Assessing Singapore's Electric Vehicle Policies

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Introduction

Singapore begun exploring the option of adopting electric vehicles (EVs) in the late 2000s. In 2009, the Land Transport Authority (LTA) and the Energy Market Authority (EMA) launched the EV Phase I test-bed in order to assess the feasibility of a larger-scale roll-out of EVs in Singapore[1]. After the conclusion of the Phase I test-bed in 2013, the LTA and Economic Development Board (EDB) announced Phase II of the EV test-bed in 2014. Phase II is focused on fleet electrification and electric car-sharing, in contrast to Phase I which focused on individual corporate users[2]. Under Phase II of the test bed, Singapore is expected to involve the launch of over a 1,000 EVs and 2,000 charging stations by 2020[3].

More recently, Singapore has made a much bigger push towards the adoption of EVs. In February 2020, Singapore announced the ambitious target of phasing out internal combustion engine (ICE) vehicles entirely by 2040[4]. The Singapore government concurrently announced the introduction of a number of policies in order to achieve this target[5]. First, the existing Vehicular Emissions Scheme, which involves the use of tax rebates and surcharges as a function of a vehicle's emission levels, was extended to light commercial vehicles. (It previously covered cars and taxis). Second, the government introduced an EV Early Adoption Incentive, providing a rebate of up to 45% on the Additional Registration Fee for purchases of EV cars and taxis from 2021 to 2023 (capped at S$20,000). Third, the road tax for EVs and some hybrid vehicles was reduced. Finally, the government announced that it will substantially expand the EV charging infrastructure, from 1600 charging points to 28,000 charging points. To compensate for the shortfall in excise duties from fuel sales, the government will instead charge a lump sum tax for EVs starting at S$100 in 2021 and increasing to S$350 from 2023 onwards[6].

Singapore's electric car population equalled 1,125 in early 2020, or just 0.18 per cent of the total population of vehicles.[7] Thus the target of phasing out ICE vehicles by 2040 is highly ambitious and marks a significant departure from Singapore's earlier transportation policies. It is not yet clear whether "cleaner" categories of ICEVs, such as hybrids, will be phased out.[8] It is also unclear whether the target of phasing out ICE vehicles by 2040 constitutes a hard target that will be achieved if necessary through regulations, though the policies announced so far (such as the tax rebate or the reduction in road tax) suggest that the government is taking a largely market-based approach towards incentivizing EV adoption.

Environmental Externalities in the Transport Sector

From the perspective of economic efficiency, policy interventions that affect individuals' choices of whether to drive an EV or an ICEV are only justified if they correct an existing market failure. There are two key environmental externalities to consider. Firstly, pollutant emissions from ICEVs (e.g., emissions of particulate matter (PM), oxides of nitrogen and sulfur, carbon monoxide) are damaging to human health.[9] Secondly, CO_2 emissions from ICEVs contribute to global warming and thereby generate a negative externality: the "social cost of carbon" (SCC) is the marginal damage generated by an additional unit of CO_2 emissions. The size of these negative externalities is what determines the extent to which government intervention is justified.

Formulating an appropriate policy response to the negative externality caused by carbon emissions, in particular, poses considerable conceptual and practical challenges. Firstly, estimating the SCC is fraught with difficulties. The usual approach towards estimating the SCC is to rely on Integrated Assessment Models (IAMs) that "integrate a description of GHG emissions and their impact on temperature (a climate science model) with projections of abatement costs and a description of how changes in climate affect output, consumption, and other economic variables (an economic model)".[10] The results from these models are, however, sensitive to crucial assumptions regarding the value of equilibrium climate sensitivity (or the expected global warming due to a doubling of accumulated greenhouse gases in the atmosphere), the discount rate, and the damage function. A recent review concluded that these issues are severe enough to warrant IAMs "close to useless as tools for policy analysis," which in turn naturally implies a considerable degree of uncertainty of the SCC estimated through these models.[11]

A brief survey of recently published SCC estimates is indicative of this uncertainty. Nordhaus (2017) estimates an SCC of $37/ton in 2020 under baseline assumptions (measured in 2010 US dollars), with a range of $22/ton to $140/ton depending on the discount rate adopted.[12] Even holding the discount rate fixed, a recent analysis based on several of the leading IAMs suggests that the SCC in the year 2020 (measured

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See footnotes at end of text.

at constant 2005 US dollars) ranges from $2/ton to $55/ton, due to uncertainty over population growth, total factor productivity and equilibrium climate sensitivity.[13] The equilibrium climate sensitivity plays a key role in determining the SCC. A recent study suggests that using empirically grounded estimates of this parameter would reduce the SCC in 2020 from $12/ton to $7/ton in the DICE model (using a 5% discount factor) and from $2.5/ton to -$0.5/ton in the FUND model.[14] The uncertainty over SCC also reflects uncertainty over the extent to which accelerating plant growth caused by CO2 emissions can help modulate global warming.[15]

Secondly, the optimal Pigouvian tax to place on carbon emissions equals the SCC only when all parties adopt a uniform carbon tax. In a world where different national jurisdictions adopt different policies on regulating carbon emissions, a Pigouvian externality tax imposed unilaterally in one jurisdiction (such as Singapore) inevitably leads to carbon "leakage": the reduction in carbon emissions in the country imposing the tax is accompanied by an increase in carbon emissions elsewhere. This reduces the net social benefits from the Pigouvian tax and implies that a carbon tax calibrated to the global SCC will be too high.[16]. When carbon leakage occurs, the optimal tax levied by governments should be equal to the best estimate of SCC in the case where carbon leakages occur.

A third issue that arises is whether the global SCC is the most appropriate measure of the external cost of carbon for policies instituted by an individual country. The global SCC differs from the country-level SCC, or the portion of the global SCC that is borne by an individual country. The country-level SCC is naturally significantly lower than the global SCC, given that the benefits from CO2 mitigation are global. A recent study that calculated country-level SCCs under different emissions scenarios found, for example, that the country-level SCC for US was on average 11% of the global SCC.[17] From the perspective of maximizing global welfare, the global SCC is evidently the appropriate measure to use (after suitably adjusting for the issue of carbon leakage), but an individual country may well find it in its own interests to refer to the country-level SCC when formulating policies, especially in a situation where its own carbon mitigation efforts are not being reciprocated elsewhere.

Policymakers face a choice between whether to price in the SCC using a Pigouvian tax or use an alternative market-based instrument such as cap-and-trade. The key difference between the two instruments is that a tax fixes the price of carbon but allows emission levels to vary, while the cap imposes a limit on emissions and lets the price of tradable carbon allowances vary. To the extent that the ultimate objective is to set an optimal path of emission reduction to reach a target end-state of stabilized and reduced emission rate, the cap-and-trade solution is the correct one. It achieves an environmental goal, but the cost of reaching that goal is determined by market forces. In contrast, a tax provides certainty about costs of compliance, but the resulting reduction in carbon emissions cannot be predetermined.

Cost-effectiveness of EVs in Singapore

A study released in 2018 analyzed the cost-effectiveness of EVs in Singapore relative to ICEVs.[18] The key conclusion was that, under reasonable base case conditions, EVs are a highly costly transportation option relative to ICEVs, even after accounting for the health damages of fuel emissions from ICEVs. In particular, the upfront cost of EVs is more than 50% higher than the upfront cost of a comparable ICEV vehicle, and this more than compensates for the additional health damage costs from the particulate matter (PM) and SO_2 pollution emitted by ICEVs. Crucially, the operating or variable costs of operating EVs on a lifetime basis are comparable to those of ICEVs: because over 90% of Singapore's population live in high-rise apartments, widespread EV adoption will necessitate a heavy reliance on costly communal charging stations, which offsets some of the savings from not needing to run on gasoline. As a consequence, EVs are a highly costly means of achieving CO2 emissions reductions: the social cost of carbon (SCC) would need to be as high as S$9,700 per tonne of CO2 before EVs break even with ICEVs on the basis of social costs.

The analysis of the Phase I EV test-bed published by LTA and EMA in 2014 also came to similar conclusions.[19] EVs were found to be technically feasible in Singapore: the daily average driving distance for corporate EV users was equal to 46 km, considerably lower than the EV manufacturers' reported range of 120-160km per charge, and this meant that the bulk of charging took place at the participants' primary charging sites. However, the study noted that "EVs are currently not economically feasible for adoption, even after factoring in the health and environmental benefits to society", primarily due to the high upfront cost of EVs.

Subsidies vs. Taxes

Even if EVs are costlier than ICEVs, there is an economic case for market-based instruments that correct the negative externalities imposed by ICE vehicles. The aforementioned study calculated that the lifetime external cost (from the health damages caused by PM and SO2) of driving a typical ICEV equals about S$6,300.[20] However, it is important to note that subsidies are generally considered by economists as only a second-best policy tool for addressing negative environmental externalities in comparison to first-best policies such as carbon taxes and cap-and-trade. This is because the latter address the issue of environmental damages directly by putting a price on the externality and letting the market determine the cheapest and most efficient way of achieving the desired reduction in emissions: which, in the case of the transport sector, may involve greater EV penetration, increased fuel efficiency in ICE vehicles, or other technologies under development (such as hydrogen fuel cells). Targeted subsidies (such as subsidies for EVs), by contrast, provide incentives for just one means of emission reduction, so that there is no guarantee that the emissions reduction will be achieved at least cost, and in general the costs will be higher. For instance, a 2008 study found that carbon prices provide the most cost-effective means of achieving climate mitigation targets for the United States, and that the overall cost of achieving the same target using subsidies for renewables is almost 2.5 times greater.[21]

Despite the theoretical benefits from targeting negative externalities from ICEVs directly by raising the cost of driving ICEVs, Singapore has largely adopted the alternative approach of subsidizing EVs. It could be speculated that this is because the political costs of taxes are higher than the "hidden costs" of subsidies and command-and-control mandates.[22] While Singapore has recently introduced a carbon tax, this is targeted at large industrial emitters and is not currently applicable to emissions from the transportation sector. Singapore also charges a fuel excise tax that in 2015 was between S$0.56-0.64 per liter for octane (varying depending on the grade).[23] It is unclear whether Singapore's current fuel excise duties have appropriately priced in the negative externality from ICEV fuel emissions.

Any government subsidy support of specific technologies, such as EVs, runs counter to the principles of microeconomics. We have already expostulated the economic efficiency requirements in resolving externalities. Aside from the case for a Pigouvian tax to mitigate externalities and allowing markets to incentivize appropriate technologies, there is nothing in economic theory that suggests governments are adept at "picking winners". The question remains as to why governments should have technology-specific policies in the first place. Governments which set aside technology-agnosticism in their discretionary policy actions do so at the peril of wasting tax-payer funds.

Two other important considerations arise when evaluating subsidies for electric vehicles. Firstly, EV subsidies are likely to be quite regressive: given their high upfront cost, EVs are likely to be affordable only for high-income households, and thus on the margin the benefits from EV subsidies are likely to be enjoyed by these households. It would be egregious from an equity perspective if EV subsides are funded from general tax revenue, paid for by the average tax-payer, so that the rich could buy their "EV toys" at subsidized prices.[24] Secondly, from the perspective of energy security, it is not clear whether EVs provide a tangible benefit over ICEVs. While reducing the use of ICEVs will indeed reduce Singapore's dependence on oil imports, this in turn is replaced by a corresponding increase in imports of natural gas (needed to generate electricity). Moreover, the mass adoption of EVs potentially increases Singapore's dependence on rare earth minerals (such as cobalt and lithium) that are necessary for EV batteries. Globally, production of these minerals is highly concentrated; for example, 60% of cobalt production takes place in the Democratic Republic of Congo (DRC),[25] and China controls over 90% of global rare earths production.[26] This makes Singapore susceptible to supply disruptions in these countries: for instance, China has threatened in the past to reduce its exports of rare earth minerals during its trade war with the US.[27]

Concluding Remarks

As a high per capita income signatory to the Paris Agreement, the Singapore government is under pressure in international forums to signal the country's commitments to reducing greenhouse gas emissions. EVs offer a means of reducing emissions from the transport sector. And doubtless, along with many other governments, EVs will be seen by Singapore's policy makers as a "high technology" sector that offers potential spinoffs that may benefit national industrial development. Nevertheless, in a world where government are seldom capable of picking winners, the first-best policy is to tax externalities across all sectors on a level playing field and allow markets to incentivize innovation. Furthermore, when there are great uncertainties as to the measurement of theorized social costs such as global warming and the level of credible international participation in global agreements, policy circumspection is called for. Primum non nocere or "first, do no harm", commonly attributed to the Hippocratic Oath, may well be the best policy advice for those who advocate EVs.

Footnotes

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