IMPACT OF PULLING DOWN REGULATORY STATE BARRIERS ON URANIUM IN AUSTRALIA: IS THERE A NEED IN ORDER TO MAINTAIN AND INCREASE AUSTRALIA'S GLOBAL MARKET SHARE OF URANIUM?

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Abstract

This paper sets a prospective framework to study the impact of opening more mines to meet future growing demand on Australia's economy. The structure is aimed at decomposing investments and exports variables into Uranium exports and Uranium Exploration expenditure and analyse their impacts on each State GSP (Goods State Product) and for Australia as a nation. The demand and supply factors affecting the uranium market are defragmented before providing the research methodology and data specifics. Later analysis is expected to have policy implications by serving as a guide to pull down State Regulatory barriers like those imposed currently in Queensland, which is rich with uranium deposits and allow only uranium exploration but no uranium mining. Empirical findings would suggest whether exporting the carbon free energy would add value to Australia's different competing states and as a whole globalized economy.

Keywords: Australia, Uranium, Investments, Exports, GSP

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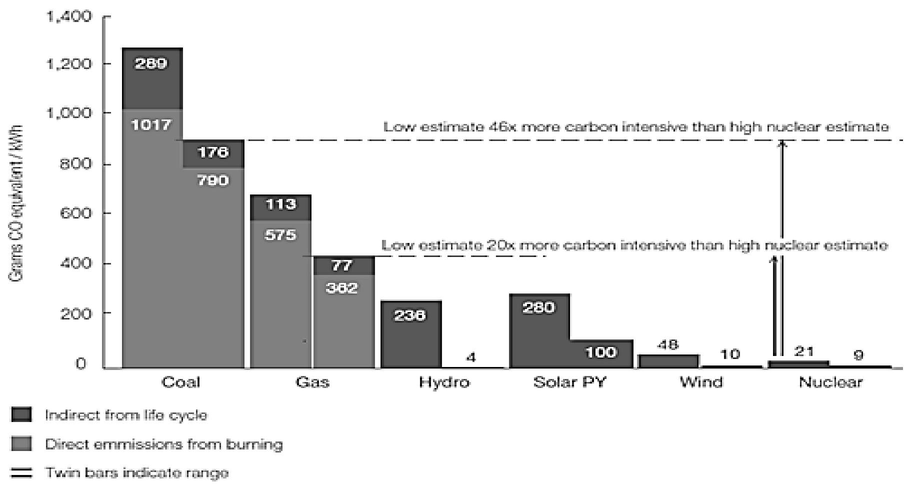
1. Introduction and Background to Study

Sir Nicholas Stern's report on the economics of climate change, published in late 2006, put a strong case that the costs of climate change to the world economy are likely to be significantly higher than the cost of taking early action to arrest it (HM Treasury, 2007). As Professor Ross Garnaut has stated in his interim report on the effect of climate change on Australia (Garnaut, 2008): "*Australia is a major exporter of minerals that will receive advantages from a strong international [greenhouse gas] mitigation effort, notably uranium (by far the world's largest reserves of high quality uranium oxide) and natural gas (exceptionally large resources per capita amongst developed countries).*" A report by the International Atomic Energy Agency (IAEA, 2001) further confirms that uranium is in fact a cleaner energy than natural gas and coal as shown in Figure 1:

Figure 1. Environmental friendly Uranium



Source: IAEA (2001)

In the UK, a recent White Paper on nuclear power even concludes from its analysis that: *Nuclear power is the most cost effective low-carbon generation technology. It has an estimated abatement cost of £0.3/t CO2 compared to onshore wind power, the next nearest currently available low-carbon electricity generation technology, which has an estimated abatement cost of £50/t* CO_2 (Department for Business, Enterprise and Regulatory Reform, 2008). However, it is also a fact that several states in Australia still have uranium bans in place. Western Australia is the last state to have removed its ban in 2008. Others are still regulated by the *Uranium Mining and Nuclear Facilities (prohibitions) Act 1986*). While, it is important for policymakers to keep security risk in mind, it is important to note that the proliferation issue does not arise primarily from trade in uranium, but rather from the technology used to produce nuclear fuel. Constraining the growth of the Australian uranium industry will not reduce proliferation risk. Only a small portion of natural uranium is able to produce energy in a nuclear power reactor. This must be 'enriched' to a small degree to produce the large amounts of energy that generates electricity. The proliferation risk arises because the plant needed to 'enrich' uranium for nuclear power can potentially produce highly-enriched uranium, at which point it can be used in nuclear weapons. At present, enrichment plants are operated by only a small number of companies in a small number of countries. With Australia exporting nearly 100% of its uranium, and with its trading partners abiding to strict international security rules, Australia remains in a highly competitive position to retain and grow its market share of the yellow cake global production and sale.

2. Aims of Study and Policy implications

Key policymakers need to be right if Australia is to maintain and enhance its competitive position in global markets. With the economy gathering steam, an immediate challenge is to avoid the mistakes of the past when domestic capacity constraints, including congested ports, chronic skills shortages and delayed project approvals, resulted in a loss of market share to aggressive international competitors. As Reserve Bank Governor Glenn Stevens has observed, Australia starts this upswing "*with less spare capacity than some previous ones*" based on measures of capacity utilisation, unemployment and underemployment. The challenge is to avoid the mistakes of the last phase of rapid expansion in global mineral demand. Between 2002 and 2007, export bottlenecks, skills shortages and other **capacity constraints** saw Australia lose global market share in eight minerals commodities, including coal and iron ore (Minerals Council of Australia, 2010). Capacity constraint is particularly due to the small number of operating mines as a consequence of regulatory constraints in various states.

While states like Western Australia are slowing moving towards more mines, there is a need for more capacity to take the most advantage of the shortage in the uranium market. Australia has a big part to play with its world's largest resources of low cost uranium. State government policies regarding uranium mine development, rather than resource availability is expected to be the major factor determining growth in Australia's uranium production and exports (ABARE, 2006). While OECD Nuclear Energy Agency (2010) showed that total identified resources of uranium are sufficient to supply nuclear plants globally for over a century, and that Australia has the largest identified uranium resources, its production capabilities sit below those of Canada and Kazakhstan. While progress is being made in streamlining processes in the uranium industry, some states like Queensland still have a ban on uranium mining. To help in promoting Australia's uranium industry, this study will look at the impact of opening more mines to meet future growing demand on Australia's economy. Two important factors of Australia's GDP are Exports (X) and Investment (I). This study will decompose these two factors into Uranium exports and Uranium Exploration expenditure and analyse their impacts on each State GSP (Goods State Product) and for Australia as a nation. This will have policy implications by serving as a guide to pull down State Regulatory barriers like those imposed currently in Queensland, which is rich with uranium deposits and allow only uranium exploration but no uranium mining. In determining those uranium exports and investment expenditures, this study will be looking at various different scenarios from 2011 up to 2030.

These **different scenarios** will take into account international factors like the demand of uranium in terms of existing/prospective new/expanding nuclear plants globally, the growing demand from China and its electricity usage by 2030, the supply of uranium from key competitors like Kazakhstan and Canada (existing and new proposed mines), discovery of more uranium deposits globally, the production capacity of those mines, the regulatory barriers existing in these countries in the production and sale of uranium, the opening of prospective new mines in Western Australia and other states, the expansion of existing mines and their production capacity, depletion rate of existing mines due for decommissioning by 2030 to optimise production capacity of each mine, and new trading partners with Australia. All these different scenarios will be analysed against a "no further new mines" scenario. Finally, but not least, this study will add value to the uranium industry in Australia, by showing its contribution towards reducing global GHG emissions by exporting more of the Carbon free energy. Importantly, while uranium exports do not reduce Australia GHG emissions under current Kyoto protocols, it will indirectly help other countries which use nuclear reactors to generate electricity as opposed to other energy sources like coal. To get a better picture of how exports and investment in the uranium industry will be driving a multiplier effect on the Australian economy, it is important first to understand the **nature of the global uranium market** by looking at its demand and supply, and the factors affecting those.

3 Literature Review

3.1 Uranium Demand - Doubling of World Electricity demand by 2030.

The International Energy Agency projects a doubling of world electricity demand by 2030, creating the need for some 4,700 GWe of new generating capacity in the next quarter century. Worldwide energy investment will be directed primarily at satisfying local base load requirements (World Nuclear Association, 2010a). Given also the fact that the current world total of 370 GWe generated from nuclear sources requires 67,000 tons of uranium per year (World Nuclear Association, 2010b), China's goal of supplying 160 GWe from nuclear will increase world uranium demand to 96,000 tons by 2030.

Demand Factors

Increased Competitiveness (from electricity producing utilities) through lower costs - A joint study by OECD and IEA in March 2010 concluded that in order to enhance the competitiveness of low carbon technologies such as nuclear, strong government action is needed to lower the cost of financing. A more recent WPA report concludes a fall in the following cost side factors - Lower construction costs per kW for nuclear plants; lower financial costs as new approaches are developed and tested to increase certainty; lower operating costs as owners have found it worthwhile to invest in nuclear plant refurbishment and capacity up-rates; and lower waste and decommissioning costs since they are spread over reactor lifetimes that are becoming even longer.

Technological Progress **-** Generation 3 and 4 reactors that are currently being constructed meet new benchmarks in terms of efficiency in fuel use, *safety, flexibility and a competitive cost of electricity*. Gas Cooled Pebble Bed Modular Reactor (PBMR) draws on well-proven German technology and aims for a step change in safety, economics and proliferation resistance. Construction of a demonstration plant commenced in 2007 for completion in 2010 and the South African government has announced a program to build 24 PBMR generators (Australian Uranium Association, 2008).

Capacity up-rating - Up-rating the power output of nuclear reactors is recognized as a highly economic source of additional generating capacity. The refurbishment of the plant turbo generator combined with utilizing the benefits of initial margins in reactor designs and digital instrumentation and control technologies can increase plant output significantly, by up to 15-20% like in Sweden, the

United States and East European countries. In Sweden, all of the remaining reactors will most likely be up-rated (World Nuclear Association, 2010a).

Table 1. More nuclear reactors on the way

nuclear reactors under construction or planned, 2006–15

		net generating capacity MWe	start of operation
north America		**3 765**	
United States	Browns Ferry 1.	1 065	2007
	South Texas 1 (no name)	1 350	2014
	South Texas 2 (no name)	1 350	2014
European Union		**5 110**	
Finland	Olkiluoto 3	1 600	2009
France	Flamanville	1 630	2012
Slovakia	Mochovce 3	940	2012
	Mochovce 4	940	2012
north east Asia		**23 626**	
Japan	Tomari-3	866	2009
	Shimane-3	1 375	2011
	Fukushima - Daiichi 7	1 325	2011
	Ohma	1 325	2011
	Fukushima - Daiichi 8	1 325	2012
	Tsuruga 3	1 500	2013
	Tepco Higashi Dori 1	1 320	2013
	Tsuruga 4	1 500	2014
	Kaminoseki 1	1 320	2014
	Tepco Higashi-dori 2	1 320	2015
		13 176	
Republic of Korea	Shin-kori 1	950	2010
	Shin-wolsong 1	950	2011
	Shin-Kori 2	950	2012
	Shin-Wolsong 2	950	2012
	Shin-Kori 3	1 350	2013
	Shin-Kori 4	1 350	2014
	Shin-Ulchin	1 350	2015
		7850	
Chinese Taipei	Lungmen 1	1 300	2009
	Lungmen 2	1 300	2010
		2 600	
Russian Federation		**10 500**	
	Volgodonsk 2	950	2008
	Balakovo 5	950	2010
	Kalinin 4	950	2010
	Belayorsk 4	750	2010
	Balakovo 6	950	2011
Russian Federation	North West 1	250	2011
	Leningrad 2-1	1 300	2012
	Bashkira 1	950	2012
	North West 2	250	2013
	Bashkira-2	950	2014
	Leningrad 2-2	1 300	2015
	Volgodonsk 3	950	2015
China		**11 050**	
	Tianwan 1	1 000	2006
	Tianwan 2	1 000	2007
	Lingao-3	935	2010
	Qinshan-6	610	2010
	Qinshan-7	610	2010
	Lingao-4	935	2011
	Hongyanhe 1	1 080	2012
	Hongyanhe 2	1 080	2012
	Yangjiang 1	900	2013
	Yangjiang 2	900	2013
	Sanmen 1	1 000	2014
	Sanmen 2	1 000	2014
India		**3 602**	
	Tarapur 3	490	2006
	Kaiga 3	202	2007
	Kaiga 4	202	2007
	Kudankulam 1	917	2007
	Rajasthan 5	202	2007
	Rajasthan 6	202	2007
	Kudankulam 2	917	2008
	Kalpakkam	470	2010
other		**3 811**	
Bulgaria	Belene - 1	953	2013
	Belene - 2	953	2014
Pakistan	Chasnupp	300	2011
Romania	Cernavoda 3	655	2007
Ukraine	Khmelnitski-3	950	2015
total		**61 464**	

3.2 Uranium Supply - Production from world uranium mines supplies only 76% of the requirements of power utilities (World Nuclear Association, 2010c). The balance comes from secondary sources and is essentially inventories of various types and includes inventories held by utilities and other fuel cycle companies, and uranium in depleted uranium stockpiles. In 2009, ten companies provided approximately 88% of the estimated world uranium mine production of 130 million pounds U_3O_8.

Primary Supply:

Table 2. Production from mines (tonnes U)

Country	2003	2004	2005	2006	2007	2008	2009
Kazakhstan	3300	3719	4357	5279	6637	8521	14 020
Canada	10457	11597	11628	9862	9476	9000	10173
Australia	7572	8982	9516	7593	8611	8430	7982
Namibia	2036	3038	3147	3067	2879	4366	4626
Russia	3150	3200	3431	3262	3413	3521	3564
Niger	3143	3282	3093	3434	3153	3032	3243
Uzbekistan	1598	2016	2300	2260	2320	2338	2429
USA	779	878	1039	1672	1654	1430	1453
Ukraine (est)	800	800	800	800	846	800	840
China (est)	750	750	750	750	712	769	750
South Africa	758	755	674	534	539	655	563
Brazil	310	300	110	190	299	330	345
India (est)	230	230	230	177	270	271	290
Czech Repub.	452	412	408	359	306	263	258
Malawi							104
Romania (est)	90	90	90	90	77	77	75
Pakistan (est)	45	45	45	45	45	45	50
France	0	7	7	5	4	5	8
Germany	104	77	94	65	41	0	0
total world	**35 574**	**40 178**	**41 719**	**39 444**	**41 282**	**43 853**	**50 772**
tonnes U_3O_8	41 944	47 382	49 199	46 516	48 683	51 716	59 875
percentage of world demand			65%	63%	64%	68%	76%

Source: World Nuclear Association (2010b)

Supply Factors

Prospective New Mines and Expansions in Australia

Western Australia

Western Australia has some significant identified calcrete deposits - *Yeelirrie mine development, Mayningee mine development, Oobagooma mine development, Lake way and Centipede mine developments, Mulga Rock mine developments, Kintyre mine development, Lake Maitland mine development (See Garnaut (2008) for full details of each Australian uranium mine, including their production capacities).*

Table 3. Prospective New Mines and Expansions in Globally (except Australia)

	startup year	country	company	capacity t U_3O_8
new projects				
Eastern Mynkuduk	2006	Kazakhstan	Kazatomprom	1 180
Southern Moinkum	2006	Kazakhstan	Kazatomprom	590
Langer Heinrich	2006	Namibia	Paladin Resources	1 180
Dominion	2007	South Africa	Uranium One	1 800
Zarechnoye	2007	Kazakhstan	Kazatomprom	590
Central Mykuduk	2007 a	Kazakhstan	Kazatomprom	2 400
Southern Inkai	2007 a	Kazakhstan	Kazatomprom	2 400
Irkol	2007 a	Kazakhstan	Kazatomprom	880
Kharasan	2007 a	Kazakhstan	Kazatomprom	2 400
Inkai	2007	Kazakhstan	Cameco/Kazatomprom	2 400
Kayelekera	2008	Malawi	Paladin Resources	1 000
Western Mynkuduk	2008 a	Kazakhstan	Kazatomprom	1 180
Budenovskoe	2008 a	Kazakhstan	Kazatomprom	1 180
Cigar Lake	2009	Canada	Cameco	8 000
Midwest	2010	Canada	Cameco	2 600
expansions/life extensions				
Priargunsky	2006 - 15	Russian Federation	JSC/TVEL	5 500
Khigda	2006 - 15	Russian Federation	JSC/TVEL	1 000
Dalur	2006 - 15	Russian Federation	JSC/TVEL	2 000
McArthur River/Key Lake	after 2008	Canada	Cameco	9 980
Rossing	until 2016	Namibia	Rio Tinto	4 000

a Given infrastructure and regulatory constraints in Kazakhstan, these dates are considered to be uncertain.

Source: Digges (2006) and Ux Consulting (2006)

With Kazakhstan and Canada bearing most of future mine development it is important to look at these two countries in particular in terms of their supply in the near future and longer term.

Canada

Canada's uranium industry is heavily regulated by the Canadian Nuclear Safety Commission and provincial government agencies. These tight regulations may delay the construction and operation of new mines. For example, it took almost a decade for Cameco to obtain a construction licence for its Cigar Lake mine after the environmental impact assessment was lodged in 1995 (Cameco 2006). Environmental approval, and in some circumstances, approval from the traditional landowners, must be obtained before any construction commences. In addition, most of the deposits in the Athabasca Basin require expensive, mechanised operations to extract the uranium due to the radioactive qualities of the high grade ore. The difficult mining conditions can delay the development of new mines. For example, Cameco's Cigar Lake project has been delayed by at least a year after a rock fall resulted in significant water inflow, causing the mine to flood in October 2006.

Kazakhstan

Kazakhstan has substantial low cost uranium deposits suitable for in situ leaching - a mining method that is expected to account for most of Kazakhstan's production over the longer term (OECD–NEA and IAEA 2006). In situ leaching is a low cost extraction mining technique that develops mines relatively faster than underground mines. As a result, it is considered likely that Kazakhstan will take some market share from Canada, where mining methods and environmental approvals are likely to slow the development of mines, and Australia. The government of Kazakhstan has directed its policy towards significantly increasing U3O8 production for export purposes and is seeking to improve legal and regulatory frameworks and standards within the country. This is expected to reduce investment risk over the longer term and may have positive implications for private investment, especially in the energy and minerals sector (World Bank, 2006).

3.3 Australia Regulatory Framework for Uranium development and mining

It is important to note that *WA Government* has removed the ban on mining in late 2008. A number of companies have been preparing to mine in the WA State, with five working towards target production dates within the next 5 to 7 years - North of Kalgoorlie, BHP Billiton's significant Yeelirrie deposit, Mega Uranium's Lake Maitland project, Energy and Minerals Australia's Mulga Rock resource and Toro Energy's deposits at Centipede and Lake Way near Wiluna; East Pilbara's large Kintyre project, a joint venture between Cameco Australia and Mitsubishi Development. WA holds around 43 per cent of Australia's major undeveloped uranium deposits (Australian Uranium Association, 2010). uranium development in Northern Territory (NT) is governed by the Commonwealth, while for uranium mining, authorisation is required by NT Mining Management Act. For South Australia (SA), uranium development is allowed after obtaining a license from the SA Radiation Protection and Contract Act 1982. Uranium mining is allowance after complying with Australian Government 2005 Mining Code. Olympic Dam is regulated under its own Indenture Act. Other bodies like SafeWork SA, the Environmental Protection Authority (EPA) also have regulatory powers in SA. Queensland still prohibits both uranium development and mining.

4. Research Methodology and Data

Essentially, this study will look at the impact of uranium exports and investment on each State's welfare by using Goods State Product (GSP) and on Australia's economy by using GDP. The Keynesian cross model will be adopted to analyse the contribution of uranium to each State GSP and Australia's GDP. Keynesian Cross Model - GDP can be derived as the *sum of all final expenditures on goods and services* (that is, final consumption expenditures and gross fixed capital formation), changes in inventories of finished goods, work-in-progress and raw materials, and the value of exports of goods and services less the value of imports of goods and services. Imports are deducted because, although included in final expenditures, they are not part of domestic production. For the purpose of this study, the expenditure approach will be adopted. Using the expenditure Approach and in line with the Australian Bureau of Statistics (ABS) calculation methods, GDP **equals** final consumption expenditures by households (C) and government (G) **plus** investment in fixed capital and inventories (I) **plus** exports less imports of goods and services (X – M or NX). These data are available from an industry-industry matrix from ABS. Using the industry by industry matrix above, the traditional Keynesian Consumption function $C = C_0 + b(Y)$ can be changed to $C = C_0 + b(Y-t)$, C_0 is autonomous consumption, Y= GDP, and *b* is the marginal propensity to consume. The Keynesian cross model can be redefined as:

$$Y = C + I + G + NX$$

$$Y = C_0 + b(Y - t) + I + G + NX$$

$$Y = \frac{C_0 + I + G + NX - bt}{(1-b)},$$

where the multiplier effect is $\frac{1}{1-b}$. This means that \$1 increase in any of the exogenous variables increases Y by $\$\frac{1}{1-b}$. The mechanism by which this happens can be explained fairly easily. Suppose exports go up by \$1. Since output is the sum of consumption, investment, government purchases, and net exports, Y = C + I +G + NX there will be a corresponding increase of 1 unit in output - *direct effect*. When output (income) increases by \$1, consumption will increase by \$b since the consumer spends a fraction b of every dollar that he/she receives – *feedback effect*, which goes on until infinity. Therefore, an increase in exports causes a larger increase in output. The intuition is that expenditure of a dollar by 1 person in the economy sets off a chain reaction of expenditure through the economy. **Supply** (S) will be determined mostly as a function of capacity of mine (new/operating and those considering expansion). This can be cross checked with the number of reactors (Demand) (new and operating ones in terms of the amount of electricity they can produce), and the country trading partners with which Australia has major contracts with. Existing mines will be subject also to some depletion rates over the long term as reported by Geo Science Australia. Once the supply (quantity) is determined under the different scenarios stated earlier, the Price factor is calculated, so that the extra value (Price*Quantity) can be attributed to uranium exports and regressed against GDP and GSP.

Determining changes in Exports (X) value - The exports of goods and services shown in the national accounts are identical to those provided in the balance of payments statistics. *Balance of Payments and International Investment Position: Australia, Concepts, Sources and Methods* (Cat. no. 5331.0) provide an extensive description of the concepts, sources and methods used to compile statistics for exports. The main data source for exports of *goods* is the ABS International Trade Statistics (ITS), which are derived from information reported to the Australian Customs Service. The annual estimates are obtained by summing the quarterly estimates. Most *exports* of goods are quantity revalued. Volume estimates of most of the balance are derived using export price indexes. Volume estimates of exports of services are derived using a range of price indexes (These ABS price indexes are those published in Export Price Index, Australia (Cat. no. 6405.0) and Price Indexes of Articles Produced by Manufacturing Industry, Australia (Cat. no. 6412.0). See ABS (2010) for more information). As a cross checking reference, ABARE mineral statistics (ABARE, 2010) provides the historical data on quantity, price and value of exports for the Australian uranium industry.

Gross fixed capital formation (in determining I) - Gross fixed capital formation is equal to the total value of a producer's acquisitions, less disposals, of fixed assets plus capital work done on own account during the accounting period plus certain additions to the value of non-produced assets realised by the productive activity of institutional units. Importantly, section 4.89 on *Intangible produced fixed assets* (ABS, 2010) include mineral exploration, comprising the capitalised value of expenditures on exploration for petroleum, natural gas and mineral deposits. Table 5 from ABS 8412.0 provides data on mineral exploration expenditure for the uranium industry both at national and state/territory level.

***Complementing the Keynesian model* –** It is a fact that GDP does not measure factors that affect quality of life, such as the quality of the environment (as distinct from the input value) and security from crime. This leads to distortions - for example, spending on providing assistance to coal fired plants through coal sector assistance scheme (as part of CPRS) might be included in GDP, but the negative impact of the carbon releases on well-being is not measured. To add value to the use of GDP and the Keynesian model, the beneficiary impact of opening new mines in Australia over the global climate (through a multiplier effect of X on GDP under different scenarios) can be implemented by converting the amount of energy (electricity) it would produce. This amount of energy can then be converted back to how much coal would have been needed for a similar energy produce. The amount of coal can then be used to calculate the release of carbon. An important assumption here is that this possible reduction in CO2-e does not help Australia in reducing its Kyoto target, but possibly help other partner countries who import the uranium to produce cleaner electricity. Data is expected to be acquired from various sources including ABS, AUA, Geo Science Australia, OECD, IPCC, ABARE, NEA, IAEA and WNA.

***Scope of study* -** This study does not consider the effect of uranium exports and investment on other energy sources like coal or natural gas in Australia, and does not consider local nuclear power usage. Due to the uncertainty regarding mining tax (MRRT), the impact of the latter on GDP is excluded for now until more clarity following post-election results. Due to the major concentration of the study being on exports (X), changes on final consumption expenditures (C+G) are not expected to move significantly under different scenarios to be analysed. A decomposition of each C and G expenditures is not warranted unless some components of C and G will affect X and I.

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