THE TAXATION OF PETROLEUM AND MINERALS: PRINCIPLES, PROBLEMS AND PRACTICE

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First published 2010
by Routledge
2 Park Square, Milton Park, Abingdon, Oxon OX14 4RN

Simultaneously published in the USA and Canada
by Routledge
270 Madison Avenue, New York, NY 10016

Routledge is an imprint of the Taylor & Francis Group, an informa business

Typeset in Times by Wearset Ltd, Boldon, Tyne and Wear
Printed and bound in Great Britain by Antony Rowe Ltd.
Chippenham, Wiltshire

British Library Cataloguing in Publication Data
A catalogue record for this book is available from the British Library

Library of Congress Cataloging in Publication Data
The taxation of petroleum and minerals: principles, problems and practice/ edited by Philip Daniel, Michael Keen and Charles McPherson.
p. cm.
Includes bibliographical references and index.
Petroleum–Taxation. 2. Mines and mineral resources–Taxation. 3. Mining leases. I. Daniel, Philip. II. Keen, Michael. III. McPherson, Charles P., 1944–

HD9560.8.A1T39 2010
336.2'66553–dc22

2009047902

ISBN13: 978-0-415-56921-7 (hbk)
ISBN13: 978-0-203-85108-1 (ebk)

5 International mineral taxation

Experience and issues

Lindsay Hogan and Brenton Goldsworthy

1 Introduction

Minerals (other than petroleum) are an important source of export earnings and taxation revenue in a wide range of countries. For example, world exports of selected major mineral commodities were valued at US$448 billion in 2006 comprising coal (11 percent), ores and concentrates (24 percent) and metals (65 percent) (see Table 5.1). Nearly half of world exports of these commodities were sourced from developing economies: 60 percent for ores and concentrates, 46 percent for metals and 45 percent for coal. Mineral taxation revenue accounts for a significant share of total fiscal revenue in several countries: most notably, over the period 2000–2005, this share was 62.5 percent in Botswana, 17.9 percent in Papua New Guinea, 17.8 percent in Guinea, 9.4 percent in Chile, 8.2 percent in Mongolia and 5.9 percent in Namibia (IMF 2007).

In Chapter 2, Boadway and Keen (2009) present an extensive discussion of resource taxation issues, and the evaluation of resource tax regimes is discussed by Daniel *et al.* in Chapter 7 with particular reference to the oil industry. There are two main objectives in this chapter: first, to examine the international evolution of fiscal regimes in minerals and, second, to discuss key economic issues in mineral taxation using an approach complementary to that in Chapter 7. In particular, this chapter uses a simple economic framework – the certainty equivalent approach – to illuminate the implications of four key fiscal instruments for private risk assessments.

The structure of the chapter is as follows. In Section 2, the international evolution of fiscal regimes in minerals is discussed. In Section 3, criteria for assessing fiscal instruments are presented and, based on the approach taken in Baunsgaard (2001), an overview of the advantages and disadvantages of the most common mineral taxation options is provided. In Section 4, economic issues in the design of selected mineral taxation options are discussed further and a simplified graphical representation of these options is provided. In Section 5, simulations of some hypothetical resource projects are presented, based on the certainty equivalent approach to the assessment of risky projects, to illustrate some important implications of key mineral taxation options. Concluding comments are provided in Section 6.

Table 5.1 World exports for selected mineral commodities, 2006

	Developed economies		*Developing economies*		*World*
	Exports	*Share of world*	*Exports*	*Share of world*	
	US$b	*%*	*US$b*	*%*	*US$b*
Coal	27.3	55.4	22.0	44.6	49.3
Ores and concentrates					
Iron ore and concentrates	14.8	45.1	18.0	54.9	32.8
Copper ores and concentrates	6.3	19.7	25.6	80.3	31.8
Nickel ores and concentrates	4.0	52.6	3.6	47.4	7.5
Aluminium ores and concentrates[1]	7.6	60.6	4.9	39.4	12.6
Ores and concentrates of base metals, nes	10.6	46.2	12.3	53.8	22.9
Total of above	43.2	40.1	64.4	59.9	107.6
Metals					
Silver, platinum[2]	19.8	55.7	15.7	44.3	35.5
Copper	46.7	42.1	64.1	57.9	110.8
Nickel	13.8	62.9	8.1	37.1	21.9
Aluminium	65.2	65.2	34.9	34.8	100.1
Lead	2.0	53.9	1.7	46.1	3.8
Zinc	8.6	54.7	7.1	45.3	15.7
Tin	0.7	19.1	2.7	80.9	3.4
Total of above	156.7	53.8	134.5	46.2	291.2
Total of above	227.2	50.7	220.9	49.3	448.1

Source: United Nations Commodity Trade Statistics, *Yearbook 2006* (available at: http//comtrade.un.org/pb/).

Note
1 Including alumina.
2 Includes other metals of the platinum group.

2 Evolution of fiscal regimes for minerals

Fiscal regimes for minerals (and other resources) tend to differ from those found in other sectors due to the presence of resource rents and unusual risks. Resource rents represent surplus revenues from a deposit after the payment of all exploration, development and extraction costs, including an investor's risk-adjusted required return on investment.[1] Since rent is pure surplus, it can be taxed whilst upholding the core taxation principle of neutrality. Furthermore, governments aim to capture the resource rent, not least because minerals are typically owned by the state.

The unusual and substantial risks inherent in the mining sector need to be emphasized. These risks include, for example: a long exploration period with uncertain geological outcomes; a large significant outlay of development capital that is not transportable (i.e. becomes "sunk") once invested; uncertain future revenues due to very volatile and unpredictable mineral prices; a long period of production to reach break-event point, which exposes the investor to political

and policy instability; and potentially significant environmental impacts requiring large costs to be incurred when the mine closes, and often during production to support affected local communities. These considerations motivate measures, such as accelerated depreciation and extended loss-carry forward limits, to hasten payback of initial outlays.

While rents and risks are also present in other sectors, their scale and characteristics (such as the rent being derived from minerals owned by the state) have led to special tax treatment of the sector, using a wide variety of fiscal instruments.[2] These instruments include royalties, resource rent taxes, windfall taxes, corporate income taxes and state ownership. Each has its advantages and disadvantages with respect to the impact on investor behavior, the degree of progressivity (i.e. extent to which the "government take" increases as a project's profitability increases), the sharing of risk between the government and investor, and the administrative and compliance costs. The characteristics of fiscal instruments are discussed in Section 3.

Mineral fiscal regimes vary widely between countries and minerals for a number of reasons. For example, the level of taxation is likely to vary with country risk.[3] This is because investors base their decisions on risk-adjusted rates of return, and the lower the country risk the higher the level of taxation consistent with a given project exceeding the minimum required return. The royalty rate and other instruments most directly targeted at rent are also likely to vary with the perceptions of the size of rent available.[4] This explains why high value minerals like diamonds and gold tend to attract a higher royalty rate.

The optimal mix of fiscal instruments will also vary depending on the country's preferences and capabilities. Some governments may prefer production-based

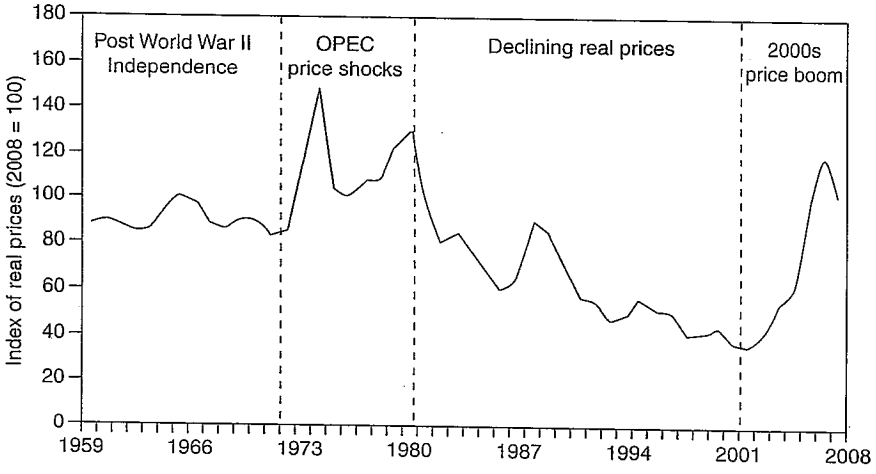

Figure 5.1 Mineral prices[1] (source: IMF WEO).

Note
1 Excludes oil (simple average of Aluminium, Copper, Gold, Iron Ore, Nickel, Tin, Uranium and Zinc).

instruments as they are easier to administer and provide earlier and more stable revenue. However, as this shifts more of the risk onto companies, governments will most likely need to accept a lower overall expected level of taxation.[5] Other countries might therefore prefer a more progressive regime that involves the government assuming more risk but also expecting to receive a higher take from profits. A summary of current arrangements for selected countries is provided in Appendix I.

In addition to variation between countries, a number of global trends can be identified over the past half century. These have tended to be punctuated by external events that shifted the balance of power between mineral producing countries and investors. This shift in power, which is evident in the evolution of mineral prices (Figure 5.1), can usefully be analyzed with reference to a number of distinct periods.[6] The experiences of Papua New Guinea, Chile and Zambia provide useful illustrations of these trends (Box 5.1).

Box 5.1 Selected country experiences

Chile – state participation, private competition, royalty rates

By the late 1960s, Chile's four principal copper mines were owned by US companies. Frustrated by low revenues, successive governments introduced measures to increase government participation in the mines via Codelco (a state owned enterprise). The mines were eventually nationalized after the socialist Salvador Allende won the 1971 election. After Pinochet's coup in 1973, the nationalized mines remained under Codelco's control but market-oriented reforms paved the way for new foreign investment. Chilean copper production grew rapidly but the taxes paid by private companies were comparatively low (Pizarro, 2004). In part, this reflected generous fiscal terms designed to attract new investment, including a zero royalty rate. Dissatisfaction over the private companies' contribution to revenue grew in line with rising copper prices. After a failed attempt to introduce a profit-based royalty in 2004, a sliding scale royalty (0–5 percent) based on sales became effective in 2006.

Papua New Guinea – renegotiation, additional profits tax

Bougainville Copper Limited (BCL) commenced commercial production at the Panguna mine in 1972. The mine was highly profitable and in 1974 the government sought to renegotiate terms. A revised agreement, which became effective in December of that year, eliminated various tax incentives, and introduced an additional profits tax under which the mine was subject to a marginal rate of 70 percent after it had earned a 15 percent rate of return on funds invested. An additional profits tax became an integral part of the fiscal regime for all mines, seen as a means of capturing a large share of any future rents, whilst still attracting investment by ensuring an adequate return to the investor. From the late 1980s successive governments made a number of changes, and in 2002, when real mineral prices were near record lows, the terms were revised once more with a view to

making the sector more attractive to investors. Key changes included: abolishing the additional profits tax (which no company other than BCL is understood to have paid); relaxing ring-fencing rules; more attractive accelerated depreciation arrangements; and elimination of loss-carry forward time limits.

Zambia – state participation, privatization, renegotiation, windfall tax

After independence in 1964, President Kaunda nationalized the copper industry, and the Zambia Consolidated Copper Mines (ZCCM) conglomerate was created. The industry flourished, with rising copper prices and the mineral rights now accruing to the state (formerly benefiting the British South African Mining Company). However, a combination of falling prices and deteriorating mining infrastructure led to declining copper production and large deficits for ZCCM and the government. A market-reform orientated government led by President Chiluba privatized various operating divisions of ZCCM in 1997–2000.

The Mines and Minerals Act of 1995, which facilitated the privatization process, permitted the government to enter into "Development Agreements" under which fiscal terms could be negotiated on a mine-by-mine basis. Typical fiscal terms were generous (e.g. a royalty rate of 0.6 percent and a company income tax rate of 25 percent) and "locked" in by fiscal stability agreements. While successfully rejuvenating the copper industry, the government take was low and was considered unacceptable when copper prices rose unexpectedly. In 2008, the government controversially scrapped development agreements and introduced a new fiscal regime, which included a higher royalty rate (3 percent), a variable income tax and a windfall tax applied to the value of production with a sliding scale of rates triggered by the copper price. The windfall tax was repealed in 2009.

A Before World War II

The typical arrangement prior to World War II was for the government to grant concessions to corporations or investors to explore for and extract mineral resources. In return, the government received payments through mechanisms such as initial bonuses, royalties and land rental fees. Income taxes were less common in developing countries. Royalties, which provided the bulk of revenues, were levied on production at relatively low rates. For countries occupied by colonial powers, an implication of low taxes was that much of the rent flowed out of the country to corporations and investors in the colonial power.

B After World War II – independence

The shift to independence after World War II in much of the mineral-rich world led to an increased focus on a country's sovereignty over its natural resources. A central element of this was a desire for the home government to attain a larger share of resource rents. Against a background of reconstruction and a related rapid increase in demand for raw materials, the environment was ripe for an overhaul of existing mining arrangements in favor of mineral producing countries. The key developments were the following:

- *State ownership*. Many governments sought to increase state ownership and control over mineral assets through nationalization, equity participation or joint ventures. Nationalization began in Bolivia with tin mining in 1952 and later occurred in Chile (copper), Peru (iron ore, copper), Venezuela (iron ore), Zambia (copper), Democratic Republic of the Congo (formerly Zaire; copper), Ghana (gold), and Jamaica, Guyana and Suriname (bauxite). In addition to attaining a larger share of rents, a major driving force behind increased state ownership was the belief that greater control over mineral assets would lead to greater beneficial spillovers to the rest of the economy.[7]
- *Ad valorem royalties*. Royalties based on production value, and not simply volume, became increasingly common. The royalty was most often applied at a constant rate for a specified mineral. More recently, several jurisdictions have adopted sliding scales based on price, production, sales and even perceived cost of operation.[8] In developed countries with advanced tax administrations, there has been a recent shift toward profit-based royalties (most provinces in Canada, the Northern Territory in Australia, and Nevada in the United States). The shift from volume-based to value- and profit-based royalties represents an attempt to more accurately target rent.
- *Income tax*. In many countries, there was a shift from royalty to income tax as the major source of revenue. Investment incentives were – and still are – often incorporated into the income tax regime, most commonly through accelerated depreciation allowances, loss-carry forward provisions and, for exploration and mining companies, the full expensing of exploration costs.
- *Introduction of other payments*. Most developing countries introduced withholding taxes on dividends, interest and foreign-provided services. Withholding taxes are now commonly used, both to provide revenue and to counteract tax avoidance and evasion through, for example, use of related party debt and payment of contractors at non-market prices. Customs and excise duties, sales taxes and, more recently, value added taxes were also introduced, although many countries now provide exemptions to encourage investment and to ease the administrative burden from having mining companies in large VAT refund situations due to the zero rating on their exports.

C 1970s price shocks

In 1973–1974, oil prices quadrupled following a decision of the Organization of Petroleum Exporting Countries (OPEC) to restrict oil production. Many mineral prices also increased sharply around this time, albeit by a much smaller amount and partly influenced by independent factors.[9] These developments further encouraged mineral producing countries in their efforts to capture a higher share of the rent through taxation and nationalization. Papua New Guinea, followed by others, introduced special instruments designed to increase the government "take" in boom times. The specific form varied from country to country but most typical was a cash flow-based tax that increased the marginal rate of income tax for projects that earned more than a specified rate of return.[10] There was also a

growing focus on using the fiscal regime to encourage local processing, such as by imposing export duties on raw materials.

D Declining real mineral prices: 1980s and 1990s

In the 1980s and 1990s, mineral prices declined in real terms. State-owned enterprises, which often struggled to deliver the expected higher revenues in the boom years due to inefficient operations, became an even greater drain on government finances. Combined with a poor economic performance overall, a high debt burden, and the break-up of the Soviet Union which discredited central planning, mineral producers reconsidered the role of the state. Some began a process of privatizing their mining industry and confined government's role to one of regulation and investment promotion. Others commercialized state enterprises, lowered the level of state participation and placed greater emphasis on attracting private sector involvement. Countries that made substantive changes in this direction included Bolivia, Chile, the Democratic Republic of Congo, Ghana, Indonesia, Peru and Zambia.

Depressed prices discouraged mineral exploration and mine development. In an effort to promote activity in the sector and foreign direct investment more broadly, countries became increasingly concerned with how their level of mining and non-mining taxation compared with that of competitors. International competition prompted revised fiscal terms in a number of countries that, in general, involved lower rates. Mining corporate tax rates fell from an average of 50 percent to 30–40 percent (Kumar, 1995; non-mining rates fell similarly), royalty rates were lowered and reduced to zero in Chile,[11] and Indonesia, Papua New Guinea and Namibia (variable income tax) removed additional profits taxes. Table 5.2 illustrates the

Table 5.2 Mining corporate income tax rates

	1983	*1991*	*2008*
Australia	46	39	30
Canada[1]	38	29	22
Chile	50	35	35
Indonesia	45*	35	30
Mexico	42	35	28
Papua New Guinea	36.5*	35*	30
South Africa[2]	46–55†	50–69†	28
USA[1]	46	34	35
Zambia[3]	45	45	30*†

Source: *Mining Taxation: A Global Survey*, Coopers & Lybrand, Washington, DC, 1991 and 1983.

Notes
* denotes additional profits/windfall tax also applies.
† denotes a variable income tax formula.
1 Federal only.
2 High rate is maximum payable for gold under variable income tax formula. Low rate is non-gold, non-diamond flat rate. Diamond mining was subject to 52% in 1983 and 56% in 1991.
3 In 2008, a flat rate of 30% applies if the windfall tax based on price is payable, otherwise variable income tax applies with a minimum rate of 30%.

decline in corporate income taxes in select countries. At around the same time, pressures emerged to introduce or strengthen environmental, safety and community obligations, thereby increasing some non-fiscal costs.

E 2002–2008 price boom

In 2002 the trend decline in real mineral prices suddenly changed course with prices tripling over a five-year period, largely on account of rapid demand growth in China and other emerging market economies.[12] This prompted governments to reassess whether they were receiving a reasonable share of increased rents. Liberia introduced a resource rent tax, and Mongolia and Zambia introduced windfall taxes triggered by prices. Kazakhstan, Botswana and South Africa (gold) were percipient in having progressive arrangements in place prior to the boom. Among developed countries, the application of windfall taxes has been debated in the United States, United Kingdom and Australia, most commonly focused on the petroleum industry. As many mining companies are domiciled in these countries, the application of windfall taxes would capture rents otherwise taxable in the host countries.

During this period there has also been an increased emphasis on transparency, in recognition that weak governance has contributed to the persistence of poverty in resource-rich countries. The Extractive Industries Transparency Initiative (EITI), launched in 2002, attempts to strengthen governance through the verification and publication of company payments and government revenues from extractive industries. The EITI is gaining adherents among developing countries and mining companies operating within them.[13]

IMF (2007) provides a guide on resource revenue transparency containing a number of recommendations based on best practice. One encouraging development is that there is a movement away from negotiating fiscal terms on a mine-by-mine basis towards establishing terms applicable to all mining projects in general legislation.[14] In addition to being more transparent, this reduces administrative costs and probably the investor's perception of risk that the government will renege on the terms. Furthermore, the investor would invariably have more information than the government on the profitability of the project, placing them in a stronger negotiating position.

3 Criteria for assessing fiscal instruments

Baunsgaard (2001) evaluated several fiscal instruments in mineral taxation including: direct tax instruments (corporate income tax, progressive profit tax and the resource rent tax), indirect tax instruments (royalties, import duties and the value added tax) and non-tax instruments (fixed fees and bonus payments, production sharing and state equity). Using the ratings approach in Baunsgaard (2001), Table 5.3 provides an overview of the advantages and disadvantages of the most common fiscal instruments in the mining sector based on seven criteria: neutrality, stability, project risk, flexibility, fiscal loss, revenue delay and administration. These criteria

Table 5.3 Fiscal instruments

	Neutrality	*Investor risk*		*Rent collection and government risk*			*Administration and compliance*
		Stability	*Project risk*	*Flexibility*	*Fiscal loss*	*Revenue delay*	
Rent-based taxes							
Resource rent tax	+2	+8	+2	+3	−2	−3	−3
Excess profits tax	+1	+3	+2	+2	−1	−1	−2
Profit-based taxes							
Corporate income tax	−1	+1	0	+1	0	0	−1
Profit-based royalty	−1	+1	0	+1	0	+1	−1
Output-based royalties							
Ad valorem royalty	−2	0	−1	−1	+1	+2	+1
Graduated windfall tax – price-based	−2	+2	+1	0	0	0	+1
Specific royalty	−3	−1	−2	−2	+2	+2	+2
State equity							
Paid equity	+3	+1	+3	+3	−3	−1	+3
Carried interest	+2	+3	0	+3	−2	−3	+1

Sources: Rating system based on Garnaut and Clunies Ross (1975) and Baunsgaard (2001).

Note
7 point scale −3 to +3, where +3 means that the instrument performs extremely well on the criterion and −3 signifies the opposite.

and the rationale for the assessments in the table are discussed below. It should be emphasized that the comparative assessment is broadly indicative and will vary according to the actual settings for the fiscal parameters including, for example, the tax and royalty rates. The fiscal instruments are defined in Box 5.2.

Although it is useful to look at the characteristics of each instrument in isolation, a regime will typically comprise multiple instruments in which case it is necessary to assess the tax system in its entirety.[15] For example, the international trend toward lower corporate income tax rates in recent decades may have implications for the design of other fiscal instruments to ensure that a reasonable share of the resource rent is collected by the government.

Box 5.2 Fiscal instruments

Rent-based taxes[16]

- *Brown tax* – named after Brown (1948), this is levied as a constant percentage of the annual net cash flow (the difference between total revenue and total costs) of a resource project with cash payments made to private investors in years of negative net cash flow. The Brown tax is a useful benchmark against which to assess other policy options, but is not considered to be a feasible policy option for implementation since it involves cash rebates to private investors.[17]
- *Resource rent tax* – rather than providing a cash rebate, negative net cash flows are accumulated at a threshold rate and offset against future profit. When this balance turns positive it becomes taxable at the rate of the resource rent tax. The resource rent tax was first proposed by Garnaut and Clunies Ross (1975) for natural resource projects in developing countries to enable more of the net economic benefits of these projects to accrue to the domestic economy.
- *Excess profits tax* – the government collects a percentage of a project's net cash flow when the investment payback ratio (the "R-factor") exceeds one. The R-factor is the ratio of cumulative receipts over cumulative costs (including the upfront investment). This method differs from the resource rent tax in that it does not take explicit account of the time value of money or the required return of the investor. No excess profits tax in the R-factor form has been applied to the mining sector.

Profit-based taxes and royalties

- *Corporate income tax* – typically an important part of the fiscal regime for all countries; a higher tax rate may be applied to mineral companies within the standard corporate income tax regime, and it may be designed to vary with taxable income (e.g. Botswana).
- *Profit-based royalty* – the government collects a percentage of a project's profit; typically based on some measure of accounting profit. This differs from the standard income tax in that it is levied on a given project rather than the corporation.

Output-based royalties

- *Ad valorem royalty* – the government collects a percentage of a project's value of production.
- *Graduated price-based windfall tax* – the government collects a percentage of a project's value of production with the tax rate on a sliding scale based on price (that is, a higher tax rate is triggered by a higher commodity price).
- *Specific royalty* – the government collects a charge per physical unit of production.

State equity

- *Paid equity* – the government becomes a joint venture partner in the project. Paid equity on commercial terms is analogous to a Brown tax where the tax rate is equal to the share of equity participation.
- *Carried interest* – the government acquires its equity share in the project from the production proceeds including an interest charge. Carried interest is analogous to a resource rent tax where the tax rate is equal to the equity share and the threshold rate of return is equal to the interest rate on the carry.

A Economic efficiency

Neutrality

A fiscal instrument is neutral if an action or project that is assessed to be financially viable in the absence of the fiscal instrument (that is, profitable or economic before tax) remains viable after the fiscal instrument is applied. Typically, the neutrality criterion is used to evaluate the extent to which fiscal instruments may have a negative impact on mineral exploration, development, production and closure decisions. In particular, some projects that are viable before tax may become unprofitable after a fiscal instrument is applied, resulting in efficiency losses.

Compared with output-based royalties, rent- and profit-based taxes and state equity instruments rank more highly under this criterion since the government take under these arrangements tends to vary with project profitability. Notably, there are differing degrees of efficiency within this group and the resource rent tax ranks more highly than profit-based taxes.

Investor risk

Investor risk is incorporated in the economic efficiency criterion since fiscal instruments may have a significant impact on private risk assessments and influence industry outcomes.

SOVEREIGN RISK (STABILITY)

Sovereign risk refers to the investor's assessment of the political or policy risks associated with a resource project. Changes in the fiscal settings over the life of a project may have a significant impact on the future profitability of the project. In particular, the risk of future adverse policy change may influence the initial decision to invest in the project: the higher the perceived risk, the higher the investor's risk premium (all else constant), and the lower the assessed viability of the project. Osmundsen provides in Chapter 15 a useful discussion of the issue of sovereign risk, or time consistency issues more broadly, in petroleum resource taxation with particular reference to developments in Norway.

Rent and profit-based taxes and state equity instruments rank more highly under this criterion since the government take tends to vary with project profitability so that the government may be less likely to adjust fiscal settings in response to major changes in market conditions. A major concern under output-based royalties is the risk of higher royalty rates during mining booms (including the risk of delay in reducing rates following the end of the boom). However, while royalties have a lower ranking, they too can contribute to fiscal regime stability by ensuring a politically popular payment whenever production occurs.

PROJECT RISK

Project risk refers to the investor's assessment of the market risks associated with a resource project. The choice of fiscal instrument may have significant implications for the investor's assessment of project risk and hence project viability. A fiscal instrument for which tax revenue is not responsive to changes in future market conditions results in greater variability in future possible outcomes for project profitability compared with an alternative fiscal instrument where the tax revenue varies with project profitability.

Rent and profit-based taxes and state equity instruments rank more highly under this criterion since the government take tends to vary with project profitability and both the investor and government share in the risks of adverse market outcomes.

B Rent collection and government risk

Rent collection – flexibility

Flexibility refers to the responsiveness of fiscal instruments to changes in future market conditions – that is, the capacity of fiscal instruments to collect a reasonable share of the resource rent over time under a range of future market outcomes (including both better and worse than expected outcomes).

Rent and profit-based taxes and state equity instruments rank more highly under this criterion since the government take tends to vary with project profitability.

Government risk

A major concern expressed by a wide range of governments is the risk associated with the magnitude and timing of mineral taxation revenue, specifically the risk of fiscal loss and revenue delay.

FISCAL LOSS

Fiscal loss refers to the situation where the government obtains a lower than expected return to the resource, particularly under adverse market outcomes. The paid equity instrument also exposes the government to the risk of project failure with losses including part or all of the equity. A fiscal instrument where tax revenue is not responsive to changes in future market conditions results in greater stability in tax revenue flows, reducing the risk of fiscal loss (but also not managing well the risk of fiscal gain).

Output-based instruments rank more highly under this criterion since the government receives royalty payments in all years in which production from the resource project is positive, including any in which losses may occur.

REVENUE DELAY

Revenue delay refers to the situation where the government does not start to collect tax revenue until some time after the project's production commencement date. Under a resource rent tax, for example, revenue collection is delayed until investors have received a specified threshold rate of return on their capital outlays.

Output-based instruments rank more highly under this criterion since royalty revenue is collected throughout the production phase of the project.

Dependence on minerals taxation revenue and stability of the revenue stream are significant issues, particularly in several developing economies. In Chapter 2, Boadway and Keen provide a useful discussion of the issue of government preferences for the timing of resource tax revenue.

C Administration and compliance costs

Administration and compliance costs refer, respectively, to the costs incurred by government in designing, implementing and monitoring compliance with a fiscal instrument and to the costs incurred by investors in complying with the fiscal instrument. In general, both types of cost associated with a fiscal instrument tend to be higher if the information requirements of the policy are higher. Ideally, information on project profitability is required for all fiscal instruments to determine appropriate fiscal settings. Output-based instruments tend to require less information that is more readily verified than is the case with rent- or profit-based instruments (which also require an assessment of expenditures). However, output-based instruments are also more likely to be adjusted over time as market conditions change, increasing administrative and compliance costs. Baunsgaard (2001) also includes international tax arrangements, particularly the availability of tax credits, as a criterion for evaluating fiscal instruments.

Output-based instruments tend to rank more highly under this criterion since the information requirements tend to be lower than for profit-based instruments. Rent-based taxes rank the lowest due to the additional calculations required but, as Land (2009) notes in Chapter 8, they are in some respects simpler than profit-based taxes in that capital investments are expensed in full so there is no need to worry about depreciation.

The Chapters by Calder (11 and 12), Land (8) and Mullins (13) provide useful discussions of resource tax administration issues, the last two focusing on issues related to resource rent taxation and international considerations, respectively. Netback pricing issues are discussed in Chapter 6 by Kellas. Otto *et al.* (2006) and IMF (2007) examine issues associated with administrative feasibility and resource revenue management in developing economies. Increasing transparency and ensuring that minerals taxation arrangements are part of the legal framework are important in increasing the efficiency of administrative processes and the effectiveness of policy assessments and outcomes. Increasing capacity through training and recruitment of quality audit staff is also critical.

4 More detailed assessment of selected mineral taxation options

A Resource rent – economic rationale for rent-based taxes

The economic rent in an economic activity is the excess profit or supernormal profit, and is equal to revenue less costs where costs include normal profit or a "normal" rate of return to capital. This normal rate of return, which is the minimum rate of return required to hold capital in the activity, has two components: a risk-free rate of return, and a risk premium that compensates risk averse (RA) private investors for the risks incurred in the activity (information on attitudes toward risk and the profitability assessments of risky projects is presented in Box 5.3).

The economic rationale for mineral taxation in addition to that applied to all industries is based on the scale of resource rent in the minerals industry. The concept of resource rent in the minerals industry applies over the longer term and takes into account the costs of the following distinct economic activities:

- *Exploration* – the cost of finding new mineral ore deposits.
- *New resource developments* – the cost of new resource developments based on mineral ore deposits that are known.
- *Production* – the cost of extracting resources from established mine sites (including abandonment costs such as mine site rehabilitation costs).

Resource rent in the mining sector may persist in the long run due to the quality or scarcity value of different ore deposits (these concepts are discussed by Boadway and Keen in more detail in Chapter 2). Resource rent is typically assumed to be equal to the economic rent in the minerals industry, although it is important to note that economic rent may be larger than the resource rent due to other factors such as managerial skills.

A graphical representation of the mineral industry's economic rent is provided in Figure 5.2 where, for simplicity, price is assumed to be determined on

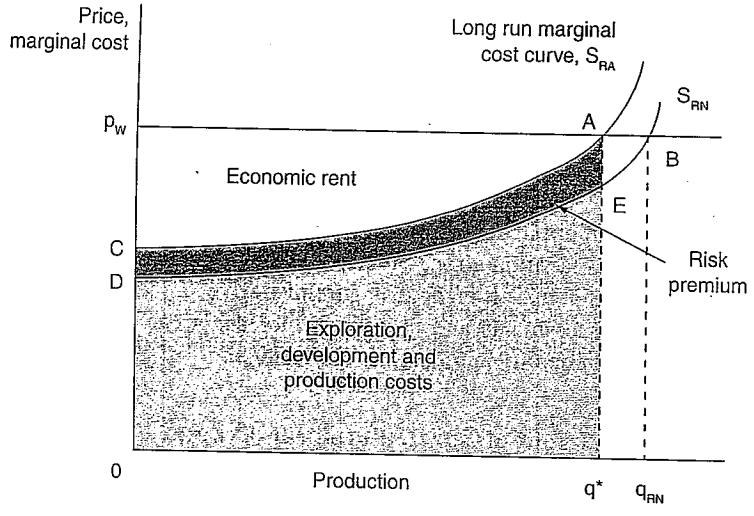

Figure 5.2 Illustrative economic rent in the minerals industry (supernormal profit or excess profit).

world markets at p_w. The long run industry supply curve, S_{RA}, is an annual representation of the long run marginal cost of exploration, development and production including a normal return to capital.[18] The equilibrium position for the industry occurs at point A, with production given by q*. It would not be profitable for the industry to incur any additional costs by increasing production beyond this level and there would be unexploited profit opportunities if activity stopped at a lower level.

Total industry revenue is given by the area $0p_wAq^*$ (equal to the world price multiplied by output, or p_wq^*), total industry costs are given by the area under the supply curve, $0CAq^*$, and the economic rent is given by the area Cp_wA (total revenue less total costs).

To identify the industry's risk premium, Figure 5.2 explicitly includes the industry supply curve, S_{RN}, that would exist if private investors were risk neutral (RN). The equilibrium position for the risk neutral industry occurs at point B with output given by q_{RN}. The industry's risk premium (expressed as a value, not a rate of return to capital; see Box 5.3) is the difference between the two supply curves up to the industry output, q^*, and is given by the area ACDE. In the presence of risk and risk averse private investors, industry output is lower than would otherwise be the case since a number of marginal projects are assessed to be too risky to be undertaken given future possible outcomes relating to the geological, economic and policy environments.

B Rent-based taxes

Brown tax

Under the Brown tax, the government essentially acts as a silent partner in all resource projects. In years where net cash flow is negative – typically in the exploration and development stages of a resource project – the government pays the investor the Brown tax rate multiplied by the losses. In years where net cash flow is positive – typically in the production stage – the government receives the same fixed proportion of the profits.

If private investors are assumed to be risk neutral, the Brown tax is a neutral mineral taxation policy: in profitability assessments undertaken by private investors, the Brown tax reduces the expected profit of a project or modifies the expected loss, but it does not result in any switching between economic and uneconomic projects. A graphical representation of the Brown tax assuming risk neutral private investors is presented in Figure 5.3. Under the Brown tax, industry output is unchanged from the before-tax outcome of q_{RN} and the government collects a constant share of the economic rent (equal to the tax rate).

The Brown tax shares the risks of resource projects between risk averse private investors and the government (this is similar to the paid equity fiscal instrument which is an alternative to the Brown tax). With risk averse private investors, the risk premium is therefore reduced and it is possible that a project may switch from being uneconomic before tax to economic after tax. Industry output may therefore increase under a Brown tax (this implies that, in Figure 5.2, output would be larger than q^* but still less than q_{RN}; see Hogan (2007) for further discussion of this issue).

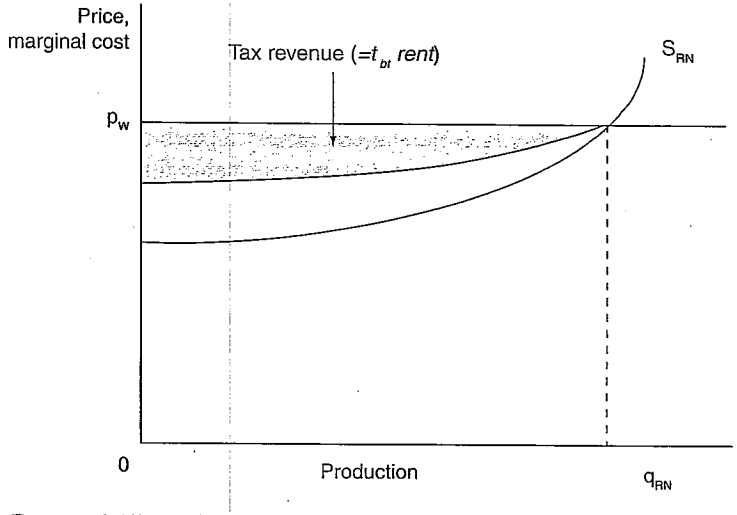

Figure 5.3 Illustrative industry impact of a Brown tax, risk neutral investors.

Resource rent tax

The resource rent tax is typically regarded as a practical alternative to the Brown tax since the government avoids the need to provide private investors with a cash rebate during years of negative net cash flow. The resource rent tax is only paid when a private investor achieves the threshold rate of return on the investment in the resource project. To achieve full loss offset in a resource rent tax while avoiding cash rebates, the main options are:

- *Transfers between projects within a company* – to allow companies to transfer the losses from failed projects to successful projects within the same group.
- *Transfers between companies* – for companies without successful projects against which to offset losses, to allow the sale of losses on failed projects to other companies with resource rent tax obligations.
- *Carry losses forward* – to allow companies to carry losses forward at a specified interest rate as an offset against future resource rent tax obligations from successful projects.

The transferability of losses between projects or between companies typically applies only to mineral operations within the same jurisdiction or country.

For risk neutral private investors, the threshold rate at which all losses are accumulated should clearly be set at the risk free interest rate (typically assumed to be the long-term government bond rate in developed economies).

For risk averse private investors, there are significant issues relating to the inclusion of a risk premium allowance in the threshold rate and the setting of the tax rate. If the threshold rate for a given project is set at the private investor's minimum rate of return (comprising the risk free interest rate plus an appropriate risk premium), the remaining net cash flow represents the economic rent of the project. If the economic rent and resource rent are equivalent, it is reasonable for the government to target the entire economic rent as a return to the mineral resource. If the economic rent exceeds the resource rent – that is, part of the rent represents a return to factors other than the mineral resource (such as a return to managerial skills or a technology leader) – it may be reasonable for the government to target less than the entire economic rent as a return to the mineral resource. There are also likely to be significant estimation errors in measuring rents.

The tax rate needs to be sufficiently below 100 percent to ensure that it does not seriously weaken efficiency incentives in the private sector (or encourage rent dissipating activities): this includes, for example, the risk of early mine closure, transfer pricing, "inflating" costs and lobbying government for tax breaks. A threshold rate that is below the minimum rate of return would compensate the government, at least to some extent, for a tax rate that is below 100 percent provided the project remains profitable for the private investor (that is, the certainty equivalent value of the project remains non-negative; see Box 5.3).

However, reducing the threshold rate may increase the possibility of some negative distortions to private investment decisions.

Lack of full loss offset in the resource rent tax is another consideration. For example, a resource rent tax that is levied only on successful resource projects fails to fully account for all revenues and costs in the minerals industry. A lower tax rate would compensate private investors for the lack of full loss offset. The original approach suggested by Garnaut and Clunies Ross (1975) was for the resource rent tax to apply to individual resource projects where, importantly, exploration activity in a failed lease area would be treated as a distinct resource project. They argued that a higher risk premium and/or lower tax rate than would otherwise apply would compensate industry for the lack of full loss offset.

Fane and Smith (1986) argued that the threshold rate should be set equal to the risk free interest rate (the long-term government bond rate) since, with full loss offset, the accumulated expenditures represent a perfectly certain reduction in future resource rent tax liabilities. They argued that an investor has the option of reducing current holdings of long-term government bonds to finance expenditure, foregoing the annual interest rate that would otherwise have accrued, to be compensated when the reduction in tax liabilities is triggered. Alternatively, if the company does not hold long-term government bonds, the expenditure may be financed through the release of corporate debentures with interest rates typically only marginally higher than the long-term government bond rate: this is analogous to a carried interest state equity approach (see Box 5.2). Fane and Smith (1986) further argued that the difficulties in making any actual tax proposal approximate the theoretical concept of a pure rent tax (or neutral tax) provide a justification for choosing a fairly low rate of rent tax. In practice, few systems incorporate full loss offset in which case some risk premium in the fiscal settings would be justified.

Developments in Australia's petroleum resource rent tax provide an indication of various issues associated with the implementation of a resource rent tax. The threshold rate of return in Australia's petroleum resource rent tax comprises a risk free rate of return and a risk premium. The original petroleum resource rent tax was introduced in Australia in the mid-1980s. An important modification to the petroleum resource rent tax was introduced in 1990 to allow companywide deductibility of exploration costs in recognition that typically a private investor may undertake exploration in a number of lease areas before a significant discovery is made that leads to petroleum field development and production. The threshold rate, which was relatively high to compensate private investors for the lack of full loss offset, was reduced. In 2005, exploration expenditure by established companies in specified frontier areas was provided with a 150 percent tax deduction in recognition of the relatively high risks associated with this activity (see Hogan (2003) for further information). A tax rate of 40 percent has applied in the petroleum resource rent tax since its inception.

Chapter 15 by Osmundsen discusses Norway's petroleum taxation system. This represents an alternative approach to the resource rent tax whereby the Brown tax is approximated using the corporate tax system.

C Output-based royalties

Ad valorem royalty (levied at a constant rate)

The ad valorem royalty is most often applied at a constant rate with the government collecting a constant percentage of the value of production from each resource project. From a government perspective, the main advantages of this ad valorem royalty are revenue stability – the risk of fiscal loss and revenue delay are reduced compared with rent-based taxes – and lower administration and compliance costs.

However, the ad valorem royalty reduces the expected revenue and hence expected profitability of a resource project. Some resource projects may therefore switch from being economic to uneconomic under the ad valorem royalty. These efficiency losses are illustrated in Figure 5.4 with industry output reduced from q_{RN} to q_{adv}. The ad valorem royalty is regressive since the share of the rent collected through the royalty is higher for lower profit resource projects: that is, compared with a rent-based tax, the ad valorem royalty tends to "overtax" low profit projects and "undertax" high profit projects.

For risk averse private investors, there are two important mechanisms whereby the ad valorem royalty influences the risk assessment. First, the royalty is paid in all years in which production is positive even if net cash flow is low or negative: that is, the ad valorem royalty is responsive to unexpected changes in price but not net cash flow. Second, sovereign risk tends to be a significant issue under this policy instrument since governments sometimes raise the ad valorem royalty rate during periods of high prices. The ad valorem royalty results in an increase in the private investor's risk premium, resulting in greater efficiency losses than would otherwise occur (see Hogan (2007) for further discussion of this issue).

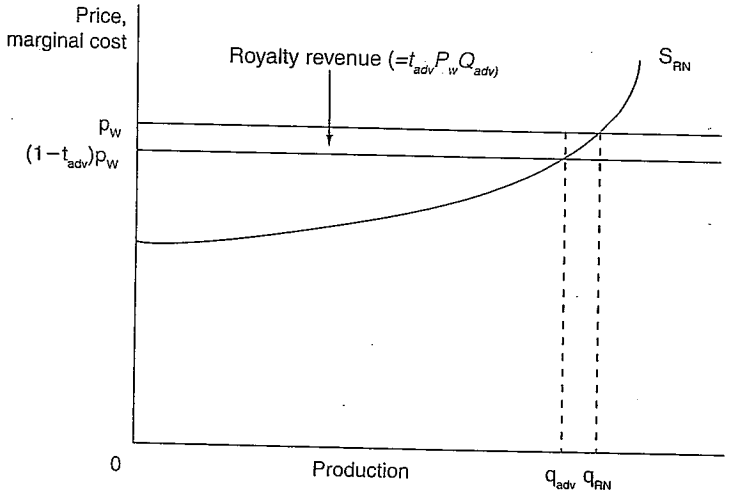

Figure 5.4 Illustrative industry impact of an ad valorem royalty, risk neutral investors.

Since mining is a dynamic process, the industry's supply curve may be interpreted as an annual snapshot of the industry's cost structure including a return to capital (alternatively, the supply curve may represent an industry position over a number of years). The industry's long run marginal cost curve may change over time in response to various factors. Importantly, technology adoption is an important process that places downward pressure on industry costs, while declining ore grade quality over time places upward pressure on industry costs (differences in ore grade quality result in the upward slope in the long run marginal cost curve; however, the mix of ore grades will change over time, particularly as high quality ore deposits are depleted). In a recent study, Topp *et al.* (2008) found these have been significant influences on productivity in Australia's mining sector. The basic ad valorem royalty is not responsive to changes in the industry's cost structure.

Other output-based royalties and taxes

OTHER AD VALOREM ROYALTIES AND TAXES

Variants of the basic ad valorem royalty have been adopted in both developed and developing economies to address, at least to some extent, the limitations of the basic instrument. These ad valorem royalties generally aim to reduce efficiency losses, increase the flexibility of the system and/or increase the share of rent collected through the royalty by introducing a sliding scale in the royalty rate. Ad valorem royalties and taxes incorporating a variable rate include:

- *Exemption for relatively small or low income mines* – adopted in several countries, a zero royalty rate applies to small or low income mines, including artisanal mines in some developing economies, to reduce the efficiency losses under the royalty.
- *Sliding scale based on sales or production* – sales or production is sometimes used in the sliding scale, with a higher royalty rate applying to larger resource projects. This attempts to proxy a rent-based tax on the argument that larger resource projects tend to be more profitable due to the presence of economies of scale. This system may also include an exemption for small mines.
- *Sliding scale based on cost* – of limited use in practice, this aims to reduce efficiency losses by applying a lower royalty rate to higher cost resource projects.
- *Sliding scale based on price* – a graduated price-based windfall tax where a higher tax rate applies to a higher price bracket. Adopted in some countries, particularly during the recent price boom, to increase the flexibility of the system: the focus for several governments was on increasing tax revenue during a period of relatively high commodity prices.

Efficiency losses may be reduced somewhat through these modified ad valorem royalties, although sovereign risk is likely to remain a significant issue. The government would be more likely to adjust the fiscal settings over time in

response to future market changes under these royalties than under a rent-based tax. Under a graduated price-based windfall tax system, a particular focus for private investors would be to assess the risks to net cash flow during periods of relatively high commodity prices: for example, industry costs increased significantly during the recent commodity price boom. A further issue for such a system is the private investor's assessment of the government response to the risk of fiscal loss during periods of relatively low commodity prices.

Administration and compliance costs are likely to be higher under these arrangements than under the basic ad valorem royalty. An important issue relates to the additional complexity that is established in the policy framework through variable royalty rates. A sliding scale provides an economic incentive for mining companies to adopt strategies to avoid moving into a higher royalty bracket.

SPECIFIC ROYALTY

The specific or unit-based royalty is still utilized in most countries for low value, high volume minerals (for example, industrial minerals) and, in some cases, for a range of other minerals. The specific royalty is typically levied as a constant charge per physical unit of production for a specified mineral. For a given price, the specific royalty rate may be calibrated to collect the same amount per unit of output as under an ad valorem royalty. In this case, the impact on industry production is identical, for risk neutral investors, as that indicated in Figure 5.4 (the royalty revenue collected under a specific royalty, levied at t_{sp}, is $t_{sp}q_{sp}$ where $t_s = t_{adv}p_w$ and noting $q_{sp} = q_{adv}$). In practice, however, mineral prices change over time and the revenue collected under an ad valorem royalty will differ from that collected under a specific royalty (unless the latter is adjusted regularly).

The main advantage of the specific royalty is its relative administrative simplicity: this is the primary justification for its continued application to low value, high volume minerals that have low variation in grade quality across mines. The main disadvantage of the specific royalty is its lack of responsiveness to changes in price or net cash flow. The private investor's risk premium would be higher under the specific royalty compared with the ad valorem royalty, increasing the likelihood that an economic project would become uneconomic under the specific royalty.

D Mixed system: resource rent tax and ad valorem royalty

Introducing a sliding scale in the ad valorem royalty may address some of the disadvantages of the basic ad valorem royalty, but an alternative approach is to combine the basic ad valorem royalty with a resource rent tax (with royalty payments fully deductible under the resource rent tax). This mixed system is illustrated in Figure 5.5 under the assumption of risk neutral private investors: industry production is reduced from q_{RN} to q_{mix} (where, assuming a lower royalty rate, q_{mix} exceeds q_{adv} in Figure 5.4).

The aim in this mixed system would be to manage the government risks of fiscal loss and revenue delay through the ad valorem royalty – reducing efficiency losses by applying a lower rate than in a stand alone system – while increasing the flexibility of the system through the resource rent tax: in particular, to provide a relatively efficient mechanism for rent collection from higher profit resource projects. Under this mixed system, the private investor's risk premium would be higher than under a stand alone resource rent tax but lower than under a stand alone ad valorem royalty.

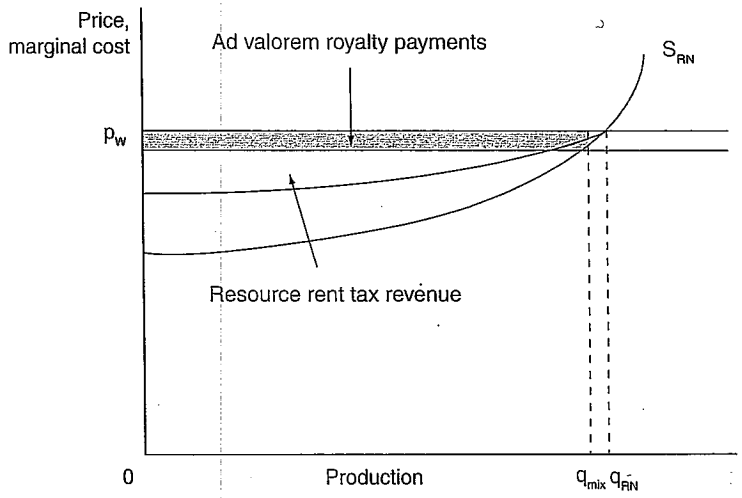

Figure 5.5 Illustrative industry impact of a mixed system, risk neutral investors.

Countries that have introduced rent-based taxes (e.g. Kazakhstan, Liberia) or profit-based royalties (e.g. many of the large mineral producing provinces in Canada) tend to adopt a mixed system by combining them with an ad valorem royalty.

5 Simulations of key mineral taxation options

The objective in this section is to provide simulations of hypothetical projects to illuminate the comparison between four key fiscal instruments. The certainty equivalent approach provides a simple economic framework that clarifies the roles of risk and attitudes toward risk in the private investor's profitability assessments. This approach is complementary to the evaluation of fiscal regimes for oil resource developments in Chapter 7 by Daniel *et al.*

In the certainty equivalent approach – discussed briefly in Box 5.3 – ex ante measures of project profitability, or economic rent, that are assumed to be used as decision rules by private investors are: the net present value (NPV), if the investment is risk free; the expected net present value (ENPV), if the investment is risky and the investor is risk neutral; and the certainty equivalent value (CEV) if the investment is risky and the investor, being risk averse, demands a risk premium (RP) as compensation for incurring risks (where CEV = ENPV – RP).

Box 5.3 Certainty equivalent approach for assessing project profitability

Mining is an inherently risky activity. The private investor's assessment of the profitability of a prospective resource project following successful exploration activity depends on risks in the geological, economic and policy setting over the life of the resource project and the attitude of the investor to incurring risks. In the assessment of risky projects using the certainty equivalent approach, it is assumed the investor is able to identify a range of possible outcomes reflecting significant sources of risk and assign (objective or subjective) probabilities to each of these outcomes.

It is useful to consider the profitability assessments for resource projects in three categories that vary according to the presence of risk and attitudes toward risk.

Risk free investment

A private investor ranks risk-free projects according to the net present value (NPV) since it is a measure of the return to the investment when future conditions are known with certainty. It is important to note that the net present value is the sum of the annual net cash flows over the duration of the project discounted at the risk-free interest rate (assumed to be the long-term government bond rate or LTBR). A project with a net present value that is greater than or equal to zero is assessed to be profitable since it indicates that the investment will achieve a return that is greater than or equal to the risk-free interest rate.

Risky investment

Risk neutral investors

A risk neutral investor is indifferent to the risk that an outcome may be either worse or better than expected, and so summarizes the profitability of a resource project by calculating the expected net present value (ENPV). The expected net present value is the probability weighted sum of the net present value of each possible outcome (where the net present value is calculated based on the risk-free interest rate, as in the previous case). A project with an expected net present value that is greater than or equal to zero is assessed to be profitable since it indicates that the investment is expected to achieve a return that is greater than or equal to the risk-free interest rate.

Risk averse investors

A risk averse investor is relatively more concerned about the risk of unexpected losses than the risk of unexpected gains. In the presence of risk, a risk averse investor summarizes the profitability of a resource project by calculating the certainty equivalent value (CEV). The certainty equivalent value is equal to the project's expected net present value (calculated using the risk-free interest rate, as above) less a risk premium (RP) that provides adequate compensation for the risks associated with the project (that is, CEV = ENPV – RP). A project with a certainty equivalent value that is greater than or equal to zero is assessed to be profitable. The certainty equivalent value of a project may be interpreted as the net present value of a risk-free project that is ranked equally with the risky project. The valuation of the risk premium may have an important influence on the assessment of project profitability.

A Project assumptions

The hypothetical projects we consider vary widely in size, with the value of production assumed to range from $5 million for project 1 to $250 million for project 5. The cost structure reflects the presence of economies of scale, whereby average operating costs are lower for larger projects: in the sensitivity analysis, capital costs are assumed to be 25 percent higher than in the base case. Production and operating costs are assumed to be constant during the production phase of each project. The mine life is assumed to be 20 years for project 5 and ten years for the other projects.

For simplicity, the resource price is the only source of risk. This price risk – usually considered to be a major source of risk in resource development projects – is introduced into the project simulations in a relatively simple way. There are assumed to be seven possible price outcomes over the development and production stages of the resource projects. For example, the probability that a price of $1,000 a tonne will occur is assumed to be 30 percent, while the price outcomes of $650 a tonne or $1,350 a tonne are each assumed to occur with a probability of 1 percent.

In the profitability assessments, risk averse private investors need to estimate the risk premium for each hypothetical resource project. The coefficient of relative risk aversion, R, is assumed to be 2 and the risk premium is given by the variance of the distribution of the net present values divided by the expected net present value (see Newbery and Stiglitz (1981, page 73 and related examples) for further information).

B Results

Before tax or royalty

The main simulation results are summarized in Table 5.4. Before tax, all five projects are profitable for both risk neutral and risk averse investors. For risk neutral investors, the expected net present value ranges from $8.9 million for the relatively small project 1 to $995 million for the relatively large project 5. For risk averse investors, the risk premium ranges from $2.3 million for project 1 to $52 million for project 5. As a consequence, the certainty equivalent value ranges from $6.5 million for project 1 to $943 million.

With higher capital costs, each of the five hypothetical resource projects remains profitable before tax, although project profitability is reduced (see the results for the sensitivity analysis at the bottom of Table 5.4). Under the higher capital cost assumption, the certainty equivalent value ranges from $3.3 million for project 1 to $817 million for project 5.

Rent-based taxes

The Brown tax, included as a benchmark fiscal instrument, is levied at a rate of 40 percent. For consistency, the resource rent tax is also levied at a rate of 40

Table 5.4 Key results for illustrative resource projects[1]

	Before tax $m	*Rent-based taxes*			*Output-based royalties*			
		Brown tax $m	*Resource rent tax*		*Ad valorem royalty*		*Specific royalty*	
			5%[2] $m	*10%[3] $m*	*10% $m*	*5% $m*	*$100/t $m*	*$50/t $m*
Expected tax revenue								
Project 1	–	3.5	2.8	2.0	3.7	1.8	3.7	1.8
Project 2	–	18	16	12	18	9	18	9
Project 3	–	50	46	40	37	18	37	18
Project 4	–	130	124	113	74	37	74	37
Project 5	–	398	386	364	184	92	184	92
Project profitability assessments								
Risk neutral investors – expected net present value (ENPV)								
Project 1	8.9	5.3	6.1	6.9	5.2	7.0	5.2	7.0
Project 2	44	27	28	32	26	35	26	35
Project 3	125	75	79	85	89	107	89	107
Project 4	324	195	201	211	251	288	251	288
Project 5	995	597	609	631	811	903	811	903
Risk averse investors								
Risk premium (RP)								
Project 1	2.3	1.4	1.3	1.2	3.2	2.6	4.0	2.9
Project 2	12	7	7	6	16	13	20	15
Project 3	16	10	9	8	19	17	23	19
Project 4	25	15	15	13	27	26	33	29
Project 5	52	31	30	28	51	52	64	57
Certainty equivalent value (CEV = ENPV–RP)								
Project 1	6.5	3.9	4.8	5.7	2.0	4.4	1.2	4.1
Project 2	33	20	22	26	10	22	6	20
Project 3	109	65	70	77	70	90	65	88
Project 4	299	179	186	198	224	262	218	259
Project 5	943	566	578	603	759	851	747	846
Sensitivity analysis: certainty equivalent value under the higher capital cost assumption								
Project 1	3.3	2.0	2.5	3.3	–3.2	0.6	–4.6	0.2
Project 2	16	10	11	15	–16	3	–23	1
Project 3	81	49	53	64	39	61	33	58
Project 4	247	148	155	173	170	209	163	206
Project 5	817	490	503	540	631	724	617	718

Source: Hogan (2007).

Notes

1 In present value terms. See Box 5.3 for further information.
2 No risk premium in the threshold rate.
3 5% risk premium in the threshold rate.

percent. Two options are considered for the threshold rate in the resource rent tax: 5 percent (equal to the risk free interest rate) and 10 percent (equal to the risk free interest rate plus a risk premium of 5 percent). The tax rate and risk premium of 5 percent in threshold rate are consistent with the settings in the Australian Government's petroleum resource rent tax.

Under these rent-based taxes, the government tax take varies with project profitability. For example, under a resource rent tax with a threshold rate of 10 percent, the expected present value of tax revenue ranges from $2.0 million for project 1 to $364 million for project 5.

The private investor's risk premium is reduced compared with the before tax outcome reflecting the reduced dispersion of possible returns under these rent-based taxes. For example, under a resource rent tax with a threshold rate of 10 percent, the risk premium ranges from $1.2 million for project 1 to $28 million for project 5.

Reflecting the efficiency advantages of these fiscal instruments, all projects are assessed to be profitable under each of these rent-based taxes. For example, under a resource rent tax with a threshold rate of 10 percent, the certainty equivalent value ranges from $5.7 million for project 1 to $603 million for project 5. With higher capital costs, each of the five projects remains profitable under the rent-based taxes, although the certainty equivalent value is lower in each case: this contrasts with the results for output-based royalties where projects 1 and 2 become uneconomic or marginal (discussed further below).

Output-based royalties

The ad valorem royalty is levied at a rate of 10 or 5 percent (an ad valorem royalty rate of 10 percent applies to petroleum projects in most state and territory governments in Australia). The specific royalty is levied at a rate of $100 a tonne and $50 a tonne (this equates the royalty revenue under the ad valorem and specific royalties for the expected price of $1,000 a tonne).

Under output-based royalties levied at a constant rate, the government tax take varies with the value and/or volume of production and there is some tendency, depending on the royalty rate, for ad valorem and specific royalties to overtax low profit projects and undertax high profit projects. For example, under the 5 percent ad valorem royalty, the expected present value of tax revenue ranges from $1.8 million for project 1 to $92 million for project 5. Under a 10 percent ad valorem royalty, the government tax take increases to $3.7 million for project 1 and $184 million for project 5. It should be noted these are relatively simple numerical examples that do not take into account factors such as sovereign risk.

The risk premium under these output-based royalties is higher than under the rent-based taxes and, except for project 5 under the ad valorem royalties, is higher than the before tax outcome. For example, under the 5 percent ad valorem royalty, the risk premium ranges from $2.6 million for project 1 to $52 million for project 5. The ad valorem royalties have a negligible impact on the risk assessment of the highly profitable projects reflecting the relatively low government tax take.

All projects are assessed to be profitable under each of these output-based royalties for the base case assumptions. For example, under the 5 percent ad valorem royalty, the certainty equivalent value ranges from $4.4 million for project 1 to $851 million for project 5.

In contrast to the results for the rent-based taxes, with higher capital costs, projects 1 and 2 become unprofitable under the 10 percent ad valorem royalty and $100 a tonne specific royalty: that is, these projects switch from being economic before tax to uneconomic after the royalty. Production will then not occur and royalty revenue is zero under these options. Under the 5 percent ad valorem royalty and $50 a tonne specific royalty, the certainty equivalent value of projects 1 and 2 is reduced significantly, but remains positive in each case.

The project assumptions and results are discussed in further detail in Hogan (2007).

6 Conclusion

A complex system of mineral taxation arrangements currently apply in the world economy. Mineral taxation arrangements vary between countries, between jurisdictions within countries, between minerals and between projects. Progress has been achieved in several areas, enabling governments to obtain a return to the community from mineral extraction while reducing adverse impacts on the industry. For coal, metallic minerals and gemstones, output-based royalties and taxes mainly apply (in addition to the standard corporate income tax arrangements). However, profit-based royalties have been adopted in some developed economies, including most jurisdictions in Canada and a single jurisdiction in Australia (the Northern Territory) and the United States (Nevada). Rent or profit-based taxes have also recently been adopted in some developing economies including, for example, Kazakhstan and Liberia. Specific royalties mainly apply to high volume, low value non-metallic minerals, particularly construction materials.

This paper has discussed key economic issues in mineral taxation with some focus on the implications of fiscal instruments for the risk assessments of private investors. Rent or profit-based taxes and state equity instruments tend to rank highly on neutrality, investor risk and flexibility criteria, while output-based instruments tend to rank highly on government risk (fiscal loss and revenue delay) and administration and compliance criteria. An alternative approach is to combine an ad valorem royalty with a rent or profit-based fiscal instrument (with the former fully deductible against the latter): the ad valorem royalty would ensure a minimum return to the government, while the rent or profit-based tax can be a relatively efficient mechanism for rent collection from higher profit resource projects.

Appendix I Mineral taxation in selected countries

Table 5.5 Summary of mineral taxation in selected developed countries

Fiscal regime	*Royalties*	*Corporate income tax*	*Additional minerals tax*	*Import duties*	*VAT*	*Withholding taxes*		*State participation*
						Interest	*Dividend*	
Australia								
Western Australia	• Ores: 7.5% • Concentrates: 5.0% • Metals: 2.5% • Gold: 1.25–2.5% based on price • Export coal: 7.5% • Coal not exported: Specific royalty	Federal tax rate: 30% No separate state income tax.	nil	nil	The standard rate is 10%; exported minerals are GST free.	10% or as specified by tax treaty.	30% on unfranked dividends; varies (usually 15%) if there is a tax treaty.[1]	nil
Queensland	• Coal: 7% • Other minerals: Fixed rate option: 2.7%. Variable rate option: 1.5–4.5% based on price							
New South Wales	• Aluminium: AUD 0.35 per ton of bauxite • Industrial minerals: AUD 0.4 or 0.7 per ton • Coal: 4.7% ad valorem • Phosphate: AUD 0.7 per ton • Copper, Gold, Iron, Zinc: 4% of ex-mine value							
Northern Territory	• 18%, profit-based							
Canada								
British Columbia	• Minimum tax is 2% ad valorem (deducible against profit royalty) • 13% profit royalty • Losses can be carried forward under profit royalty	*British Columbia* 14.36% on net resource income; the 2% royalty on net proceeds can be deducted.	nil	Most minerals are exempt.	The standard GST rate is 7%; exported minerals are exempt.	25% is withheld on payments made to non-residents.		None in Ontario; n/a for others.
Northwest Territories	• 5–14% profit royalty (sliding scale) • No tax if income below CAN$10,000	*Federal* 22.12%, which includes the 28% statutory rate, 4% surtax and 7% resource rate reduction. Provincial royalty and mining taxes are not deductible from federal taxes.[2]						
Ontario	• 10% profit royalty • No tax if income above CAN$500,000 • Tax reductions for mines in remote regions							

continued

Table 5.5 continued

Fiscal regime	*Royalties*	*Corporate income tax*	*Additional minerals tax*	*Import duties*	*VAT*	*Withholding taxes*		*State participation*
						Interest	*Dividend*	
United States								
Arizona	• At least 2% ad valorem • Rate set by commissioner	*Federal* 15–35% rates. Foreign countries taxed on gross withholding basis. An additional branch profits tax of 30% (or as stated by tax treaty) applies on income of foreign companies from US sources.	nil	Vary by country and commodity.	nil	30% to non-treaty countries; 0–15% to treaty countries.	30% to non-treaty countries; 0–15% to treaty countries	n/a
Michigan	• 2.7% ad valorem (sliding scale)	*Arizona* 6.968%. Applies to taxable income that is assessed similarly to federal taxable income and adjusted for Arizona tax.						
Nevada	• 2–5% profit royalty (sliding scale) • 5% if net proceeds above US$4 million	*Michigan* 4.95%[3] *Nevada* nil						

Notes

1 If dividends paid out of profits have already been taxed at corporate tax rate, the company gets franking credits for the tax paid and may choose to use them.

2 Allowable deductions are costs directly related to operations, loss carry forwards, development and exploration costs, asset depreciation and accelerated depreciation allowance, resource allowance, reclamation contributions, and depletion allowance.

3 The New Michigan Business Tax. First $45,000 of tax base exempt. Plus, 0.8% of modified gross receipts (receipts less purchases from other firms) on receipts of $350,000 or more. A surcharge of 21.99% applies.

Table 5.6 Summary of mineral taxation in selected other countries

Fiscal regime	*Royalties*	*Corporate income tax*	*Additional minerals tax*	*Import duties*	*Withholding taxes*		*State participation*
					Interest	*Dividend*	
Africa							
Botswana	• Most minerals: 3% • Metals: 5% • Precious stones: 10%	Variable rate formula: 70–1500/Y where Y is the ratio of taxable income to gross income. 25% minimum tax.	nil	nil	15%	15%	nil
Ghana	• All minerals: 3–6% rate graduated on operating profit	25%	nil	nil	8%	8%	Minimum 10%
Malawi	• Most minerals: 3% (on gross value minus transport costs)	30%	10% RRT when after-tax cumulative cash flows exceeds 20%	nil	15% (non-resident, no double-taxation, agreement, under which withholding taxes are waived)	10% (no double-taxation agreement)	
Mozambique	• Coal and other minerals: 3% • Basic minerals: 5% • Semiprecious stones: 6% • Precious metals: 10% • Diamonds: 10%–12%	32%	nil	5 year exemption	20%	20%	nil
Namibia	• Most minerals: 5% maximum • Uncut precious stones: 10%	37.5% non-diamond mining 55% diamond mining	nil	nil	nil	Residents are exempt; 10% for non-residents	nil
South Africa	• Variable rate depending on EBIT • Max rate for refined minerals 5%, for unrefined 7%	28% normal CIT Gold mining companies subject to variable income tax: a) y = 34–170/x where company has elected not to pay the secondary tax on companies (STC), or b) y = 43–215/x where company pays STC on companies; where x is the ratio of taxable income from gold mining to income from gold mining and y is tax rate.	nil	nil	nil	10% STC to be withdrawn in 2010	nil

continued

Table 5.6 continued

Fiscal regime	*Royalties*	*Corporate income tax*	*Additional minerals tax*	*Import duties*	*Withholding taxes*		*State participation*
					Interest	*Dividend*	
Zambia	• Base metals, industrial minerals, and energy minerals, including copper: 3% • Precious stones and gemstones: 5%	variable according to the following formula: 30% + 15% × (1 – 8%/Y) when Y is the ratio of taxable income to gross income	nil (windfall tax introduced in 2008 was repealed in 2009)	nil	15%	Exempt	Varies: 10% is an indicative rate
Asia and Pacific							
China	• Aluminium, iron and zinc: Ad valorem + per unit charge • Copper: 2% + 0.4–30 • Gold: 4% + 0.4–30 • Industrial minerals: 2% + 0.5–20 CNY/tonne	25%[1]	nil	nil	Exports are zero rated; imports of mining equipment are exempt.	10%	nil	nil
India	• Aluminium: 0.35% • Copper: 3.2% • Gold: 1.5% primary, 2.5% byproduct • Industrial minerals: 45–55 INR/tonne • Iron: 4–27 INR/tonne • Phosphate: 5% apatite, 5–11% rock • Zinc: 6.6%	30% residents 40% foreign 10% surtax residents 10% surcharge non-residents	nil	2–7.5%	Inputs purchased and used in the manufacture of export goods will be refunded; exports are exempt.	20%	17%	Government-owned companies account for 75% of the value of the country's mineral production.
Indonesia	• Aluminium, iron and phosphate: Unit based • Copper: 45–55 USD/tonne • Gold: 7.5% from placer, 2.5% otherwise • Industrial minerals: 0.14–0.16 USD/tonne	10% on first IDR 50m, 15% on next IDR 50m and 30% on balance.	nil	nil	Pre-production purchases of machinery and equipment are exempt; exports are zero rated	Residents exempt; 20% non-residents.	15% residents; 20% non-residents.	nil
Mongolia	• Most minerals: 5% • Domestically sold coal and other minerals: 2.5%	10% on taxable income up to MNT 3 billion, 25% on excess.	68% when copper price exceeds USD 2,600 per metric ton and gold exceeds USD 500 per troy ounce. Base is value of production.	5%	10%; exports are zero rated; goods supplied to mining companies are exempt.	20%	20%	Up to 50%
Philippines	• Most minerals: 2%	35%, to be reduced to 30% in 2009	nil	nil	Exports are zero rated; VAT on goods and services are exempt.	10% on residents 35% for non-residents or 15% if the non-resident foreign company's domicile country allows a deemed-paid tax credit of at least 20%.	20%	nil

continued

Table 5.6 continued

Fiscal regime	*Royalties*	*Corporate income tax*	*Additional minerals tax*	*Import duties*	*Withholding taxes*		*State participation*
					Interest	*Dividend*	
Latin America							
Argentina	• Most minerals: 0–3%	35%	nil	nil	35% for residents non-residents are exempt	35% for residents 15.05% for non-residents	nil
Bolivia	• Gold: 4–7% depending on price • Gold from marginal deposits: 3–5% depending on price • Silver: 3–6% depending on price • Lead, tin and copper: 1–5% depending on price	25%	nil	nil	Residents exempt 12.5% for non-residents	Residents exempt 12.5% for non-residents	nil
Brazil	• Aluminium and phosphate: 3% • Copper, iron, zinc: 2% • Gold: 1% • Industrial minerals: 2%	34%[2]	nil	nil	15% on interest paid to non-residents	nil	nil
Chile	• Copper: 0.5–5% based on sales	35%	nil	10% (deductible)	4% if loan granted by foreign bank, 35% otherwise	35%	nil
Mexico	nil	28%	nil	nil	nil	nil	n/a
Peru	• Most minerals: 1–3%	30% +0.5% tax on total assets above DEN 1 million	nil	12%	30% non-treaty rate	4.1%	8% workers profit share based on net income before tax.
Venezuela	• Most minerals: 3–4%	34%	nil	0–10%	3–5%	nil	n/a

Notes
1 Companies operating in special economic zones benefit from a reduced tax ratio of 15%.
2 34% is total effective tax rate: 15% CIT, plus a 9% social security tax (non-deductible against corporate tax), and 10% surtax tax on income greater than BRL 240,000.

Acknowledgments

The authors wish to thank Craig Andrews for providing insightful discussant comments at the IMF conference in September 2008. The authors are also grateful to Michael Keen and Philip Daniel for providing very helpful comments and suggestions on earlier drafts of this chapter, and to Elsa Sze and Diego Mesa Puyo for excellent research assistance. The views expressed are those of the authors and should not be attributed to the International Monetary Fund.

Notes

1 Resource rent can be categorized into different types depending on how it is created. See Otto *et al.* (2004) for an explanation of the types relevant to the resource sector.
2 See Chapter 2 by Boadway and Keen.
3 Country risk is sometimes referred to as political risk, but may also encompass broader factors relating to the risk of operating in a specific country including, for example, political and legal stability.
4 Because royalties tend to be viewed as a payment for rights to minerals they typically accrue to the owner of the minerals. In the United States, unlike other jurisdictions, mineral rights belong to the owner of the surface rights of the land – private royalty systems may operate on private lands, although federal lands are also important in mineral production. In Australia and Canada, for example, the rights to onshore resources belong to the state and territory governments (although the Australian Government has jurisdiction over uranium resources in the Northern Territory).
5 When the government and investor have different time preferences and risk attitudes, there may be some scope for mutual benefit from changing the time and risk allocation between them.
6 Much of this discussion is based on material in Kumar (1995).
7 See McPherson's detailed discussion of the evolution of state participation in Chapter 9.
8 For example, in New South Wales in Australia, the ad valorem rate for coal varies for deep underground (5 percent and assessed to be the highest cost category), other underground (6 percent) and open cut (7 percent).
9 Gold, tin and zinc price rises were particularly sharp. The gold price was influenced by the end of the gold standard in the US in 1971, and the tin price by increased demand arising from the Vietnam War.
10 See Land's thorough discussion of such instruments in Chapter 8.
11 Greenland, Mexico, and Sweden also do not apply a royalty (Otto *et al.*, 2006).
12 Prices fell sharply in the second-half of 2008 due to the global financial crisis, although the prices of most minerals remain well above their lows. It remains to be seen what impact, if any, this latest development will have on mineral taxation.
13 29 developing countries are in the process of becoming EITI compliant. See http://eitransparency.org/ for further details.
14 Otto *et al.* (2006) report that the practice of setting a royalty on a mine-by-mine basis is becoming less frequent, although mine-specific arrangements still exist in several jurisdictions (for example, Olympic Dam and the Argyle diamond mine in Australia).
15 See Chapter 7 by Daniel *et al.* for a comprehensive evaluation for oil.
16 See Boadway and Keen's discussion of other rent-based taxes in Chapter 2.
17 Cash payments to investors under the Brown tax can be approximated in other rent or profit-based systems. For example, Norway's fiscal regime for petroleum can approximate a Brown Tax when companies have significant portfolios of projects, deducting expenditures from one against income from others – see Chapter 15 by Osmundsen for further information. The issue of full loss offset under a resource rent tax is discussed in section IV.
18 Fixed costs are for simplicity assumed in the figures that follow to be zero.

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6 Natural gas

Experience and issues

Graham Kellas

1 Introduction

Sales of natural gas are growing significantly around the world. Who benefits from this production is, in large part, determined by the fiscal terms applicable in the various links of the gas value chain. Fiscal policies can influence the price received by producers and processors of gas as well as the extent and timing of the recovery of investment costs. Fiscal policies can also drive different operational and ownership structure of gas projects.

This chapter discusses the various issues that need to be considered by policymakers when designing an appropriate fiscal regime for the development of their natural gas resources.

While many aspects of the natural gas business are very similar to oil, there are some significant differences (which are discussed in Section 3D on petroleum economics) that result in a very different investor perspective on gas projects, compared to their oil equivalent. Moreover, in many countries the development of natural gas has occurred only recently whereas oil has been produced for many years. In particular, the export of gas, primarily via liquefied natuaral gas (LNG) schemes, has only really emerged in the last 15 years. These developments have generated a number of particular issues which fiscal policymakers need to address and these are also considered in this paper.

To put the fiscal policymakers' task into perspective the chapter starts with a description of the growing size of the natural gas business and how its 'value chain' is created. This introduces both the 'size of the prize' and some of the major issues involved in determining how this prize gets distributed between the different participants in the business, including government.

2 Background

A Natural gas: resources and demand

The supply of natural gas worldwide has increased by 25 per cent between 2000 and 2008 (from 80 trillion cubic feet per annum (Tcfpa) to 102 Tcfpa) and is expected to increase to over 140 Tcfpa by 2020, as illustrated in Figure 6.1. In