016 study analysed the spending patterns of the comparative revenues raised through carbon taxes and cap and trade policies. The authors reported that, to date, most revenue from carbon taxes is refunded to taxpayers or directed into general funds, and 15% of carbon tax revenues were earmarked for “green” spending (Carl and Fedor, 2016[52]). One additional theoretical analysis showed the potential returns from similar types of combined tax-subsidy schemes. The authors used a model calibrated to Finnish conditions to show the potential costs and benefits of a scenario in which tax revenue from farms’ GHG emissions was recycled back to the sector through a subsidy on afforestation or green set-aside. The analysis showed that such an approach could bring about substantial additional reductions in nitrogen utilisation (and consequently improvements in water quality through reduced runoff), as nitrogen application would cease for the land taken out of production (Ervola, Lankoski and Ollikainen, 2018[53]).

However, there is not clear evidence that directing energy tax revenues to specific uses leads to higher environmental benefits, or whether it should be advocated as a policy design at all. A recent review of carbon pricing initiatives in OECD countries, for example, concluded that there was not sufficient evidence to indicate which uses of carbon tax revenue were to be preferred, or even how strong the commitment to that revenue use should be (Van Dender, 2019[54]). There is even some dispute as to the validity of the “double-dividend hypothesis”, where countries ostensibly benefit twice from environmental taxes by both reducing the negative externality and then utilising revenues to achieve some additional policy objective. As with all taxes, environmental taxes may have other market-distorting affects that may decrease overall welfare and thus negate any net benefits. For example, Fullerton and Metcalf (1997[55]) emphasise that the net impact of any given reform will depend upon to what extent the policy discourages polluting activities and encourages productive market activities.

Transport taxes

Transport taxes are levied on either motor vehicle ownership or usage, typically as a means to reduce environmental (or other) externalities associated with road transit. At this writing, no literature was identified on the effect of transport taxes specifically in the agricultural sector. A number of OECD countries utilise transport taxes more generally (OECD, 2014[40]), and there is mixed evidence that they can be effective as a tool for achieving overall sustainability goals (by making the ownership and utilisation of pollution-emitting vehicles more expensive). For instance, a forthcoming OECD analysis of the French vehicle feebate system estimated that the programme resulted in an emissions reduction of 4.8 million tonnes of CO_2 (Teusch, Braathen and Van Dender, 2019[56]). On the other hand, one analysis of the effectiveness of several environmental taxes in the European Union over the period from 1995 to 2013 concluded that transport taxes had no effect on emissions (Aydin and Esen, 2018[57]). The authors surmised that the lack of effect could be due to the level of the tax being too low to influence purchase decisions, or else there could be too many exemptions to the policy.

Pollution taxes

Pollution taxes are levied on emissions that pollute the air and water, and are sometimes employed as a lever through which to either reduce the use of polluting products, or to curb their emissions. These taxes are highly relevant to the agricultural sector, as runoffs of agricultural inputs like fertilisers and pesticides can pollute air and waterways. In response, a number of OECD countries have enacted regulations designed to reduce the usage of these products [see, for example, OECD (2012[58])], but the effectiveness of these measures has been mixed, due to both the design of the policies and the response functions of producers. For both fertiliser and pesticide taxes, the literature includes both *ex ante* academic studies that offer insights into optimal policy design, as well as *ex post* analyses of how effective these policies have been in achieving their pollution reduction targets. Literature under the two categories are considered in this section.

For fertilisers, *ex ante* analyses have indicated that fertiliser taxes can be an effective means of reducing fertiliser use. In an analysis integrating farm, soil, and water models, researchers concluded that taxes could be an effective means of reducing nitrate emissions in the upper Rhine valley, but that the tax should be set at a relatively high level in order to be effective (Graveline and Rinaudo, 2007[59]). In the same vein, a bio-economic model of a nitrogen fertiliser tax for Yolo County, California concluded that nitrogen taxes could be used to achieve substantial reductions in nitrogen leaking, by incentivising both adjustments in cropping patterns and lower overall fertiliser application (Merel et al., 2014[60]). Finally, an analysis from Ireland suggested that ending that country's discounted VAT on fertilisers (that is, applying the standard VAT of 23% up from the current level of 0%) would result in a non-trivial 10% reduction in fertiliser consumption (Morganroth, Murphy and Moore, 2018[61]). At the same time, this analysis notes that there are both caveats to the finding and challenges to the implementation of such a change in policy. First of all, such a tax could disproportionately affect small farmers. Additionally, the policy would need to be designed in such a way as to not disincentivise measures to address sub-optimal soil fertility levels – a condition which affects the majority of Irish soils. Finally, the policy would face challenges in implementation due to the fact that a large majority of Irish farmers are not VAT registered.

Other work modelled different tax designs to achieve reduced fertiliser use. Iho (2010[62]), for instance, suggested that rather than taxing phosphorus use, similar outcomes could be achieved by instead taxing soil phosphorus content. The author's findings suggested that such a tax would actually require less information to enforce (as soil quality is already tested in many jurisdictions), and the tax could also be better targeted to achieve reduced phosphorus runoff. Also arguing against a pure input tax model, researchers using data on Switzerland's Lake Baldegg watershed suggested that the optimal approach to achieve reduced nitrogen runoff would be through the combined application of both nitrogen input taxes and land-use taxes (Goetz, Schmid and Lehmann, 2006[63]). The authors asserted that most analyses of nitrogen taxes focused on intensive usage and discounted potential extensive margin effects, which could offset any per hectare reductions incentivised by a nitrogen tax. Their analysis concluded that combining land-use and nitrogen input taxes would be roughly 18% more cost efficient than input taxes alone. Finally, a quantitative analysis of various hypothetical policy scenarios based on Finnish data suggested that nitrogen fertiliser taxes and a soil greenhouse gas (GHG) emissions tax could be effective at reducing GHG emissions and nutrient runoff, leading to gains in overall social welfare over a baseline case, but also resulting in reduced farm income (Lankoski et al., 2018[64]).

While these *ex ante* analyses have provided support to using fertiliser taxes to achieve improved sustainability outcomes, in practice, there is mixed evidence that this policy instrument has been successful. Early iterations of taxes on fertiliser were often designed to raise revenue for export subsidies (for example, in Austria and Finland), with improved environmental outcomes relegated to a secondary policy goal (Rougoor et al., 2001[65]). Because tax rates in these cases were set primarily to raise revenue and not to curb fertiliser utilisation, the rates were typically not high enough to incentivise large use responses. As such, they achieved only marginal reductions in fertiliser use and runoff. For example, calculations based on the Finnish case indicated that a 15% tax rate on nitrogen would induce only a 4-5% reduction in nitrogen use, resulting in only a 4-5% decline in nitrogen runoff as well (Lankoski and Ollikainen, 2013[66]). The Dutch Mineral Accounting System (MINAS) provides another example of a nutrient tax that was ultimately unsuccessful. MINAS combined a whole farm mineral accounting system with a tax on nutrient surpluses over a certain threshold, which was reduced over time to incentivise lower nutrient utilisation. But the system ran into problems. The burden of the tax fell heavily on pig producers (with large mineral surpluses and relatively little land), leading to the widespread perception that the tax was unfair, to a point that many farmers stopped paying their levies or else exploited loopholes to reduce their tax burden (Wright and Mallia, 2008[67]). Furthermore, administrative and enforcement costs for the programme were very high (substantially reducing any societal net benefit), there was some uncertainty about the farm-level nutrient surplus calculations, and the system's complexity introduced some non-pecuniary costs to farmers (OECD, 2015[68]). In this environment, the European Court of Justice ruled in 2003 that the MINAS policy did not comply with the EU's Nitrate Directive (which instead targeted reducing nitrogen application at the source), and the policy was replaced in 2006. The final example comes from Sweden, where long-standing taxes on nitrogen and phosphorous in commercial fertilisers were eliminated in 2009. A 2018 OECD analysis on land use and ecosystem services indicated that Sweden's measures were dropped partly because there was not sufficient evidence that the taxes had curbed fertiliser use (Hardelin and Lankoski, 2018[69]). In all of the cases cited above, part of the reason that these policies failed in achieving their sustainability objectives of curbing fertiliser use is that fertiliser demand is relatively inelastic. As such, the effectiveness of such a tax on curbing fertiliser use would require input tax rates so high as to likely be politically infeasible (OECD, 2012[58]). In the cases explored above, either the rates were set too low to achieve any desired response (Austria, Finland and Sweden), or else they were set so high that, although they would have induced dramatic reductions in mineral use, they caused such a political backlash that they were ultimately scrapped (the Netherlands).

A recent OECD assessment of the effectiveness of various policy instruments (including taxes, tradable permits, direct environmental regulation, public financial support, payments for ecosystem services, information measures, and voluntary schemes) utilised for the purpose of curbing nitrogen runoff offers some comprehensive analysis on the relative effectiveness of nitrogen taxes. The report notes that taxes can be effective in reducing pollution, but the level of their effectiveness varies. Taxes are also cost-efficient and administratively feasible, but policy frameworks often allow exemptions and discounts that can blunt their overall effectiveness. To ensure maximum effectiveness and political feasibility, the report ultimately concludes that country policy frameworks should utilise a mix of available instruments (OECD, 2018[70]).

With respect to pesticides, one cross-country analysis of Denmark, France, Norway, and Sweden concluded that pesticide taxes had demonstrated only limited effectiveness in their aims to reduce pesticide usage, but very high taxes on a specific product could substantially reduce its application (Böcker and Finger, 2016[71]). Recent OECD work comparing the effectiveness of different environmental tax schemes highlighted the example of Norway as one success story. Norway introduced a pesticide tax programme in 1999, which classified products according to different bands defined by their environmental and health-related risks. The analysis reported that this policy had been effective in reducing the application of more harmful products, and generally encouraged more conservative use of pesticides (OECD, 2017[72]).[12] Several schemes in other countries have also had some success. For example, a 2016 analysis from Estonia indicated that increasing tax rates on water pollutants in that country have been effective at reducing emissions (OECD, 2018[73]).

An additional analysis from Denmark provided a more detailed picture of how the design of pesticide tax policy matters for improving water quality. Although the implementation of a pesticide tax programme in 1996 was followed by an initial decline in application rates (OECD, 2005[74]), pesticide applications subsequently rose to levels more than two times the application rate that the policy hoped to achieve – despite the tax rates being raised to a level thought to be the highest in the world (Pedersen, Nielsen and Andersen, 2015[75]). One 2015 analysis of the policy posited many reasons that the tax did not meet its objectives, including the inelastic demand for pesticides, the trajectory of grain prices during the study period, and the responsiveness of producers to economic incentives. The findings suggested that policymakers must carefully consider stakeholder objectives and response functions when designing these types of tax instruments. Denmark has since redesigned their pesticide tax scheme, introducing a differentiated tax similar to that of Norway. Recent evaluations there have indicated that this new policy is achieving its aims of incentivising the substitution of the most harmful pesticides with those that are less damaging, leading to a 40% reduction in overall pesticide load (Sommer Holtze, Martin Kühl and Hyldebrandt-Larsen, 2018[76]).

Forthcoming work from the OECD Environment Directorate investigated the experiences of several member countries regarding their usage of taxes and other instruments to incentivise reduced usage of both fertilisers and pesticides. Overall, the review concluded that taxes can be utilised as one component of a set of policies that intend to reduce the use and risk of these products, with certain caveats (OECD, 2018[77]). First of all, echoing the findings cited above, the low price elasticity of fertilisers and pesticides necessitates that the tax rate be set at a relatively high level in order to incentivise reduced use. For example, the review indicated that tax rates set by fertiliser tax schemes in both France and the United States were too low to generate reduced fertiliser usage. Second, the review suggests that the application of differentiated taxes can be an effective means of reducing the use of products that carry higher environmental risks. The authors noted that such schemes have successfully been used in Denmark, Norway, and Sweden as part of a strategy to reduce both environmental and human health risks from pesticide use. Finally, the review noted that taxation alone was unlikely to achieve environmental targets with respect to fertiliser and pesticide usage. Rather, a mix of policy instruments would likely be needed, including regulatory instruments, economic instruments (including taxes and subsidies), and information and advisory services (OECD, 2018[77]). In addition, findings from the behavioural management sphere stress that a crucial component in the success or failure of tax policies as a tool to curb non-point source water pollution is communication and interaction. Authors stressed that policies that fail to consider social acceptability as well as efficiency may not achieve targeted outcomes (OECD, 2012[78]). In summary, countries should follow some general guidelines for implementing water pollution-reducing taxes:

clearly communicate the tax's objectives, provide an incentive to polluters, reflect environmental and opportunity costs in line with the polluter pays principle, treat different sources of pollution equally, and provide for re-allocation of pollution allowances or permits (OECD, 2017[72]).

Resource taxes

Resource taxes are applied to water or other natural resources, and can be implemented as a means of reducing the extraction thereof. In the agricultural sector, resource taxes are most commonly implemented with respect to groundwater extractions. The theoretical research on water taxes indicates that the implementation and effectiveness of a tax on groundwater abstractions is not straightforward for various reasons, including recognising that demand for water may be highly inelastic (Hendricks and Peterson, 2012[79]), as well as the general difficulty of measuring the relevant costs and benefits of groundwater depletion (Koundouri, 2004[80]). The relative inelasticity of groundwater demand means that in order to elicit behaviour changes, extraction taxes need to be quite high (OECD, 2015[81]). Even in countries that tax water abstractions, agricultural uses are sometimes exempted (EEA, 2013[82]).

As a consequence of these underlying conditions, there is no strong evidence that existing groundwater taxation mechanisms have been very effective at curbing extractions. An European Environment Agency (EEA) review of groundwater extraction taxes in the European Union found scarce evidence that existing taxes were incentivising improved water use efficiency (EEA, 2013[82]). A groundwater tax instituted in the Netherlands, for example, was abolished at the end of 2011, because it was not found to be effective in reducing groundwater extractions (partly because it exempted most small users from the tax, including most agricultural users) (Schuerhoff, Weikard and Zetland, 2013[83]). Similarly, an analysis from Estonia on the impacts of groundwater abstraction taxes over the period from 2000 to 2010 indicated that, although the taxes had increased over the period, water abstraction trends seemed to vary by industry, and there seemed to be little correlation between the taxes and overall abstraction levels (OECD, 2018[73]). At the same time, the EEA review did note that there was evidence to support the introduction of volumetric pricing in lieu of flat fees – analyses cited in the EEA report indicated that regions that instituted volumetric pricing utilised between 10% and 35% less water than regions using flat-rate pricing (EEA, 2013[82]). Further on from volumetric pricing, some literature recognised that the spatial variability of groundwater sources and conditions necessitates that policies like extraction taxes or quantity restrictions vary either across space or across time in order to realise the highest net benefits (Guilfoos, Khanna and Peterson, 2016[84]).

1.6. Summary

While tax policy generally should distort markets as little as possible, the above review suggests that tax policy is often used as a lever through which to affect behaviour in the agricultural sector, impacting producer income, farmland transfer, investment, innovation, and sustainability outcomes. In some cases, the tax system is used to complement other policies in achieving larger goals. In other cases, taxes or tax concessions in one area provide incentives that are contrary to the achievement of policy goals in other areas (such as the continued utilisation of fuel tax credits, which are counterproductive to the attainment of sustainability goals).

Although many countries include provisions in their tax codes designed to influence the agricultural sector, for most of the topic areas explored in this review at least, there remains only scant sector-specific analysis that can inform future policymaking efforts. The exception to this has been in the area of sustainability, where new tax policies have been implemented alongside monitoring programmes, and periodic analyses have been published. In particular, further analysis is needed on existing tax concessions that aim to facilitate land transfer in order to inform policy recommendations in this area.

Notes

[1] Social security systems were included in the original classification typology in order to ensure that the widest tax base possible was covered, and to avoid a situation that misrepresented the overall level of differential treatment afforded to agriculture. In many countries, the tax and social security systems are integrated, so the two were analysed in concert for all countries covered by the study so as not to bias the original analysis, see OECD (2005[1]).

[2] For a more complete cataloguing of tax concessions in agriculture, see OECD (2005[1]). The cross-country comparison in Chapter 3 provides an overview of tax concessions applied to agriculture in 2018-19 and the country notes in Part II contain more detailed information.

[3] To understand just how useful tax averaging may be as an income smoothing tool, previous OECD work offered the following example. Under systems that tax income one year in arrears, businesses where income fluctuation follows a biennial pattern (as can be in the case in agricultural) may have to confront situations where their tax bills for high income years must be paid in a low income year, amplifying the fluctuation in post-tax disposable income. Tax averaging over a period of years would resolve this problem. See OECD (2005[1]).

[4] Among other provisions, the TCJA: reduced individual income tax rates; established a new 20% standard deduction for qualifying business income; raised the threshold on accelerated capital recovery to allow deduction of up to USD 1 million for depreciation in the year of capital purchase; allowed the deduction of purchases of used assets under depreciation provisions; and raised the exemption level for the estate tax to USD 11.18 million per individual (Williamson and Bawa, 2018[8]).

[5] As per Williamson and Stutzman (2016[21]), “Section 179 [of the US Internal Revenue Code] allows a taxpayer [to] treat the investment as a cost and recover the cost of the investment by deducting or ‘expensing’ it in the year of the purchase.”

[6] Including single-purpose agricultural structures, such as manure pits.

[7] Including drainage facilities, paved lots, water wells, driveways, culverts, tile and erosion control.

[8] Various authors stressed that analysing this relationship between taxation and innovation is not a straightforward undertaking. First of all, measuring an effect first requires some definition and quantification of “innovation”. Research spending and patent applications are two commonly employed metrics, but certainly these are insufficient to capture the broader advancements implied by the term. Secondly, specifically in the case of tax levies, since firms are free to determine their own optimal responses in the face of the added cost, each firm may adopt different innovations, making it difficult to find a

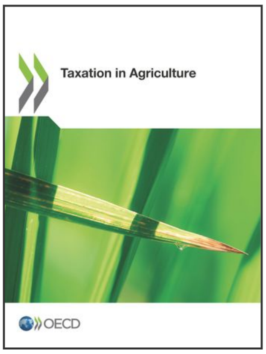
consistent means of measuring the effect. For further discussion on these points (and others), see OECD (2010[30]).

9 Several of the recommendations of the 2016 Review were incorporated into government budget proposals for 2018-19, with a view toward better targeting the programme and improving its integrity and fiscal affordability. See (Australian Taxation Office, 2019[91]).

10 In fact, in a technical sense, the revenue raised by any tax that is used for research purposes is a mechanism through which taxation affects innovation. However, these programmes are highlighted here because it is much easier to measure the direct effects of the initiatives given the earmarking of the funds.

11 See (OECD, 2015[93]) for an evaluation of the Australian innovation system, including the RDCs.

12 At the same time, the Norwegian approach has its own drawbacks as well, including the critique that there are simply too few pesticides on the market in Norway for the banded system to be completely effective. For a more detailed evaluation of Norway's pesticide tax programme, see (OECD, 2005[74]).



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