Modelling Western Australia's domestic gas reservation policy

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Modelling Western Australia's domestic gas reservation policy

Abstract

Western Australia introduced a domestic gas reservation policy in 2006, which essentially requires new gas developments to supply the equivalent of 15 per cent of their gas exports to the Western Australian domestic gas market. The aim of the policy is to secure additional domestic gas supply and thereby maintain lower domestic gas prices than may otherwise prevail. One of the key justifications given for the policy is to offset the perceived market power held by domestic gas suppliers.

A theoretical model is developed to represent the most important features of the upstream gas market. Individual gas developments have very large fixed costs and exhibit increasing returns to scale, at least up to some point. Many projects are large compared to the overall Western Australian market, and therefore exhibit oligopolistic pricing power on the domestic market.

This partial equilibrium model is used to quantitatively assess the economic impact of Western Australia's domestic gas reservation policy. The analysis shows that, while gas consumers may benefit, this trade restriction is likely to impose a net cost across all Australian households, since gas resources would be diverted inefficiently.

More specifically, the short run impact of the domestic supply requirements placed on the Gorgon and Wheatstone export projects are estimated. Results include the effects of the policy on production and prices as well as the overall welfare impacts.

1. Introduction

Under Western Australia's domestic gas reservation policy the State Government requires new gas developments to supply an amount equal to 15 per cent of their Liquefied Natural Gas (LNG) exports to the Western Australian domestic gas market. Although the policy is not formalised in legislation, it is enforced by the Government via their right to deny access to land (or potentially state waters) for LNG plants and infrastructure. The policy might be seen as a more formal version of the domestic supply provisions contained in previous 'State Agreements' between gas suppliers and the State Government. A key aim of the policy is to increase the supply of gas to the domestic market, ensuring that domestic prices are retained below export parity. The policy is justified on the grounds that it offsets the effects of inadequate competition in the domestic market.

This paper investigates the economic impacts of the policy, using a project-by-project model of Western Australia's gas industry that captures the key features of the market. This model can also be applied to other gas markets and used to analyse a wide range of issues affecting the gas industry. For example, there have been recent proposals to introduce similar gas reservation policies in the eastern states.

Section 2 of this paper discusses the context of the domestic gas reservation policy and the projects to which it has been applied in Western Australia. The related literature is surveyed in Section 3 and the economic impact of reservation policies is discussed. The model is developed in Section 4. Section 5 then presents estimates of the short run impacts of the domestic supply requirements placed on the Gorgon and Wheatstone LNG export projects. Finally, Section 6 discusses a number of additional considerations before a summary and conclusions are offered in Section 7.

2. The reservation policy and the Western Australian gas market

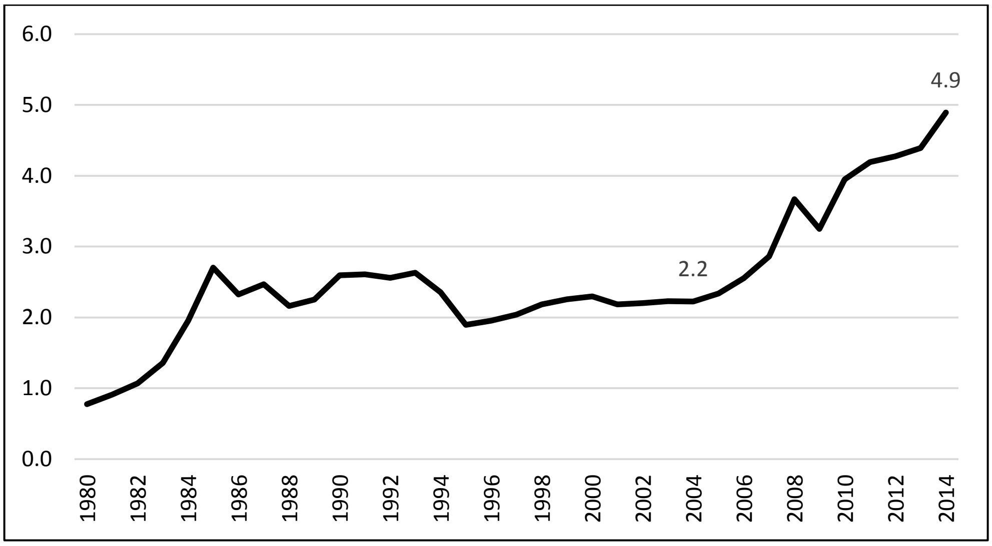
This section presents an overview of the Western Australian gas market, providing context for the remainder of the analysis. Rising domestic gas prices, the motivation for the policy, are discussed first. Next, domestic and export supply from new and existing gas projects is outlined, and the domestic supply commitments from each project are identified. Finally, consideration is given to whether the reservation policy is likely to impose a binding constraint.

2.1 Western Australian gas prices

A key aim of Western Australia's reservation policy is to secure higher levels of domestic gas supply and thereby maintain lower domestic gas prices than may prevail without the policy intervention. Some analysts have suggested that the policy "appears to have been the Western Australian Government's response to ... a sharp spike in gas prices and tight supply of domestic gas" (ERA, 2014).

Indeed, historically domestic gas prices in Western Australia have been stable and relatively low, owing mainly to the long-term contracts held by major domestic consumers with the North West Shelf (NWS) project, which were entered into during the 1980s. As shown in Figure A, domestic gas prices have been rising more recently, to $4.9 per GJ in 2014 from $2.2 per GJ in 2004. This has been the result of a combination of factors, including the expiry of the original long-term contracts and the increasing level of international competition for Western Australian gas. (BREE, 2013)

Figure A: Western Australian Domestic Gas Prices, $AUD per GJ



Source: WA Department of Mines and Petroleum, Statistics Digest Resources Data Files, 2014

Proponents of the policy are concerned that a lack of competition in the domestic market can lead to domestic prices that are above or equal to LNG netback prices[2]. For example, a 2011 Parliamentary Inquiry into domestic gas prices found that:

> *"Prices that persistently reach or exceed LNG netback values reflect an absence of adequate competition and are inconsistent with a well-functioning domgas market. Under such circumstances, some form of policy intervention in the market is appropriate.*
>
> *The Domestic Gas Reservation Policy is an essential policy instrument for ensuring that an appropriate level of gas is supplied into the local market to achieve reasonable price outcomes. This instrument should be part of a suite of policy responses, the primary aim of which should be to improve the overall level of liquidity, competition and transparency in the Western Australian domestic gas market."*

(Parliament of Western Australia, Economics and Industry Standing Committee 2011, p76)

2.2 Western Australian gas supply

The North West Shelf Development Project (NWS) supplied around 50 per cent of total domestic gas consumption in Western Australia in 2014, related to long term contracts for domestic supply. Indeed, long term supply contracts between the NWS and the Western

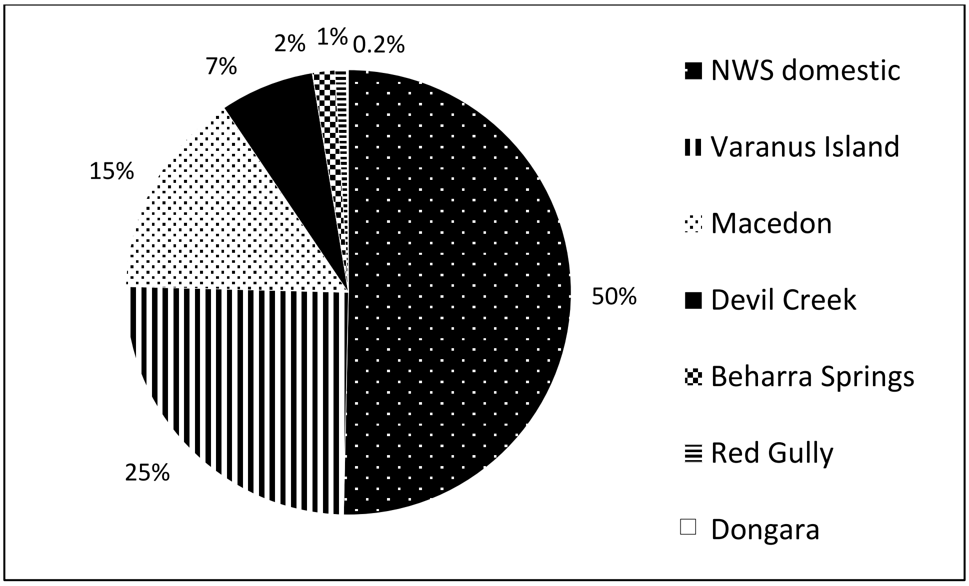
[2] LNG netback prices are the international LNG price received less any shipping and liquefaction costs. A domestic price equal to the LNG netback plus domestic processing and transport costs would indicate 'export pricing parity' is achieved.

Australian government underwrote the initial development of the project in the 1980s[3]. A number of contracts are due to expire in coming years and there has been some concern that the NWS will reduce its supply to the domestic market. However, the NWS also signed a State Agreement in late 2014 to supply domestic gas equivalent to 15 per cent of the LNG from two new fields, consistent with the reservation policy (WA Government, 2014).

Low domestic gas prices appear to have limited investment in new domestic gas processing capacity for some time. More recently, supply has been responding to the higher prices, with Devil Creek and Macedon[4] plants constructed to service the domestic market. The Devil Creek gas plant, which commenced operations in 2011 was "the first new plant built in Western Australia in almost 20 years" (Apache, 2013).

Figure B below shows 2014 domestic supply from each processing facility. Around 97 per cent of total domestic supply came from the four large processing facilities located in the Carnarvon basin. The remaining smaller facilities operate in the Perth basin.

Figure B: Western Australian Domestic Gas Supply 2014, per cent



Source: Author's calculations based on APPEA 2015, WA DMP 2015 and WA DMP 2014

Western Australia has exported LNG from the North West Shelf (NWS) project since 1989. The Pluto LNG project then came online in 2012.[5] Exports dwarf domestic consumption in

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[3] Specifically, the Western Australian energy utility (SECWA) "committed to purchase a significant quantity of the gas—an amount that at the time was far in excess of local demand—for a period of at least 20 years." (WA Parliament, 2014, p 274).

[4] The Macedon gas plant commenced operations in September 2013 (BHP Billiton 2013).

[5] Although the Pluto gas field has an agreement to supply domestic gas, "it remains highly contingent on the commercial viability of a domestic gas plant". (WA Department of Mines and Petroleum [DMP], 2015, p40)

Western Australia, with total exports in 2014 at 1,265 PJ and total domestic gas use at 359 PJ (WA Department of Mines and Petroleum [DMP] 2014).

Four other export projects drawing on gas off the northern Western Australian coast are currently under construction (APPEA, 2014). However, only two of these new projects will process and liquefy the gas using onshore plants in Western Australia – the Wheatstone and Gorgon projects – and both of these projects are constructing domestic gas facilities to honour domestic supply commitments.

The Gorgon project agreed to supply a total of 2,000 PJ to the domestic market under a State Agreement. The plant is scheduled to be operational from mid-2015, supplying 150 TJ per day (55 PJ per year) for the first six years and 300 TJ per day (110 PJ per year) thereafter. This is equivalent to 6 per cent and then 12 per cent of LNG exports from the project. The Wheatstone domestic plant is being constructed under the reservation policy. It will have the capacity to supply or 200 TJ per day (73 PJ per year) to the domestic market, which is the equivalent of 15 per cent of Wheatstone LNG. The plant is scheduled to commence operations in 2016. (Independent Market Operator [IMO], 2013) (WA DMP, 2015)

Two gas other export projects currently under construction have been able to avoid the reservation policy by locating their production facilities outside Western Australia. The Prelude project will utilise Floating LNG technology, so that the gas is liquefied at sea rather than onshore. The Ichthys project will transport gas via “one of the longest subsea pipelines ever built” to Darwin for liquefaction (Inpex, 2015).

2.3 Does a 15 per cent reservation policy bind?

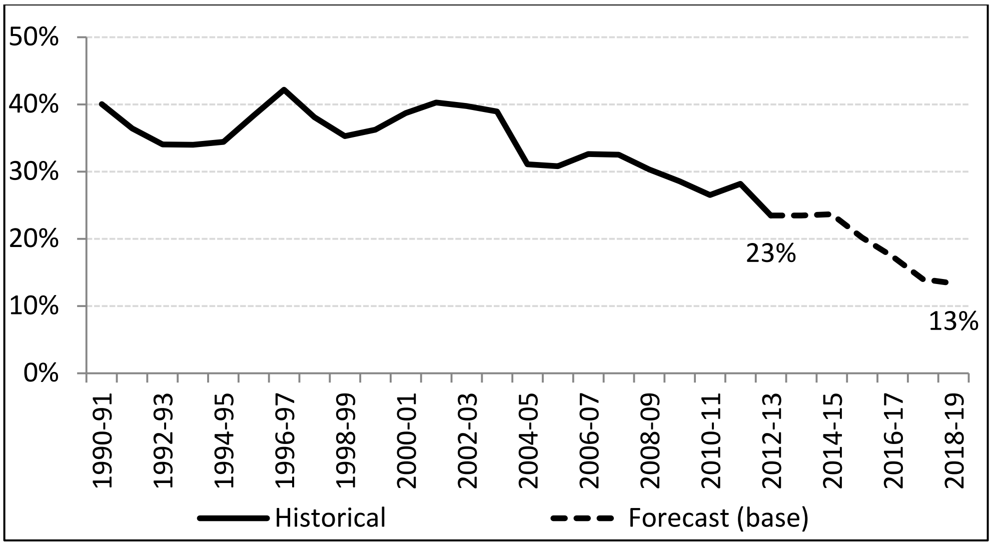
Based on figures reported by the Independent Market Operator (IMO 2014a), in 2012-13 domestic consumption of gas in Western Australia was 339 PJ [6] while, according to BREE (2014c), production in the state was 1,459 PJ. That is, domestic consumption was around 23 per cent of total production, as shown in Figure C. On the other hand, if the reservation policy were binding for all gas projects in Western Australia, then they would be obliged to supply around 12 per cent of total production to the domestic market.[7] On first consideration, this may suggest that the domestic gas reservation policy is unlikely to be binding, since

[6] This domestic consumption figure excludes gas used in LNG processing.

[7] This figure is less than the headline policy rate of 15 per cent for two reasons. Firstly, the reservation policy requires that the equivalent of 15 per cent of *LNG* production be supplied to the domestic market, which is less than 15 per cent of *total* production. Secondly, some gas is expended during liquefaction and domestic processing. See Section 4.5 for the calculation.

producers are already suppling greater than the minimum proportion to the domestic market. However, this simple interpretation does not suffice for two reasons, discussed below.

Figure C: Domestic consumption share in total gas production, Western Australia



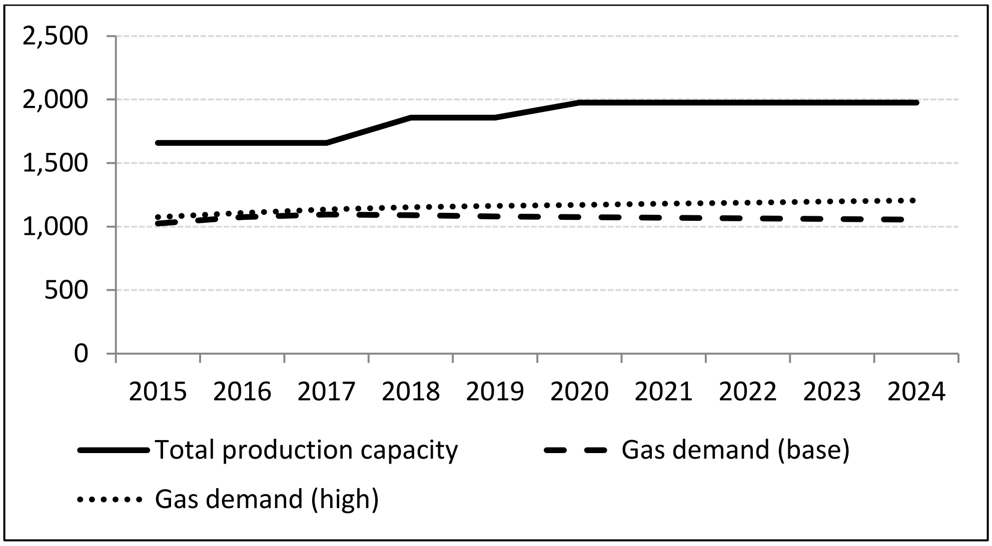
Source: Production: BREE Australian Energy Statistics 2014 and Consumption: IMO 2014a
Note: consumption data excludes gas used in LNG processing

First, LNG exports are expected to grow significantly over coming years, which will tend to reduce the domestic share of total production. In addition, the IMO forecasts that growth in domestic demand is likely to be very slow, at an average of between 0.3 and 1.3 per cent each year to 2024. Based on these forecasts, by 2018-19 domestic gas consumption could fall to around 13 per cent of total Western Australian production, as shown in Figure C. (It could be 14 per cent if the IMOs more optimistic forecasts for demand eventuate.) If exports continue to grow, then domestic consumption could fall to an even lower share following this period. This industry-wide indicator suggests that the reservation policy is likely to be binding.

Second, since the policy is applied on a project-by-project basis, the economic impact of the policy depends on how it affects decisions made by each project, rather than just the overall level of domestic supply. The economic model developed in this paper addresses this issue by separately modelling the response of each processing plant to the reservation policy.

An additional consideration is the current imbalance between domestic supply *capacity* and actual domestic consumption. Although total capacity must be greater than average demand in order to meet peak demand, Figure D confirms that domestic production capacity significantly exceeds domestic demand.

Figure D: Domestic gas capacity and demand in Western Australia (TJ per day)



Source: IMO 2014a

According to the IMO, by the third quarter in 2014, unused capacity had grown to "one third of total domestic gas production capacity" (IMO, 2014a p109). With the addition of new domestic production facilities, including the Gorgon and Wheatstone facilities under the reservation policy, "domestic production capacity is projected to be almost double the forecast level of domestic gas demand by the end of 2024" (IMO, 2014a p6). In this environment, with low demand growth and over-capacity, it is unlikely that producers would choose to construct additional domestic production facilities and infrastructure to serve the domestic market in the absence of the reservation policy. Therefore, a domestic gas reservation policy is likely to be binding for new LNG projects in Western Australia in the sense that these projects would not otherwise choose to supply the domestic market.

3. Economic impacts of gas reservation: literature review

A number of studies have examined the economic impact of domestic gas reservation policies, both in Western Australia and in the eastern states. Most of these studies have opposed domestic gas reservation, claiming that the costs incurred in the upstream gas sector outweigh any benefits to domestic gas consumers. Some contrary studies have supported gas reservation based on the benefits to gas-using industries. However, according to critics, these studies rely on some naïve assumptions. ACIL Allen (2014) contains a good analysis of the flaws in these studies.

A number of recent studies characterise the policy as an "implicit tax on gas producers that, rather than going to the government, provides domestic gas users with a price subsidy." (BREE 2014b, p112). Examples include studies by ACIL Allen (2014); BREE (2014a, 2014b); Deloitte Access Economics (2013); the Economic Regulatory Authority [ERA] (2014); and Wood et al. of the Grattan Institute (2013).

BREE finds that domestic gas reservation "is likely to see a reduction in economic welfare if Australia foregoes export earnings (and tax revenues) in favour of (presumably lower value) domestic production, and lower future exploration and gas development activity." (BREE 2014a, p107) The Economic Regulation Authority of Western Australia goes further and recommends that the domestic gas reservation policy be rescinded as soon as possible (ERA 2014, p383).

Deloitte Access Economics [DAE] (2013) models the effect of introducing a reservation policy in the eastern states and finds that the economic costs outweigh any advantages for domestic gas users, and Australians are worse off as a result. Specifically, "every one per cent of future gas exports which is artificially re-directed towards the domestic market reduces GDP by an estimated $150 million at 2025" (DAE 2013, piii). The study achieves this by using a combination of a tax and subsidy regime to represent the effect of the reservation policy in their model.

The Productivity Commission (2015) also finds that the "cost to the community of diverting the gas from the export market to the eastern Australian gas market would outweigh any gains to domestic users, which are of themselves far from guaranteed" (Productivity Commission [PC], 2015, p21). Using a detailed project-by-project model, the Commission evaluates the effect of a 25 per cent reservation policy in the eastern Australian gas market. It estimates that the policy could have a total welfare cost of between $2.2b and $23.9b (net present value) depending on LNG prices. (PC, 2015)

These studies find that the reservation policy is akin to a simultaneous tax on gas production and subsidy for gas consumers, and this argument can be summarised as follows. The domestic gas reservation policy acts as an implicit tax on Australian gas production because the additional supply to the domestic market lowers the domestic price. This reduces incentives for investment in gas production and exploration. As noted by BREE "there is a relatively lower level of investment in new supply … and, therefore total gas production is lower than otherwise." (BREE 2014b p115) Reduced interest in discovering and developing potentially large new sources of natural gas that otherwise would have been developed involves economic losses for Western Australia, or any other jurisdiction with a reservation policy.

The domestic gas reservation policy also acts as an implicit subsidy for domestic consumers. The artificially low gas price reduces production costs in gas-using industries, enabling them to expand production, hire additional labour and invest in additional capital. However, this does not necessarily imply an increase in *overall* employment or capital income for Australians in the long run. The labour and capital diverted to gas-using industries could otherwise have been employed in industries where no subsidy is necessary, that is, where they have a higher value. Simply put, an artificially-low gas price "perpetuates the existence of industries that may not have a comparative advantage in WA at the expense of investment in other industries" (ERA 2014, p293).

Some studies also point out that artificially low domestic gas prices can increase reliance on low-cost gas, leading to additional costs such as a lack of technical innovation and dynamic efficiency.[8] "For example, the policy artificially depresses domestic prices, which discourages domestic gas users to invest in technologies to lower or substitute their gas consumption." (ERA 2014, p292)

In summary, the two separate components of a domestic gas reservation policy are detrimental to overall Australian living standards. First, the implicit tax on producers lowers the incentive to invest in gas exploration and production, lowering overall activity in a sector of the domestic economy where Australia has a comparative advantage. Second, the implicit subsidy results in an opportunity cost by lowering the value of Australia's gas. It shifts labour and capital into gas-intensive industries from other sectors of the economy, diverting resources to lower-valued uses.

4. Natural Gas Industry Model

This section develops a partial equilibrium model of the gas sector, which models the supply decisions from each gas project separately. The model is designed to take into account many of the important features of the gas industry, while remaining as straightforward as possible. The model is applied to the Western Australian gas market and used to evaluate the short run effect of the domestic gas reservation policy in the following section. Since the model

[8] Many of the well-established arguments against imposing import tariffs apply equally against the domestic gas reservation policy. The reservation policy is an export quota, which is equivalent to an export tax since both policies would limit the volume of exports. A uniform export tax (on all exports) has also been shown to have the same effect as a uniform import tariff on relative import and export prices (see Tokarick 2006). Thus the negative effects of an import tariff are comparable to those of an export tax and, in turn, the domestic gas reservation policy.

includes explicit representation of the domestic supply decision for each project, it is well suited to estimating the effects of the domestic gas reservation policy.

The Western Australian gas market consists of a small number of separate gas projects, with heterogeneous costs. Fixed costs make up a significant proportion of total costs, and each project exhibits increasing returns to scale, up to a certain point, in the long run. Projects maximise profits by initially choosing investments in exploration and production capacity and then choosing whether to supply to the export or domestic market. This initial analysis focusses on the short run, when investment costs are sunk and gas reserves for each project are fixed, so projects are capacity-constrained.

These heterogeneous projects supply a homogeneous product, so all projects must share the same export and domestic prices[9]. However, while projects are price-takers on the export market, each project recognises its own pricing power on the domestic market. Specifically, the domestic market is modelled as a Cournot oligopoly. A non-cooperative Nash equilibrium is found, where each project maximises its own profits, taking its competitors' production as given.

This model represents initial work from a broader project, and a number of future model extensions are planned. For example, the short run static model presented here will be extended to a dynamic model, where each projects' strategy consists of two stages: an initial investment decision and then production decisions. This extension will take into account that the reservation policy can create a disincentive to invest in new reserve developments.

The method outlined below draws on modelling by Hartley and Medlock (2008), which focusses on the extraction decisions of a national oil company. The oligopolistic behaviour is related to modelling by Tyers (2005, 2004) which includes oligopolistic interactions in a market with homogeneous products and fixed costs.

The sections below first present the profit function used for each project, then characterises the demand side of the gas market. This allows market power by each project to be discussed. Next, the representation of the reservation policy in the model is described. Finally, some key qualitative observations on the profit-maximising outcomes are discussed.

[9] More specifically, *marginal* prices for each project are assumed to be the same for each project. (This may be considered as the spot price.) Many gas projects establish long-term contracts with their customers, which may differ from the marginal price. These long-term contracts can be viewed as infra-marginal gas supply. When the contract price differs from the marginal price, this represents an income transfer between gas producers and consumers. For simplicity, it is assumed that these transfers have a net value of zero over the life of a contract.

4.1. The profit function

The costs for gas projects have been divided into three different components. These include (1) the cost of extracting the gas from the reservoir, denoted by *X*, (2) LNG liquefaction and shipping costs for gas supplied to the export market, denoted by *E*, and (3) processing and pipeline transport costs for gas supplied to the domestic market, denoted by *D*.

Gas Extraction

Annual extraction of gas, q_{Xi}, from project *i* depends on the proved reserves that are available, the geological characteristics of the reservoir and the variable inputs used by the firm. The production function for gas extraction by each project is based on that developed in Hartley and Medlock (2008), and is as follows:

$$q_{Xi} = R_i G_i (1 - e^{-\gamma_{Xi} \cdot L_{Xi}}) \tag{1}$$

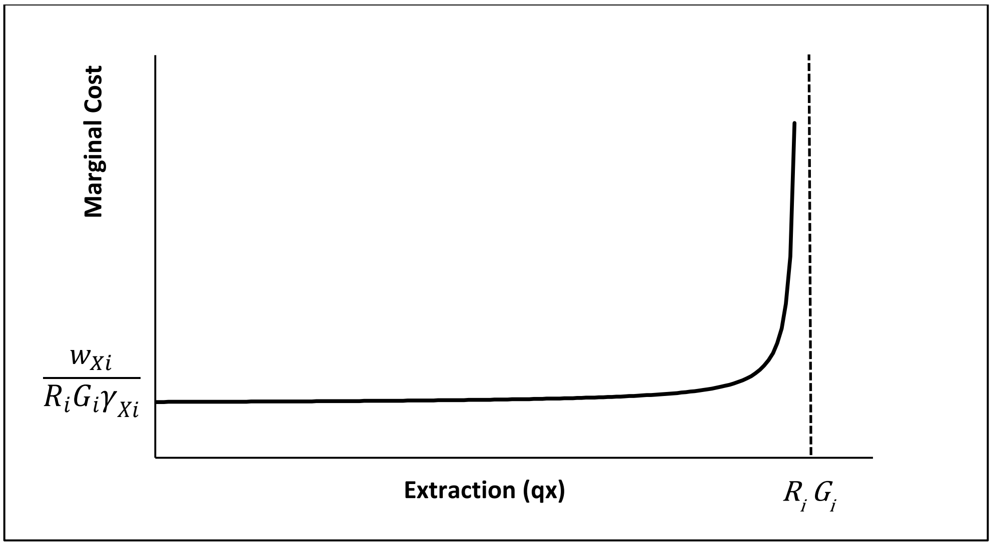
Here, R_i represents the proved gas reserves currently available to the project. These are the resources that have been identified and are economically viable to be extracted given current technology and prices. Current proved reserves are equal to the stock of reserves proved to date less cumulative extraction to date. While reserves are fixed in the short run, over time they will depend on past exploration and production decisions, as well as the overall level of resources that are ultimately discoverable. This paper focusses on short run decisions and so R_i is held fixed.

G_i represents the geological characteristics of the reservoir and governs the production to reserve ratio of a project or field, so that $G_i < 1$. Production generally becomes more difficult or expensive as cumulative extraction from a field increases. For example, reservoirs that are easier to exploit are likely to be produced first. Each well also has declining production rates over time as its pressure falls. Therefore, although G_i is fixed in the short run, it declines over time as cumulative extraction increases.

Together, $R_i.G_i$ represents the short run capacity of the project. Given this capacity, which depends on past investment decisions, each project chooses the amount of variable inputs used in extraction, L_{Xi}. Variable inputs include labour, capital and other inputs. The term in brackets in Equation (1) is bounded by zero and one, so that extraction can never exceed capacity.

Short run extraction costs depend on the cost of the variable input, w_{Xi}. With w_{Xi} exogenous to the project, the marginal cost of extraction increases as the use of variable inputs rise, as shown in Figure E below. The functional form in Equation (1) implies that the marginal cost is relatively constant until output is close to capacity.

Figure E: Marginal extraction costs for a gas project



Domestic processing costs and LNG processing costs

Once the gas is extracted, it must then be processed and transported for sale on either the domestic or export market. Gas processing is assumed to have a constant marginal cost, consistent with advice from industry.

$$q_{Di} = D_i L_{Di} \text{ , where } 0 \leq L_{Di} \leq 1 \tag{2}$$

$$q_{Ei} = E_i L_{Ei} \text{ , where } 0 \leq L_{Ei} \leq 1 \tag{3}$$

$$q_{Xi} = q_{Di} + q_{Ei} \tag{4}$$

Each processing plant has its own processing capacity, D_i and E_i for domestic and export processing plants respectively. Variable inputs can be increased to raise output in any one period, but only until capacity is reached. Equation (4) provides an additional constraint so that the total quantity processed for the domestic and export markets is always equal to the quantity extracted. Processing gas for sale also involves additional variable and fixed costs, as discussed below.

The gas consumed or lost during processing and transport represents an opportunity cost. For example, gas is used to generate electricity to power the processing plant, or LNG shipping vessel, and to operate compressors during pipeline transport. Generally, a greater proportion of the gas is consumed for LNG processing and transport than for domestic processing and transport. If the gas is to be sold domestically, a proportion, δ_i^D, of annual domestic gas production volumes are foregone. Likewise, if the gas is to be liquefied and exported a proportion, δ_i^E, of annual LNG production volumes are foregone.

Before entering the market, firms must incur fixed costs associated with the construction of either an LNG facility or a domestic processing plant (or both). LNG liquefaction facilities are significantly more expensive than domestic processing facilities. Once these main fixed costs are sunk, projects still face recurrent fixed costs associated with maintaining the plant, even if no production occurs. Recurrent fixed costs are included in this short run version of the model, represented by FC_i^D for domestic processing plants and FC_i^E for LNG facilities.

Profit function

Given its previous investments in production capacity, in the short run each project *i* will choose its level of gas extraction q_{Xi}, domestic supply q_{Di} and exports q_{Ei} to maximise its profits. Based on the discussion above, profits in the current period are as follows.

$$\begin{aligned}\Pi = {} & p^D(1-\delta_i^D)q_{Di} - w_{Di}L_{Di} - FC_i^D \\ & + p^E(1-\delta_i^E)q_{Ei} - w_{Ei}L_{Ei} - FC_i^E \\ & - w_{Xi}L_{Xi}\end{aligned} \tag{5}$$

where:

$$q_{Xi} = R_i G_i(1 - e^{-\gamma_{Xi} \cdot L_{Xi}}),\ \ q_{Di} = D_i L_{Di},\ \ q_{Ei} = E_i L_{Ei}$$

$$q_{Xi} = q_{Di} + q_{Ei}$$

$L_{Xi} \geq 0,\ \ 0 \leq L_{Di} \leq 1$ and $0 \leq L_{Ei} \leq 1$

The first row of the profit function represents the revenue and costs for supply to the domestic market. The second row shows that for the export market. Fixed costs in this short run profit function include only the recurrent fixed costs associated with maintaining the plant that must be incurred even if production is zero. It is important to note that FC_i^D need only be incurred if a domestic processing facility has been constructed, and likewise FC_i^E need only be incurred if an LNG facility has been constructed. The third row is the extraction costs which are independent of the market to which the gas is sold. The variables used in the profit function are described in the preceding discussion, but the following table summarises them.

Table A: Variables in the profit function

p^D	domestic price, initially normalised to unity
p^E	export price, relative to the initial domestic price
δ_i^D, δ_i^E	proportion of gas consumed during processing for domestic, export markets $0 < \delta_i^D, \delta_i^E < 1$
q_{Xi}, q_{Di}, q_{Ei}	total quantity extracted and processed for the domestic, export market
FC_i^D, FC_i^E	recurrent fixed costs for supplying to domestic, export markets
L_{Xi}, L_{Di}, L_{Ei}	variable factor use in extraction, domestic and export processing
w_{Xi}, w_{Di}, w_{Ei}	cost of variable factor in extraction, domestic and export processing
R_i	reserves
G_i	parameter representing production to reserve ratio
D_i	domestic processing capacity
E_i	export processing capacity

4.2 Gas demand

Domestic demand for gas is modelled using an aggregate demand curve with a constant own-price elasticity of demand, as follows.

$$C = C_0\left(p^{D^{-\varepsilon}}\right) \tag{6}$$

Where C is domestic gas consumption, C_0 is a parameter representing some 'initial' gas use, p^D is the domestic price (initially normalised to unity) and ε is the own-price elasticity of demand.

The domestic market for gas clears each period, so that domestic demand is equal to the total supply of domestic gas (net of processing losses). That is,

$$C = \sum_i (1 - \delta_i^D) q_{Di} \tag{7}$$

4.3 Market power

As discussed in section 2.2, the Western Australian gas market includes a small number of very large projects, and the supply decisions of these projects can potentially have a material impact on the domestic gas price. Each project is assumed to recognise this market power in the domestic market, although it is also assumed that there is no collusion. Large projects take the supply of all other projects as given, and choose their own output to maximise their profits. This Cournot-style interaction may be considered realistic for the gas industry, since projects produce a homogeneous product, and must commit to a certain supply capacity upfront when processing facilities are constructed.

As a result, each project recognises that the domestic price is endogenous and depends on its own supply decisions. Substituting the market clearing condition (from Equation 7) into the inverse demand curve (from Equation 6), each firm recognises that the following relationship affects their profit function:

$$p^D = \left[\frac{(1-\delta_i^D)q_{Di}}{C_0} + \frac{\sum_{j\neq i}(1-\delta_j^D)q_{Dj}}{C_0}\right]^{-\frac{1}{\varepsilon}} \tag{8}$$

On the other hand, the export market is assumed to be perfectly competitive, so large projects are price takers for exports, and therefore treat the export price as exogenous.

4.4 Domestic gas reservation policy

The domestic gas reservation policy effectively enforces a minimum proportion of total production to be supplied to the domestic market.

For projects under the formal reservation policy, exporters must supply the domestic market with the equivalent of 15 per cent of LNG export volumes. It is assumed that this 15 per cent refers to volumes after processing losses. From this, the minimum allowable domestic supply as a proportion of total exports, α_i, can be inferred.

$$q_{Di} \geq \alpha_i q_{Ei}$$

$$\alpha_i = 0.15\frac{(1-\delta_i^E)}{(1-\delta_i^D)} \tag{9}$$

For some export projects, typically those under older State Agreements, a specific volume is negotiated for supply to the domestic market. Thus, the domestic supply from these projects is more appropriately represented as being at least as large as some project-specific regulated minimum level, B_i.

4.5 Profit maximisation

Given the discussion above, the Lagrangean associated with each projects' short-run profit maximisation problem is as follows.

$$\mathcal{L} = \left(\frac{(1-\delta_i^D)\alpha_i q_i}{C_0} + \frac{Q_j}{C_0}\right)^{-1/\varepsilon}(1-\delta_i^D)q_{Di} - w_{Di}L_{Di} - FC_i^D \tag{10}$$

$$+ p^E(1-\delta_i^E)q_{Ei} - w_{Ei}L_{Ei} - FC_i^E - w_{Xi}L_{Xi}$$

$$+ \lambda_1[q_{Di} + q_{Ei} - q_{Xi}] + \lambda_X[R_iG_i(1-e^{-\gamma_{Xi}\cdot L_{Xi}}) - q_{Xi}]$$

$$+ \lambda_D[D_i(1-e^{-\gamma_{Di}\cdot L_{Di}}) - q_{Di}] + \lambda_E[E_i(1-e^{-\gamma_{Ei}\cdot L_{Ei}}) - q_{Ei}]$$

$$+ \theta_A[q_{Di} - \alpha_i q_{Ei}] + \theta_B[q_{Di} - B_i] + \lambda_2[1-L_{Di}] + \lambda_3[1-L_{Ei}]$$

Where Q_j is domestic gas supply from all other projects $\sum_{j\neq i}\left(1-\delta_j^D\right)\alpha_j q_j$. The profit maximisation problem is subject to the constraints that L_{Xi} , L_{Di}, $L_{Ei} \geq 0$.

Solving this profit maximisation problem yields the following identity for marginal revenue for exports, MR_E , which is simply the exogenous export price scaled down by processing losses.

$$MR_E = p^E(1-\delta_i^E) \tag{11}$$

The marginal revenue from domestic supply MR_D is as follows.

$$MR_D = \left(\frac{(1-\delta_i^D)q_{Di}}{C_0} + \frac{Q_j}{C_0}\right)^{-1/\varepsilon}(1-\delta_i^D) \cdot \left[1 - \left(\frac{(1-\delta_i^D)q_{Di}}{C_0}\right)\left(\frac{1}{\varepsilon}\right)\left(\frac{(1-\delta_i^D)q_{Di}}{C_0} + \frac{Q_j}{C_0}\right)^{-1}\right] \tag{12}$$

Recognising that both p^D and C are functions of the project's decisions on q_{Di} this can be simplified to:

$$MR_D = p^D(1-\delta_i^D)\left[1 - \left(\frac{(1-\delta_i^D)q_{Di}}{C}\right)\left(\frac{1}{\varepsilon}\right)\right] \tag{13}$$

Thus, marginal domestic revenue takes into account the loss in revenue when an increase in quantity reduces the price of all domestic gas sold. Equation (13) shows that this loss will be larger the larger the projects' domestic market share and the smaller the elasticity of demand (in absolute value).

The marginal cost of extraction, domestic processing and export processing are as follows.

$$MC_{Xi} = \frac{w_{Xi}}{R_iG_i\gamma_{Xi}e^{-\gamma_{Xi}L_{Xi}}} \tag{14}$$

$$MC_{Di} = \frac{w_{Di}}{D_i} \quad (15)$$

$$MC_{Ei} = \frac{w_{Ei}}{E_i} \quad (16)$$

Each project uses these marginal revenues and costs to decide on the level of supply to the domestic and export markets, which in turn depends on the level of variable inputs used. Specifically, the following conditions apply for domestic supply:

If $MR_{Di} + \theta_A + \theta_B < MC_{Xi} + MC_{Di}$ then $L_{Di} = 0$ (no domestic supply)

If $MR_{Di} + \theta_A + \theta_B = MC_{Xi} + MC_{Di}$ then $0 \leq L_{Ei} \leq 1$ (17)

If $MR_{Di} + \theta_A + \theta_B > MC_{Xi} + MC_{Di}$ then $L_{Di} = 1$ (supply at capacity)

The analogous conditions for export supply are as follows.

If $MR_{Ei} - \alpha_i\theta_A < MC_{Xi} + MC_{Ei}$ then $L_{Ei} = 0$ (no exports)

If $MR_{Ei} - \alpha_i\theta_A = MC_{Xi} + MC_{Ei}$ then $0 \leq L_{Ei} \leq 1$ (18)

If $MR_{Ei} - \alpha_i\theta_A > MC_{Xi} + MC_{Ei}$ then $L_{Ei} = 1$ (exports at capacity)

The parameters θ_A and θ_B measure the impact of the domestic gas reservation policy on production decisions. For a project where domestic supply must be greater than a certain proportion of exports, θ_A will be positive when this constraint, α_i, is binding. This increases domestic supply by forcing marginal domestic revenue, MR_{Di}, below marginal costs, $MC_{Xi} + MC_{Di}$. That is, θ_A measures the effective subsidy to domestic consumers from the reservation policy. Profit maximising firms will attempt to offset this cost on the domestic market by reducing their exports so that MR_{Ei} is higher than $MC_{Xi} + MC_{Ei}$. Thus, the effective tax on exports is $\alpha_i\theta_A$.

For a project required to supply the domestic market more than a specific minimum volume, θ_B will be positive if the constraint is binding. This only affects domestic supply, where production is again increased beyond the profit-maximising level.

In addition to these marginal revenue conditions, the influence of fixed costs on profit must also be considered. Fixed costs associated with the construction of the plant are sunk and so not relevant for short-run production decisions. On the other hand, recurrent fixed costs associated with the ongoing maintenance of the plant are not sunk. Although these costs are independent of the volume produced, they need not be incurred if the project chooses to shut down. However, shutting down would involve the cost of foregone future income, because additional expenditures may be required to start the plant up once production becomes viable again. In this short run static version of the model, it is assumed that all firms are willing to incur recurrent fixed costs, even when production is zero, because the potential future loss from not maintaining their facilities is sufficiently large.

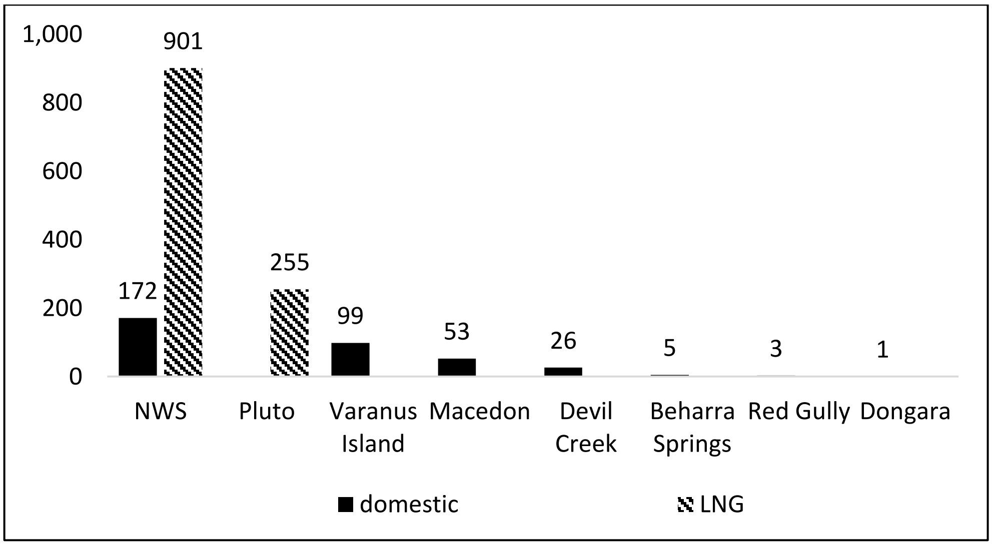
5. Impact of the reservation policy on Gorgon and Wheatstone

The model described in section 4 has been calibrated to a preliminary database representing the Western Australian gas sector in 2014. This section uses this calibrated model to estimate the short run economic impact of the domestic gas reservation policy, as it applies to the Gorgon and Wheatstone projects. As discussed in section 2.2, domestic gas plants are currently being constructed at both of these projects to meet domestic supply obligations, and are soon due for completion. This section compares the potential outcomes for the Western Australian gas sector, with and without these domestic plants. First the 2014 database and the important model parameters are discussed. Following this the scenarios are described, and the preliminary results are presented.

5.1 The 2014 database

In 2014, eight projects were operating in the Western Australian gas sector. The 2014 supply volumes from each project (net of processing losses) are shown in Figure F.

Figure F: Western Australian Gas Supply, 2014 PJ



Source: Author's calculations based on APPEA 2015, WA DMP 2015 and WA DMP 2014
Note: Supply is after estimated processing losses, including pipeline losses for domestic

Six of these projects supplied exclusively to the domestic market, one to the export market and one to both. Total domestic consumption in 2014 was 359 PJ, after processing and pipeline losses, while total LNG exports were 1,156 PJ.

The domestic price in 2014 is estimated to have been AUD$4.9 per GJ, based on volume and value data published by the Department of Mines and Petroleum (DMP). This is significantly lower than the estimated export price of AUD$13.5[10]. The difference between the domestic and export price is significant, even taking into account that LNG production costs are much higher than domestic production costs.

The NWS project is the only project currently supplying both the domestic and export markets. This supply is committed under long term contracts and a State Agreement. To represent this situation in the model, short run domestic supply from the NWS project is assumed to be unaffected by the entry of the Gorgon and Wheatstone domestic gas plants.

Detailed data is not available on the proportion of gas consumed during processing for projects in Western Australia. However, a study by Core Energy Group (2013) gives broad estimates of processing losses for the eastern states. They identify a “3 to 5 per cent loss and use in relation to field and processing facilities” a “1 to 2 per cent loss and use in relation to the transmission network” and an “8 to 10 per cent loss in relation to the liquefaction process” (Core Energy Group, 2013, p6). Similarly, the IMO assumes an 8 per cent loss due to LNG processing requirements (IMO, 2014a, p159).

The modelling in this paper assumes that domestic projects lose 4 per cent of gas during extraction and processing, the mid-point of the losses indicated in Core Energy Group. It is also assumed that gas suppliers located at the Carnarvon basin lose an additional 2 per cent during transport, while transport losses from other projects is in proportion to the distance that the gas must travel along the Dampier to Bunbury Natural Gas Pipeline to reach Perth. As a result, Dongara and Beharra Springs are assumed to lose an additional 0.9 per cent and Red Gully 0.3 per cent. For LNG facilities, it is assumed that 13 per cent is lost, which is the midpoint of field and processing losses plus liquefaction losses.

[10] It is likely that this price excludes shipping costs. World Bank data indicates that the average import price paid in Japan in 2014 was around AUD$15.30, and the difference between the DMP and World Bank data may be partly attributed to shipping costs.

Domestic gas demand is generally thought to be relatively price inelastic, particularly in the short run[11]. Thus, if the domestic gas reservation policy requires gas producers to sell additional quantities on the domestic market, producers may need to significantly reduce their prices in order to do so. Specific estimates of the own-price elasticity of demand for gas in Western Australia are not available. However, the elasticity of demand for different gas users, together with the Western Australian consumption shares shown in Figure L, can be used to arrive at an overall estimate for Western Australia.

Industrial users make up 56 per cent of demand in Western Australia. In the short run, industrial users have limited opportunities to switch between gas and other energy sources. The short-run price elasticity of gas demand has been recently estimated at -0.21 for Australian manufacturing by Hill and Cao (2014).

Residential users make up only 2 per cent of total demand in Western Australia, and are assumed to have a higher short run elasticity of -0.54, based on an Australian study by Harman and Anderson (1999).

The electricity sector makes up 42 per cent of total Western Australian gas demand. The elasticity of demand in this sector is likely to be higher than other users. Data published by the IMO (2014b) shows that while gas-fired plants represent 54 per cent of generation capacity, only 34 per cent of electricity actually generated was gas-fired[12]. This indicates that there is potentially significant opportunity to substitute gas-fired electricity for coal-fired electricity, should the domestic gas price fall sufficiently. Thus, the elasticity of demand is assumed to be -0.9 for the electricity generation sector, which is still relatively inelastic, but higher than for other gas users.

The overall average elasticity of demand is therefore assumed to be -0.5. This is somewhat higher than elasticities used in studies of gas demand in the eastern states[13], which have often used an overall elasticity of -0.3. Since gas is a major fuel for electricity generation in Western Australia, it is reasonable that the elasticity of demand should be higher. However, additional research into Western Australian gas demand is required to improve the modelling in this area.

[11] The long run elasticity of demand is likely to be higher than the short run elasticity, since users have greater options to substitute away from gas use towards other fuels in the longer term.
[12] This data relates to the South West Interconnected System (SWIS) only.
[13] See for example: Core Energy Group (2014) and ACIL Allen (2014, p42).

5.2 Scenarios

The Gorgon and Wheatsone projects are currently constructing domestic processing plants. As discussed in section 2.2, the Gorgon project is constructing a plant that will initially have capacity equivalent to 55 PJ per year, which will then be doubled six years later. The export capacity of the project is to be 865 PJ per year. The Wheatstone project is constructing a domestic plant with capacity equivalent to 73 PJ per year. Export capacity will be 493 PJ per year. All of these new projects are assumed to produce 97 per cent of their capacity. To assess the short run impact of these new plants, three scenarios have been simulated.

The **'2014 Baseline'** scenario represents the 2014 business as usual scenario, and reproduces the database exactly.

The **'G&W – no dom plants'** scenario is a hypothetical scenario representing key changes to the domestic market that may occur if the reservation policy were not in force. Specifically, the Gorgon and Wheatstone projects open, without any domestic plants. Instead, all production from the new projects is supplied as LNG exports. This scenario also assumes that the NWS contract with a major electricity generator comes to an end, as is scheduled for 2015. This is assumed to reduce domestic supply from the NWS project by 49.3 PJ per year.[14]

The **'G&W – dom plants'** scenario is the same as 'G&W – no dom plants' except that it also assumes that the Gorgon and Wheatstone projects open their domestic processing plants as planned. The initial capacity of 55 PJ per year is assumed for Gorgon. If both of these plants supply domestic gas to 97 per cent of capacity, this is equivalent to 35 per cent of 2014 consumption levels.

Comparing the outcomes of the 'G&W – no dom plants' scenario with the 'G&W – dom plants' scenario will show the estimated impact of the domestic gas reservation policy for these projects.

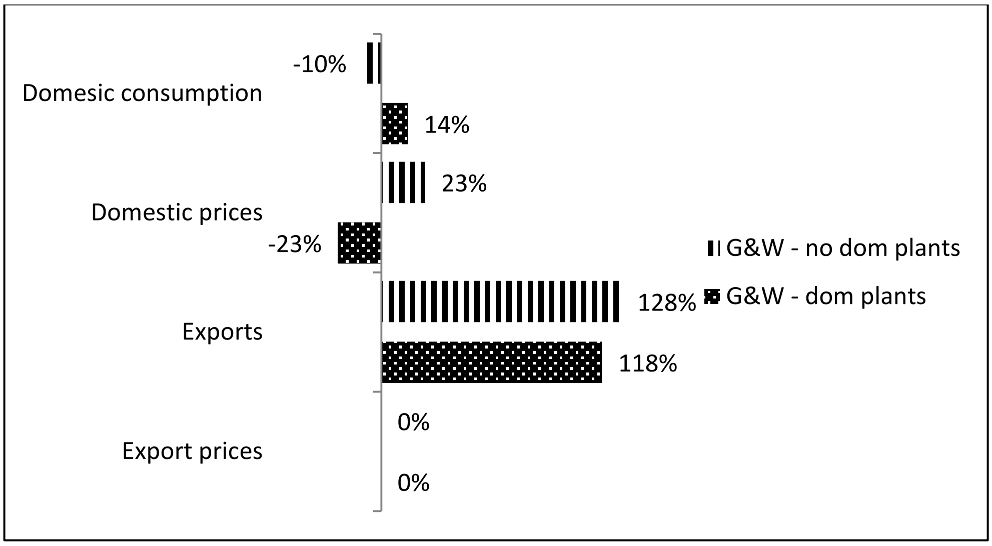
5.3 Results

Allowing the Gorgon and Wheatstone projects to supply all of their gas to the export market has no effect on domestic supply or domestic prices. However, the expiry of the NWS contract with a major electricity generator is assumed to reduce the domestic supply

[14] The IMO (2014c, p23) estimates that this contract is for 135 TJ/d. After taking processing losses into account, this is equivalent to 52.4 PJ/y. It is understood that the electricity generator (Synergy) will be taking up a new contract with the Gorgon domestic plant upon the expiry of its NWS contract.

obligation of the NWS. As a result, domestic consumption is lower and domestic prices are higher compared to 2014 baseline levels. As shown in Figure G, exports are higher by 128 per cent compared to what they otherwise would have been. Export prices do not change, since it is assumed that projects in Australia have no influence on the export price.

Figure G: Gas Industry Impacts of new plants, percent deviation from baseline

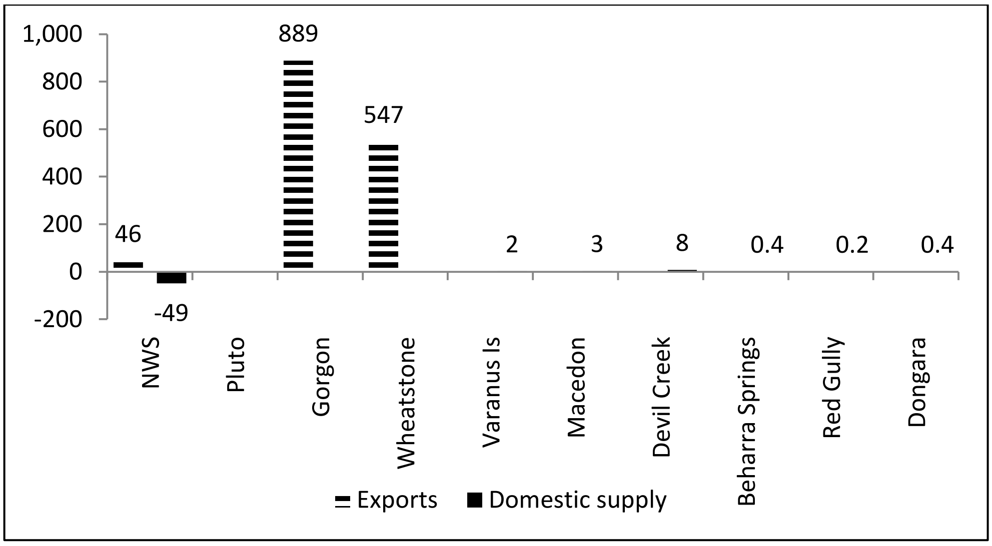


Source: Author's calculations from the Natural Gas Industry model

On the other hand, if the Gorgon and Wheatstone projects are required to construct the domestic gas plants, then domestic consumption is estimated to be 14 per cent higher than it otherwise would have been in the short run. The increase in consumption is smaller than the additional production that the two projects add to the market, which is equivalent to 35 per cent of 2014 consumption levels. This indicates that other projects must be reducing their output in response to the new output from Gorgon and Wheatstone. Nevertheless, in the short run, the higher domestic supply leads to 23 per cent lower prices than would otherwise be the case, as the new projects compete to sell their output. This price effect would be smaller in the long run, due to a higher elasticity of demand.

Supply from each project for the case where the reservation policy is not imposed on Gorgon and Wheatstone is examined more closely in Figure H.

Figure H: Impacts of G&W, with domestic plants, on annual domestic supply, deviation from baseline, PJ

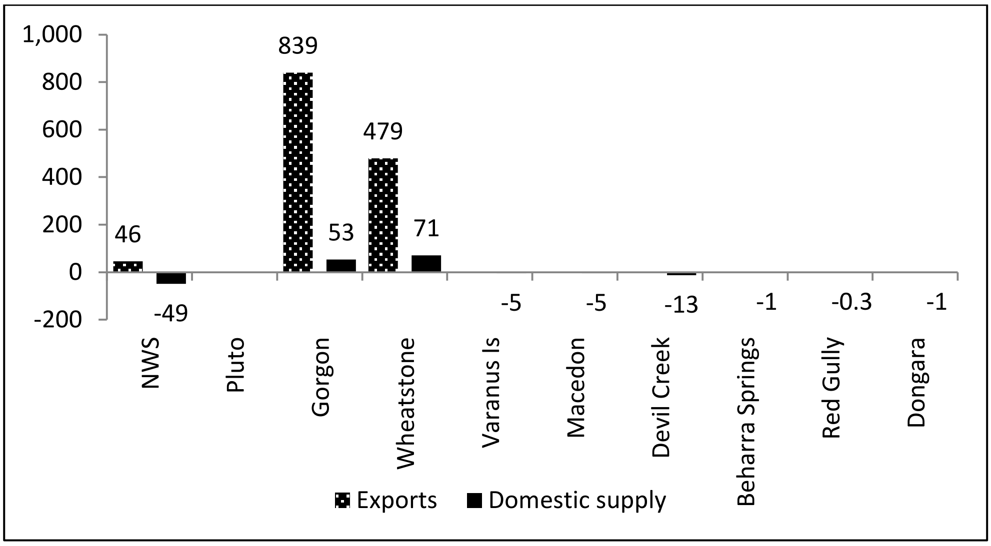


Source: Author's calculations from the Natural Gas Industry model

The two new export plants increase exports significantly. The NWS also increases its exports compared to the 2014 baseline. The project's reduced domestic supply requirements allow it to export that gas instead. In response to higher domestic prices, the domestic-oriented projects also increase their domestic supply.

However, if the two new projects are required to supply gas to the domestic market under the gas reservation policy, then this affects short run production decisions from almost all existing projects with domestic supply capabilities, as shown in Figure I.

Figure I: Impacts of G&W, with domestic plants, on annual domestic supply, deviation from baseline, PJ



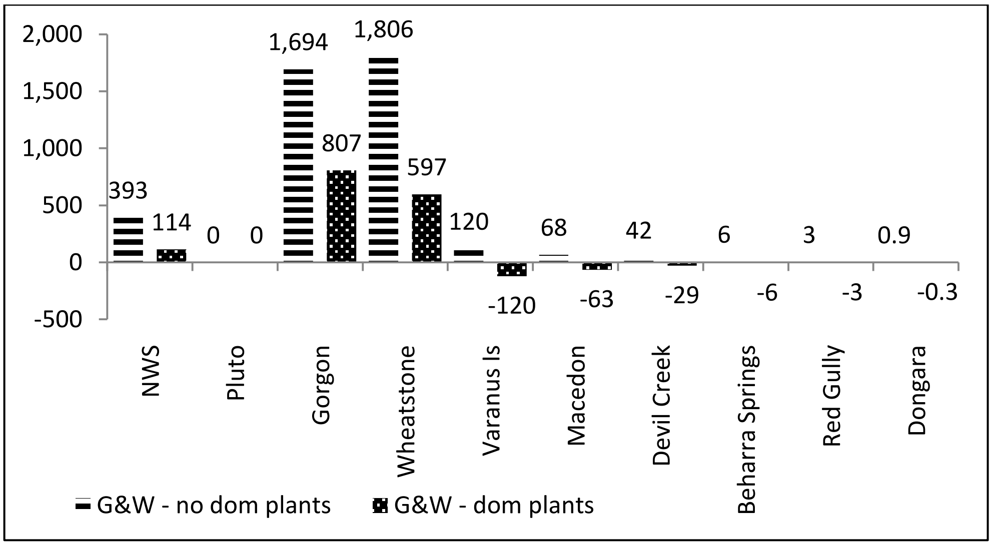
Source: Author's calculations from the Natural Gas Industry model

The additional domestic supply from Gorgon and Wheatstone puts downward pressure on prices, which reduces existing projects' ability to supply the domestic market. In response, domestic-oriented projects reduce their supply. The smaller projects are affected more than the two largest domestic-oriented projects. Devil Creek is estimated to reduce production by around 50 per cent, and Dongara is estimated to shut down completely in the short run.

The North West Shelf project, the largest supplier of domestic gas, is again able to reduce domestic supply and export the gas instead. Pluto is the only project unaffected by the policy, since it does not currently have a domestic plant.

While the data for profits is preliminary, some illustrative estimates of the impact on profits have been included in the model. These are presented in Figure J below.

Figure J: Impacts of new plants on illustrative annual short run profits, deviation from baseline, $m



Source: Author's calculations from the Natural Gas Industry model

If the Gorgon and Wheatstone projects are not required to construct domestic plants, then profits earned by all projects are higher than the 2014 baseline, except for Pluto. Exporters' profits increase due to higher export volumes, while domestic-oriented projects benefit from the higher domestic prices.

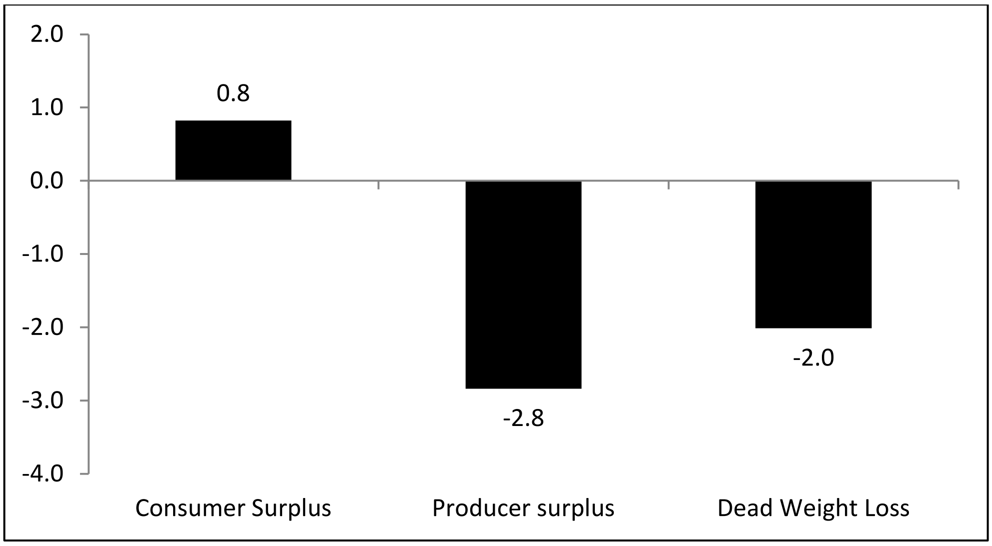
If the new projects are required to construct domestic plants, then profits from the Gorgon and Wheatstone projects are significantly lower, since some gas must be sold at the lower domestic price rather than the export price. Additional fixed costs associated with the domestic plant are also incurred.

When the two new projects supply to the domestic market, the lower domestic price also reduces profits from all other projects, except for. Reduced output from the domestically-oriented projects supresses their profits further.

Overall, gas suppliers are worse off as a result of the new domestic plants at Gorgon and Wheatstone. Figure K compares the economic surplus in the industry with and without the domestic plants at Gorgon and Wheatstone. That is, it compares the outcomes under the 'G&W – no dom plants' scenario with the 'G&W –dom plants' scenario. Due to the new domestic plants, industry profits are estimated to be $2.8 billion lower than they would be without them.

This significant decrease in profits from gas suppliers should be weighed against the gain to consumers. The gas consumers benefit from the additional domestic gas plants because prices are lower and consumption is higher. The short run addition to annual consumer surplus is estimated to be $0.8 billion.

Figure K: Impacts of domestic reservation for G&W, annual, $billion



Source: Author's calculations from the Natural Gas Industry model

On balance, this represents an overall loss to the economy of an annual $2.0 billion in the short run. This loss only represents the immediate impact of the reservation policy as applied to the Gorgon and Wheatstone projects. The long run impacts may be larger because the reservation policy is likely to result in less interest in discovering and developing new gas resources in Western Australia. An offsetting long run factor is the higher elasticity of demand which may somewhat lessen the reduction in the domestic price.

6. Further considerations

This section considers some further issues and their implications for analysing the domestic gas reservation policy. These issues are 1) the implications of foreign ownership of gas producers and gas consumers, 2) whether flexibility in the share reserved is likely to ameliorate the economic costs of the policy and 3) whether a general equilibrium analysis would change the overall assessment of the policy. In considering these issues, this section also points to areas for future research.

6.1 Foreign ownership

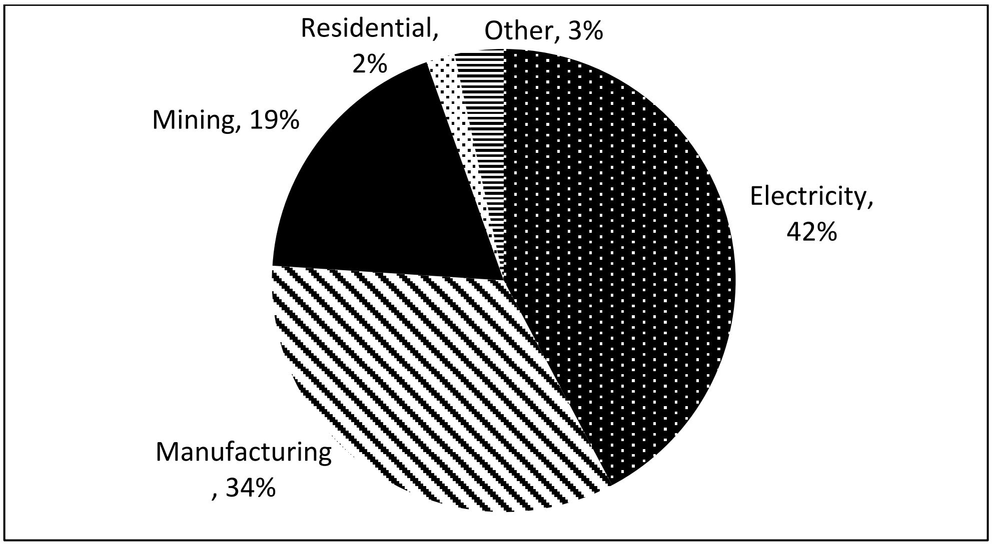
Foreign ownership of energy companies is an issue raised in a number of studies, including ACIL Allen (2014). The reservation policy can be thought of as a transfer of income from gas-producing firms to gas-consuming firms. Therefore, if gas-producing firms have higher foreign ownership shares than gas-consuming firms, then the reservation policy may act to transfer some income from foreigners to Australians. However, data on ownership of firms participating in Western Australia's gas market is not available, so it is difficult to judge the net benefits of such income transfers.

Gas producers in Western Australia include a number of international and domestic energy firms. Shareholders in these companies may be domestic or foreign financial institutions, superannuation companies or households.

The share of gas consumed by each industry in Western Australia is shown on Figure L. Interestingly, households make up only 2 per cent of total direct domestic gas demand. Large gas-users in the manufacturing industry include alumina and fertiliser manufacturers. Mining companies also make up a significant proportion of Western Australia's domestic gas demand. These gas-using companies can be owned by the same array of domestic or foreign shareholders as gas-producing companies. One exception is the electricity sector, where a significant proportion of generation capacity is owned by the State Government. However, the costs and benefits of government ownership of utilities is a separate issue and will not be discussed here.[15]

[15] Hartley and Trengove (1986) investigate the operation of public utilities, and the inefficiencies arising from the interests of politicians and employees of the public utility. Tyers (2015) discusses and models the benefits of privatisation and regulation of service monopolies in Australia.

Figure L: Share of domestic gas consumption by industry, Western Australia



Source: BREE Australian Energy Statistics 2014

An additional consideration is that the reservation policy is likely to reduce tax collections since gas-producing companies tend to pay higher taxes than gas-consuming companies. In this way, the reservation policy would reduce domestic tax revenue from resources.

Therefore, it is not necessarily the case that the reservation policy will transfer income from foreigners to domestic households and governments. However, further research on domestic ownership and taxation is required before conclusions in this area can be drawn.

6.2 'Flexibility' in reservation requirements

The 2011 Western Australian Parliamentary Inquiry into domestic gas prices noted that, "The Reservation Policy allows for 'case-by-case flexibility', allowing potential producers to negotiate with government as to the amount to be reserved and the manner in which it is to be supplied." (Parliament of Western Australia, Economics and Industry Standing Committee 2011, p79)

The Government may believe that flexibility in the share of gas sold on the domestic market could make the policy less harmful. For example, the domestic gas reservation requirement could be relaxed for projects that might be uneconomic if it were enforced. This line of thought is also raised in a recent report by the Oxford Institute for Energy Studies (Ledesma et al., 2014). While this may reduce the short-run negative impact of the policy as applied to a specific project, it may do little to ameliorate the long-run costs of the policy.

Firstly, the *possibility* of 15 per cent domestic reservation will itself tend to discourage investment in exploration for new gas resources, so it is unlikely that this flexibility will substantially reduce the policy's long-run detrimental effects.

In addition, this 'flexibility' also creates uncertainty for gas producers about the quantity of gas that they will be required to sell on the domestic market. This uncertainty, in itself, would tend to discourage investment. For example, the uncertainty created by a flexible reservation policy ranging from 11 to 15 per cent with a mean of 13 per cent would discourage investment to a greater extent than a commitment to a 13 per cent rate for all projects.[16]

6.3 Partial and general equilibrium analysis

A partial equilibrium approach, such as the one presented in this paper, captures the main losses and benefits from the reservation policy and therefore can give sufficient information to draw policy conclusions. The value of additional gas supplied to domestic users under the gas reservation policy is embodied in the demand curve for the gas sector. The price that users are willing to pay is equivalent to the value that the additional gas would contribute to the outputs of these downstream industries. When domestic industries are willing to pay less than the export price for the additional gas supplied, the value of this gas to the Australian economy is lower than it would have been if exported.

Importantly, there are not likely to be net long-term benefits from artificially expanding domestic gas supply that could be captured in a general equilibrium model. As discussed in section 2.2, the policy is unlikely to increase overall employment or capital income, but instead shift activity into less efficient sectors. Therefore, while a general equilibrium analysis would extend the detail of the results to show the extent to which gas-using industries expand and other industries contract, it is unlikely to change the overall conclusion regarding the economic cost of the policy.

However, one caveat for using a partial equilibrium analysis of the gas sector is the potential influence of distortions in other sectors of the economy. For example, if there were significant tax or other policy distortions in gas-using industries, then it is possible that the domestic gas reservation policy may partially offset or exacerbate these distortions. An appropriate general equilibrium analysis could pick up any of these effects. It is important to

[16] There is a growing literature on the negative impact of policy uncertainty on investment. For example, Pastor and Veronesi (2012) develop a model explaining why uncertainty about the impact of a policy on profitability is likely to push stock prices down. Gulen and Ion (2013) show empirically that higher policy-related uncertainty reduces industry investment.

note here that the offsetting any market failure or other distortion outside the gas sector is not a stated rationale for the domestic gas reservation policy.

Gohin and Moschini (2006) assessed the difference between partial and general equilibrium models when analysing distortions in agricultural sectors of developed countries. In line with the above, they found that partial equilibrium models yielded ‘comparable implications’ to general equilibrium models, assuming that no other major distortions exist in the rest of the economy. In addition, general equilibrium modelling of a gas reservation policy in the eastern states by Deloitte Access Economics (2013) reported results that are qualitatively similar to the partial equilibrium model developed in this paper.

7. Conclusions

The domestic gas reservation policy can be viewed as having the same effects as two separate distortions in the gas market, which are each detrimental to overall Australian living standards. The lower price that producers receive for gas sold on the domestic market acts as an implicit tax on producers. This lowers the incentive to supply gas to the domestic market and to invest in gas exploration and production. In addition, the artificially low domestic price acts as an implicit subsidy for domestic consumers. This results in an opportunity cost because the additional gas supplied to the domestic market is not put to its highest-value use. It shifts labour and capital into downstream, gas-intensive industries and away from other sectors of the economy. This should be viewed, however, as a diversion of resources towards lower-value uses rather than a generation of new net activity.

This paper develops a project-by-project model of the Western Australian gas industry and uses it to estimate the loss arising from the domestic gas reservation policy. It incorporates many of the important features of the market. Projects with heterogeneous costs produce a homogeneous good. Projects are large compared to overall demand, however, and each project recognises its own pricing power on the domestic market. Short run production decisions are constrained by previous investment and exploration activity, since fixed costs are large and sunk.

This model explicitly recognises that the reservation policy imposes a proportional relationship between export and domestic supply. This improves on the standard two-part interpretation of the policy as a simultaneous tax and subsidy. However, the model is consistent with this interpretation, and shows that the effective tax rate imposed on exports is proportional to the effective subsidy rate for gas consumers.

Under the domestic gas reservation policy, both the Gorgon and Wheatstone export projects are constructing new domestic supply facilities that are soon to be completed. These projects will be entering the market in an environment of significant overcapacity. Currently, around one third of domestic supply capacity is unused, and according to IMO (2014a) this overcapacity is anticipated to grow to around 50 per cent by the end of 2024.

The modelling confirms that the reservation policy, as it has been applied to the Gorgon and Wheatstone projects, results in a deadweight loss. The gain to domestic consumers is not sufficient to outweigh the loss to producers, and the overall short-run annual loss is estimated at $2.0 billion. The Gorgon and Wheatstone projects add domestic capacity equivalent to 35 per cent of 2014 Western Australian gas consumption. This additional domestic supply more than offsets anticipated reductions from the NWS. Overall, the domestic gas price is estimated to be lower by 14 per cent compared to what it otherwise would be. This induces other domestic-oriented projects to reduce their supply, and domestic consumption is estimated to increase by only 23 per cent overall. As a result, profits are lower than they would otherwise be if the new projects were allowed to export all of their production.

Since other domestic producers choose to reduce their domestic supply in response to the new domestic supply from Gorgon and Wheatstone, in effect, some of the newly-constructed capacity serves to merely replace existing capacity.

Importantly, the reservation policy is estimated to create a deadweight loss despite the presence of oligopolistic behaviour. Thus, rather than providing a benefit by offsetting inadequate competition in the domestic gas market, the policy generates a loss to the Australian economy.

The work undertaken in this paper will be extended in future research. Additional behaviour will be incorporated into the model, including dynamics, and the database will be improved.

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