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## Submission to the Senate Select Committee on Electric Vehicles

Prepared by Craig Milne, Australian Productivity Council, July 2018

**(a) The potential economic, environmental and social benefits of widespread electric vehicle uptake in Australia.**

The adoption of electric vehicles can deliver *economic benefits* if it is accompanied by decisive government action to support electric vehicle manufacturing in Australia. A chance would be a fine thing. Such support, if provided, would be a way for the governing class to begin to redress its contribution to the destruction of the significant automotive industry that Australia used to have.

Australia lost its automotive industry because a succession of national governments, from the 1920s until the present, comprehensively and continuously failed to devise and implement the industrial policy measures needed to ensure the viability of the industry. With an industrial strategy similar to that applied in Germany, France, Italy, Japan or Korea, Australia could have had a one million unit per annum automotive industry, supporting one or two globally recognised firms and a few hundred component suppliers providing jobs for two hundred thousand or more people.

Over the last thirty years, taxpayers stumped up billions of dollars as Danegeld to keep American automotive firms in Australia. Enough was handed over to purchase a couple of global automotive businesses outright. From the Button plan onwards, the American firms were never really interested in staying here, a fact obvious to anyone able to divine the owners' real intent by looking at the condition of their plants and the products they offered. When Joe Hockey and Tony Abbott indicated that they were not really interested in them staying here either, they left.

All of that treasure, all of that industrial experience, all of those supplier businesses, all of the jobs, skills and capabilities, a hundred years in the making, tossed away with nothing to show for it. In the catalogue of bungled Australian industry policies, a pretty long list to be sure, the loss of the automotive industry will rank as one of the most egregious failures of the responsible class of politicians, advisers and bureaucrats whose duty to the nation was not served.

Electric vehicle production could provide an opportunity to recover that which was lost. A revived industry producing, but not confined to electric vehicles, could begin the reinstatement of the technical, industrial economic, technical and industrial benefits that the nation formerly had.

Nations with common sense highly value automotive manufacturing, because it is an industry that engages a broad range of advanced productive activities and, in terms of technical complexity, quality and productivity, practices them at the deepest and most demanding level.

As recently as the 1980s, when the process of "economic reform" was unleashed on the industry, Australia assembled, or fully built, 83% of the vehicles sold in the domestic market. With the industry gone, Australia now imports the lot, at a cost of about 2% of GDP. To put the cost of this loss into context, Australian automotive imports now entail the gifting of tens of thousands of jobs, valuable technical skills, hard won industrial capabilities and profitable business opportunities to foreigners. Paying for these imports requires an outlay of foreign currency equal to more than half of the total farm gate value of production of the entire agricultural sector of Australia. If, on the business as usual model fashioned by Canberra's neo-Ricardians, electric cars are going to be just a subset of the 1.2 million motor vehicles now imported to Australia, then there will be no economic benefit from their adoption at all.

Despite the passionate claims of their boosters, the *environmental benefits* of electric cars are not particularly significant. Purely electric vehicles do not emit carbon dioxide when driven, but charging their batteries requires the production of electricity elsewhere. In heavily congested cities, like those

in China, electric vehicles have the considerable benefit of moving exhaust pollution to somewhere else, but this is not a major issue for most of Australia.

Advocates of electric cars argue that the electricity required for battery charging can be produced by renewable energy. The problem with this argument is that the contribution of renewables to the Australian energy budget is small and, given the inherent limitations of solar and wind power, and despite the prodigious investments in them, likely to remain so. In the 2017 calendar year, a total of 259,446 GWh of electrical energy was produced in Australia, 220,359 GWh of which was generated from burning hydrocarbons. Coal accounted for 72% of the hydrocarbon share, with natural gas and oil providing the balance. Of the total electrical energy output of Australia in 2017, wind and solar, despite the billions of dollars expended in their deployment, contributed a mere 8.3% .

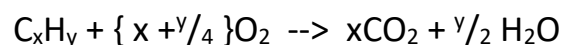
Electric cars are more efficient than cars powered by internal combustion engines (ICEs). Electric traction motors operate at energy input/output efficiencies in the 90-95% range and the charging and discharging efficiencies of modern li-ion batteries are very high. As a result, an electric vehicle powertrain can be three or more times more efficient than an ICE powered vehicle; these manage, at best, an input/output efficiency of 25-30%.

The problem for electric cars is that the energy required to charge their batteries will most likely be produced by a thermal power station. Although the input/output efficiency of the power station is higher than an ICE powered motor vehicle, because large heat engines have higher thermodynamic efficiencies than small heat engines, the sum of all other losses must be taken into account.

For example, if the electric car is being charged and used in Melbourne, the energy will likely be derived from burning lignite in the La Trobe Valley. Loy Yang, the biggest power station, has an input/output energy efficiency of about 33%; better than an ICE, but not by much. Subsequent losses are incurred at various stages between the power station and the electric vehicle; step-up transformer losses between the generator and transmission line, transmission losses between the La Trobe Valley and Melbourne, step-down transformer losses, and further losses in distribution transformers and cables to the vehicle charging point. Taken together, these can account for 10% or more of the energy produced at the generator. On top of that, the electric car has charging and discharging losses in cycling the battery plus inverter and motor losses during operation. The end result is that the electric vehicle will have a net input/output efficiency, when considering the whole energy cycle, of about 27%; much the same as an ICE powered vehicle.

It may be argued that as only 85% of Australia's electrical energy is supplied by non-renewable means, electric vehicles can still be justified because they may, at least in part, be fuelled from non-carbon dioxide emitting sources. This argument fails, however, because most Australian electricity (72% of the 85%) is produced from coal. Coal emits much more carbon dioxide per energy unit than does petrol or diesel.

What cars powered by ICEs and thermal power stations have in common is that they are both devices for converting chemical energy into shaft work. They do this by initiating a chemical reaction (oxidation), between a hydrocarbon compound, carried in the vehicle fuel tank or supplied to the boiler or gas turbine of a power station, and oxygen, which is appropriated from the atmospheric commons, as follows:



The products of this reaction are carbon dioxide, water and heat. Heat is the measure of the binding energy released by the molecular reformulation of the initial hydrogen/carbon compound into

carbon dioxide and water. The heat is subsequently applied via a thermodynamic process in an engine or turbine to produce shaft motion.

In the chemical equation for the complete combustion of a hydrocarbon shown above, the quantity of carbon dioxide produced depends on the ratio of carbon (x) to hydrogen (y) in the fuel source; generally, the more complex the hydrocarbon molecule, the higher the carbon component and, as a consequence, the higher the proportion of carbon dioxide produced by combustion. Burning methane ( $\text{CH}_4$ ), the main constituent of natural gas, will produce the least carbon dioxide. Petrol (approximately  $\text{C}_8\text{H}_{18}$ ) will produce more for the same energy yield. Coal is the most complex molecule; burning high grade anthracite ( $\text{C}_{240}\text{H}_{90}\text{O}_4\text{NS}$ ) produces the highest carbon dioxide emissions per energy unit of any of the hydrocarbon fuels.

Using petrol as a base, the quantity combusted to produce 100kg of carbon dioxide would, if substituted for methane for the same energy yield, produce 74kg of carbon dioxide. Substituting anthracite, the same energy yield would produce 145kg of carbon dioxide.

Given the current Australian energy production mix, measured by what is actually delivered rather than by the theoretical installed capacity, and considering the entire energy cycle of electric vehicles, the electrification of the national vehicle fleet would have little effect on carbon dioxide emissions.

Massive expansion of wind and solar capacity may improve the environmental benefits of vehicle electrification, but Australians are already becoming disenchanted with the high cost and inherent unreliability of renewables. Energy at hand is an excellent metric of prosperity, and the coal, oil and gas currently used in Australia provides a gross yield of about 900MJ per capita per day. Renewables will have trouble producing anywhere near that. Environmentalists argue that we should all be using less energy, which is an indirect way of saying that we should all become poorer. Australians should use energy efficiently and, while there is always room for improvement, mostly they already do.

The best way of further electrifying the economy, including transportation, while maintaining our standard of living and reducing carbon dioxide emissions, is by replacing coal-fired power generation with nuclear power stations. Unlike renewables, which already operate at close to their maximum potential efficiency, nuclear power has enormous scope for energy productivity improvement.

**(b) Opportunities for electric vehicle manufacturing and electric vehicle supply and value chain services in Australia, and related economic benefits.**

Until recently, the Australian economy had available to it most of the technical and industrial skills, together with the production facilities, needed to design, develop and manufacture motor vehicles, including electric-powered models. The closure of the industry means that this is no longer the case. The former plants have been dismantled and relocated abroad, the supplier base substantially shut down or diminished and the technical skills dispersed.

These industry capabilities could still be re-assembled with a will to do so but this will become increasingly difficult with the passage of time. Any attempt to revive conventional vehicle manufacturing would require a prodigious effort, large investments and serious government commitment to the venture as an important national project.

Every cloud has a silver lining, however, and, in one sense, the loss of the old industry presents an opportunity to envisage a new and better one. Valuable as it was, the old industry had many defects, entrenched in long established structures and techniques and, by being foreign owned at the peak

assembly level, was always subject to the operating principles and procedures of the global entities of which it was a part. Foreign ownership shaped the Australian industry as an essentially “colonial” operation, severely limiting its scope and freedom of action, in design, engineering, organisational form, choice of production technology, product mix and authority to adopt an export orientation.

A major aspect of this structure was that the Australian plants, as subsidiaries of global firms, built products in accordance with standard industry high-volume automotive manufacturing techniques. Based on unibody construction, these techniques were appropriate for markets where the required scale economies, more than 40,000 annual units per model, were achievable. With market opening and increased consumer choice in Australia, these volumes were seldom achieved or maintained over a whole model cycle.

The solution would have been to export the major part of the plant’s output This is what Toyota did with the Camry and was the reason that the Japanese company would have stayed on had Holden been retained. The American firms demurred on allowing significant Australian exports, however. Permission to export was rarely given and then only in a desultory manner and as a response to pressure. Corporate political intrigues then conspired to limit any chance of success for such ventures, by shunting the distribution of Australian cars off to dying brands like Mercury or Pontiac or starving Chevrolet dealers of inventory in the case of the excellent SS (Commodore).

The reason for American reticence was that they took a more hard-headed view of their Australian businesses. They never really wanted them in the first place, were here because of tariffs and when these finished wanted to go back to their preferred model of full importation. The Australian market was small, remote and its human factor inputs were an order of magnitude more expensive than in Asia. It wasn’t that cars couldn’t be produced and shipped profitably from Australia, given full plant utilisation, rather that they could be built and shipped much more profitably from somewhere else.

The Australian Productivity Council (APC) did a fair amount of work on addressing this problem by envisaging what an Australian automotive business could look like in a post Ford/GM/Toyota industry. The essence of the APC approach was to develop a business concept better suited to Australian cost and market volume realities than the one that had been in place. This concept was based on the view that an Australian industry needed a way of designing, building and selling cars that could make substantial margins on much smaller model volumes than those needed by conventional production methods. The business concept had three main features.

Firstly, it proposed a way of building cars on a common flexible platform (CFP) to substantially reduce initial development and tooling cost per model at the expense of a higher base unit cost. Trading up-front costs against unit costs in this way would provide better production economies, more variety and shorter model cycle times at all volumes below 40,000 annual units than the conventional manufacturing methods.

Secondly, the business proposed a different plant format, similar to production concepts developed by Volvo at Uddevalla in Sweden, as an alternative to the Toyota Production System (TPS). The proposed plant design had fixed assembly stations as distinct from a moving assembly line with part sets delivered sequentially to the workspace for assembly by a skilled two-person team completing one vehicle per shift. Such a plant is much less expensive to build, is more flexible, offers higher worker morale and a flatter, less expensive, management structure than a conventional plant.

Thirdly, the business proposed a direct-selling model from a digital platform supported by company-owned sites in shopping centres, a model subsequently demonstrated by Tesla in Australia. This would collapse the dealer margin into the producing business and enable solid profit margins,

budgeted at 30%, providing rapid growth through retained earnings while offering customers an ultra high quality product at a reasonable price.

Taken together, this business model would enable viable vehicle production in Australia at feasible sales volumes. Although the external appearance of the proposed models was similar to premium vehicles built by conventional techniques, the structural underpinnings were quite different; space frame construction was envisaged rather than unibody and light metals and/or composites were to be used in place of steel.

At the time this work was undertaken the product concept assumed the use of conventional ICE powertrains to be sourced from a European supplier. The Australian manufactured componentry was confined, at least in the beginning, to the modular base unit, body closures, glass and interior parts. At that time, electric cars were less developed and were not considered to be as appealing to potential customers. That situation has now changed; electric cars are steadily becoming more acceptable due to steady improvements in the production cost, energy density, durability and charging time of batteries.

The business model proposed by the APC would be ideally suited to electric vehicle production, in fact it would be a more straightforward project because the development work, particularly in noise, vibration, harshness (NVH) is simpler and less expensive with electric vehicles than with ICE powered designs. More than that, the electric vehicle industry is evolving along lines that simplify supplier issues for emergent vehicle assemblers.

We would be happy to discuss the proposed production model with an interested party.

### **( c ) Measures to support the acceleration of electric vehicle uptake.**

The uptake of electric vehicles has been very slow in Australia to date. There are three obvious reasons for this; electric cars are expensive, they are not yet seen as effective substitutes for ICE powered vehicles and they are not what people who purchase motor vehicles are used to.

Electric cars are expensive because the batteries used to power them are expensive. Not only are the batteries expensive, their service life is limited as well. Although the performance of an ICE powered vehicle falls off with wear, this is barely noticeable, gradual and occurs only at very high mileages. Batteries, on the other hand, degrade with each recharge and the rate of degradation increases if the battery is recharged too quickly; fast charging li-ion batteries reduces their service life considerably. Electric vehicle owners are also faced with an expensive battery replacement bill after several years of ownership; an outlay that may be difficult to justify in view of the general dilapidation and depreciation of the rest of the vehicle.

Electric vehicles are not yet considered effective substitutes for ICE powered vehicles because of range and convenience issues. Batteries are heavy and, compared to petrol, have a very low energy density. For example, the polyethylene fuel tank of a Toyota Corolla, filled to capacity with 55 litres of petrol, weighs about 50 kg. The energy yield of this fuel load, at 45MJ per litre, is 687.5kWh. In contrast, the 85kWh Tesla Model S battery weighs 540kg. Electric motor efficiency mitigates in favour of the battery, but electric vehicles are still disadvantaged under real world operating conditions. Claimed electric vehicle endurance may look impressive, assuming a steady speed, on level ground with the ancillaries turned off. However, acceleration, overtaking, hill climbing and turning on the air-conditioner will attenuate the range sharply. Recharging a battery takes much

longer than refuelling an ICE car; 9.5 hours for a Tesla battery on a domestic 240v supply, reducing to 75 minutes on a Tesla Supercharger.

In favour of electric vehicles is the fact that battery technology is improving rapidly; energy density has doubled over the last twenty years and may double again in the next twenty. Electric vehicle range issues are becoming less of an issue as newer batteries become available. In any case, for most users in urban areas the range of existing models is entirely adequate, requiring only a slight change in management practices to maintain full vehicle availability; similar to managing the battery of a mobile device or laptop computer.

For long range users, promising technologies, like petrol-powered range extenders, are in prospect. The newest designs envisage compact, mechanically simple linear reciprocating motor/generators that are able to steadily maintain battery charge from an onboard hydrocarbon fuel supply, when required, by operating in series hybrid form. Such designs will offer full electric operation when battery charge is available and an unlimited range, with occasional fuel stops, when it is not.

Electric vehicles have many driving benefits. They are smooth and quiet. They have seamless acceleration because electric motors, unlike ICEs, deliver full torque at start. They are mechanically durable as well; induction motors have one rotating part and can easily last for 30,000 hours or more, perhaps two million kilometres before needing repair or replacement. By comparison, ICEs have a cacophony of whirling and reciprocating parts, high internal stresses, vibration, balancing issues and large destructive forces to contend with. The Otto cycle engine dates from the middle of the nineteenth century. That it has survived as long as it has, and performed as well, despite its inherent defects, is a testament to the extraordinary talents of the engineers that have continuously developed it. So far, it has seen off all previous challengers because, to paraphrase Winston Churchill's comment on democracy, it is the worst form of engine imaginable, except for all of the others. Its situation today is more precarious, however, positioned like the huge reciprocating triple expansion steam engines of the 1890s; engineering masterpieces about to be pole-axed by the Parsons steam turbine. If battery producers get their costs down, their energy density up and their lifetime extended, the ICE, for most vehicle applications at least, could soon pass into history.

Left to the market, electric vehicles will steadily increase their market share, based not on regulation or government compulsion, as favoured by many environmentalists, but by the real, and increasing, list of benefits that they offer.

It is up to electric vehicle manufacturers to make the case for them. In the past, the case has been weak. The automotive market has seen them before; in the early years of automotive transport, battery electric vehicles were popular until the greater convenience of ICE alternatives drove them from the market. On present trends, their return could produce a different outcome. Australian governments should take an interest in getting cars manufactured in Australia again, but they should not take sides in trying to choose the timing for a change in propulsion technology.

#### **(d) Measures to attract electric vehicle manufacturing and electric vehicle supply and value chain manufacturing to Australia.**

If there is one lesson Australians should learn from the failure of the previous automotive industry, it is that less effort should be spent on attracting investment from foreign sources and more on raising it domestically; at the same time making sure that any strategically important businesses formed in Australia are effectively defended against foreign predation.

At the dawn of the automotive age Australia was well positioned to harvest the enormous economic benefits made available by the new transportation and production technologies. The previous road transportation technology, mainly horse-drawn vehicles, supported an extensive array of crafts and businesses in town and country. The wheelwrights, farriers, harness and saddle makers, blacksmiths, carriage builders and feed and grain merchants of Australia employed tens of thousands of people. The emergent automotive age would soon clear all of that away.

Australians made a good start in the automotive business. Unsurprisingly, a set of colonies founded by, and populated from, the leading technological and economic power of the nineteenth century, possessed many capable engineers and craftsmen. Harley Tarrant, the best of the early Australian motor manufactures, built complete motor cars in Melbourne between 1900 and 1907. A preserved example, a 1905 roadster, is on display at the RACV headquarters in Melbourne. Tarrant cars were outstanding examples of the technology of the period. An examination of cars produced by Tarrant's European contemporaries, as displayed at Beaulieu, Hampshire, or the *Musee de Arts et Metiers* in Paris, demonstrates that the Tarrant stands up exceptionally well; state of the art for the period, well-engineered and beautifully made.

The problem for Tarrant, and others like him, was that Australian manufacturing at that time, although highly capable, was generally small scale and labour intensive. This structure, given high Australian wages, made local products too expensive. In addition, Australia had no interchangeable part manufacturing capability available to support automotive production until the 1930s and could not, therefore, attempt the production of engines, gearboxes and axles on a cost-effective basis.

Instead, the industry began by building car bodies; a natural extension of the carriage building trade. By the late 1920s, the most successful firm, Holden Motor Body Builders (HMBB) in Adelaide employed 3000 people and was building nearly 50,000 bodies a year. It was the largest body-building firm in the world outside of North America.

National governments around the world were keen to ensure that their domestic businesses would find a place in the new order. The problem was the Americans. In the early twentieth century the United States was emerging from a long period of protectionist nation-building. It had the largest domestic market for automobiles by far. It had developed new and more efficient management techniques. Above all, it had perfected, after more than a century of innovation, trial and error and practice, the "American System"; the ability to produce interchangeable parts. It was this formidable manufacturing innovation that changed the industrial world and powered American hegemony to its consolidation at the end of the Second World War. No-one else could compete against that.

National governments, wiser than our own, took whatever steps that were needed to push the Americans to the margins of their markets, to make room for their own ventures. Every tactic was used. In France it was prohibitive tariffs; up to 220%. In Germany, a state-financed clean-sheet business, Volkswagen, was set up. In Italy, the foreigners, Citroen and Ford, were booted out. In Japan, a 1936 law was passed to limit the production of American firms, while channelling funds and supply contracts to local businesses. The Japanese policy was the most draconian. In 1934, American firms held more than 90% of the market but by 1939 they were gone. Ford and General Motors were driven out and Toyota, Nissan and Isuzu were pushed to the fore.

Australian governments were asleep at the wheel during this period. The problems began when HMBB built a modern plant at Woodville in 1924. General Motors, then importing chassis and fitting them with Australian made bodies, moved to contract for the entire output of the Woodville plant for a three-year period. HMBB used to supply everybody, including Ford, with bodies. The contract



with General Motors alarmed Ford. It worried that its major competitor, by procuring the entire output of Australia's best body plant, would be acting to the detriment of the company's interests. Ford's response was to send an executive of its Canadian subsidiary, Hubert C. French, to Australia to assess the situation. French's report advocated the construction of a body and assembly plant at Geelong as a remedy. The Ford plant at Corio was constructed in 1925, with French (who spent the rest of his life in Australia) in charge. This development, in turn, concerned General Motors. When HMBB fell on hard times in 1931, in large part because it had shaped its plant to meet the needs of General Motors, the American company, following a similar policy to that it had applied to solve its principal agent issues with Fisher Body in 1919, acquired the Australian business.

As a result of the establishment of Ford in Geelong and the acquisition of HMBB by General Motors, all several years before Australia was ready to commence full automotive mass production, future control of the commanding heights of the industry was ceded to the two major American firms.

It was at this point that the Commonwealth government should have intervened to secure a dominant position for a local firm, as all of the other national governments who took their industrial structure seriously had done. There was an attempt by the pre-war Menzies government to do something, opposed by the Country Party and the Tariff Board, an organisation that has maintained an animus of Balkan intensity against automotive manufacturing throughout all of its subsequent iterations. The Menzies plan disappeared with the outbreak of war in 1939. In 1944, the Curtin government revisited the issue, but chose General Motors to lead Australia into full scale automotive mass production instead; an easy and safe decision to make then, but a decision that confined the industry to stasis and under-performance for the duration of its existence. General Motors was not interested in making Holden into a world brand; it had plenty of those already. It was not interested in allowing exports either; cars could be produced more cheaply elsewhere.

Foreign investment and ownership is neither good nor bad; it depends on what it's for. An American company owning a chain of hamburger restaurants in Australia is a matter of no importance; a restaurant chain is not a strategically important industry. Australian firms are free to compete in the market and, because the barriers to entry are low, they do. An American owned motor industry is an entirely different thing. The historical presence of American automotive firms, in any nation trying to establish an industry of its own, always worked to suppress that opportunity; they were too big, too rich, too good at mass production and too determined to reduce all competitors to ruin to be given free rein.

For most of the twentieth century, Australia followed the entirely commendable policy of imposing protective tariffs and quotas on imports; the standard road to development that every late-starting nation choosing to industrialise needs to follow. The problem was that, having taken steps to foster the development of local industries, Australian governments allowed the very firms they needed to exclude, at least until a local industry had found its feet, to jump the tariff wall and set up operations on Australian territory.

To ask the question of how investments may be attracted to resume an industry in a new form is to presume that foreigners should be expected to invest in businesses that Australians are not willing to invest in for themselves. If the governing class thinks that attracting foreign investment is the best way to reconstitute an important Australian industry, then it will indicate that it has learned nothing at all from the past. If Australia is to have a successful automotive industry it needs to build it up for itself, with domestic savings for capital and with secure local ownership and skills. Government policy needs to make sure that happens.

**(e) How federal, state and territory governments could work together to support electric vehicle uptake and manufacturing, supply, and value chain activities.**

The loss of the domestic automotive manufacturing industry is probably the most serious failure of Australian industry policy of the last fifty years. It is worth speculating as to what alternative policy a national government more serious about retaining and expanding such an important industry might have pursued. Perhaps something along the lines of the following:

When General Motors finally stated its intention to cease local production, the Abbott government should have quickly moved to acquire the Holden business, with fair compensation, and negotiated an agreement for the continued use of the company's designs and component suppliers until substitutes could be developed or acquired from other sources. Peugeot made such an arrangement following its recent acquisition of Opel, General Motors' German business.

Funding should then have been provided for the re-acquired Australian firm to redevelop and extend its product range in order to enable it to rebuild its sales volume. Holden would have been freed from the technical and product development distortions, and business development limitations, imposed on it as a part of a global business operating under a strategy hostile to Australian interests.

The national government should then have taken steps to ensure that the new Australian firm, which it had underwritten, secured a nominated domestic market share of, say, 30% within ten years, by voluntary restraint agreements with importers in the first instance, backed up by the credible threat of import regulation in the case of non-cooperation.

Range extension, beyond the scope of the Australian firm to develop economically, could have been introduced via cooperation with a foreign partner interested in reciprocally acquiring cars of the type that the Australian firm could build. There are plenty of potential partners in Asia and Europe who would be amenable to this.

The Abbott government should have simultaneously enjoined Toyota to stay in Australia and moved to prevent other firms from establishing local assembly operations, as a way of circumventing import controls, until such time as the economies of scale needed by the incumbents were not put at risk by the establishment of new facilities.

A small automotive industry authority, outside of Canberra and the public service, should have been set up to monitor and report on the performance of the Australian industry, strictly on the relevant technical metrics; productivity, profitability, design and engineering competence, technological status and comparative quality performance.

The above are actions of the sort undertaken by national governments that take industrial policy seriously. The Abbott government failed to follow a course like this, either because it did not think the industry important enough or, by putting its faith in the opinions of the usual clique of economic ideologues that the governing class relies on, believed the automotive industry to be a lost cause.

The answer to the question of how governments can assist in getting Australia's new and existing manufacturing industries working properly is for the national government to get its industry policy act together, for that is where the main problems lie.

Despite promising beginnings at Federation, Australian governments have conspired to bungle one industrial opportunity after another; automotive manufacturing, aircraft production, machine tools and production equipment, agricultural and mining machinery, locomotive construction, naval

vessels and submarines. Businesses in all of these industries have been started and built up, their skills laboriously developed, their capabilities mastered, only to be squandered or tossed away because Australian governments failed to take charge of the issues that only a national government can act upon; what sort of industries are worthy of support, how many firms should operate in a sector where scale is important, how can trade unions, public bodies and firms be held to account on productivity and how should the nation react to the predations of Asian mercantilism.

In the middle 1950s nearly 30% of Australian GDP was derived from manufacturing. The nation was economically balanced, it employed everyone who needed to work, it paid its way in the world and was not overburdened by bloated government. Today, manufacturing is down to about 6% of GDP, a level commensurate only with that of a Caribbean tax haven or a no-hoper failed state in Africa. As a result, the nation has high unemployment, a fragile current account, a narrowly based economy at risk of external shocks, a debased technical capability and a government that confiscates twice as much as a share of GDP than it did in the 1960s. It's time to start doing things differently.

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July 2018