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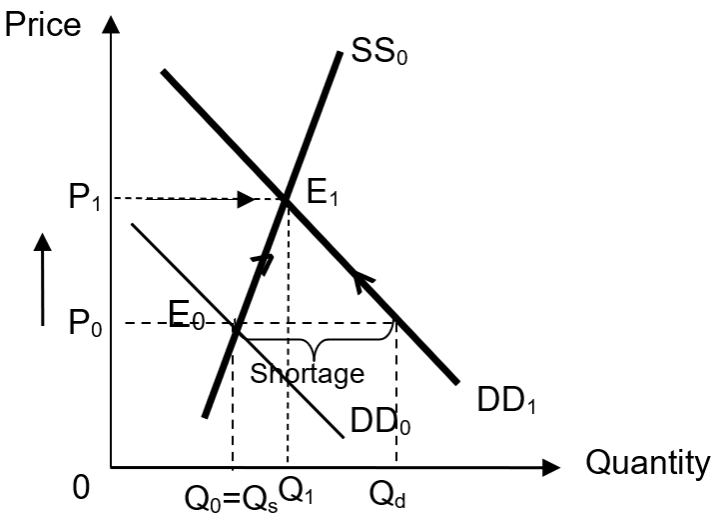
2025 EJC Prelim Exam H2 Econs P1 CSQ1

Question 1: Artificial intelligence (AI) and data centers

SAMS (Suggested Answer & Mark Scheme)

(a)	Describe the trend in the actual total electricity consumption in the US from 2018 to 2023 **and** in the projected consumption from 2024 to 2030. [2]	
	1m for general trend for actual total electricity consumption from 2018 to 2023 From 2018 to 2023, the actual total electricity consumption in the US has **generally fallen**. **1m for general trend for projected consumption from 2024 to 2030** From 2024 to 2030, projected consumption has **generally risen** or risen at a fast rate.	
(b)	With reference to Extract 1:	
	(i)	Explain the likely value of the price elasticity of supply (PES) of electricity in the US market. [2]
		1m for stating and explaining the likely value and explaining The PES of electricity in the US is likely to be **<1**. This means that as price rises, electricity producers can only increase quantity supplied by less than proportionately. Hence PES value is likely to be <1. **1m for explaining the likely value** This is because from Extract 1, it states that 'there is limited grid capacity and long lead time to build new infrastructures. This means that power plants have **limited spare capacity** as electricity generation depends on fixed infrastructure like power plants and grid capacity, which cannot be quickly expanded to meet sudden increases in demand
	(ii)	Using the PES concept **and** a diagram, explain why increasing electricity prices have intensified in the US market. [4]
		1m for a well-labelled diagram Diagram (bii): Intensified rising electricity prices in the market



1m for explaining rise in demand

A key factor contributing to the increase in electricity prices in the U.S. is a **surge in demand**, especially from AI-powered data centers, which has shifted the demand curve for electricity rightward. This is because electricity is a factor input for the data centers, so when there is a rise in demand for services by the data centers due to AI, there is a **rise in derived demand for electricity**.

1m for explaining price inelastic supply

This rightward shift in the demand curve, when met with a price-inelastic supply of electricity in the short run (PES<1), it leads to a sharp rise in equilibrium price relative to the less than proportionate increase in quantity supplied. This is because producers are unable to significantly increase the quantity of electricity supplied in response to rising prices, due to structural limitations such as 'limited grid capacity and long lead time to build new infrastructures' (Extract 1).

1m for explaining why increasing prices intensified in the graph

As shown in the below diagram, with a price inelastic supply curve, a rightward shift in the demand curve (from DD_0 to DD_1) leads to shortage. As producers can only increase Qs by less than proportionately, it becomes very challenging to clear the shortage, hence producers had to allow for a significant increase in price from P_0 to P_1, but only a less than proportionate increase in quantity from Q_0 to Q_1. This explains why electricity prices surged by 4.5% in 2023, even though the total increase in electricity quantity consumed was modest in comparison.

(c) Discuss the factors that the Singapore government has considered when deepening AI adoption 'to power Singapore's future' through initiatives such as NAIS 2.0. [8]

Question Analysis

Approach	

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Command	Discuss – two-sided explanation with a well-reasoned evaluation -6m Explain R1 + R2 -2m Evaluation
Context	Singapore government deepening AI adoption to power Singapore's future = economic transformation and growth (Extract 3)
Start Point	Factors for decision making
End Point	Main 1) Objectives and Benefits 2) Costs, constraints and unintended negative consequences

Content

	Requirement 1	**Requirement 2**
Explain	Some factors that the Singapore government has considered is the objectives and benefits of deepening AI adoption. <u>Objectives</u> For Singapore future economic growth → link to BUGPEES → maximize social welfare <u>Benefits</u> (a) Potential EG: AI → Technology → LRAS → PEG (b) Actual EG: AI industries → Attract FDI over time → Rise in AD → AEG (c) Sustained EG = PEG + AEG	Other factors that the Singapore government has considered is the costs and unintended consequences. <u>Costs</u> (a) Direct cost e.g. more than $500 mil invested by the govt (b) Constraints e.g. government fiscal budget and resources (CELL) (c) Opp cost e.g. next best alternative govt spending on environment, since there is Singapore Green Plan 2030 + value forgone <u>Unintended Negative Consequences</u> (a) Environment and resource for future generations = Non-sustainable EG (b) Structural UNN + non-IEG → Lower quality of wf → fall in LRAS in future (c) Higher energy COP & GPL (price stability) → business confidence →

		fall in FDI → fall in LRAS in future
Evaluate	**IEV1** Evaluate the limitations of each decision-making factor in the given context(s)	**IEV2** Evaluate the limitations of each decision-making factor in the given context(s)
	SEV Make a stand and justify it on the relative importance of the factors that Singapore government has considered in deepening AI adoption in the given context(s) i.e. likely benefits outweigh costs	

Introduction

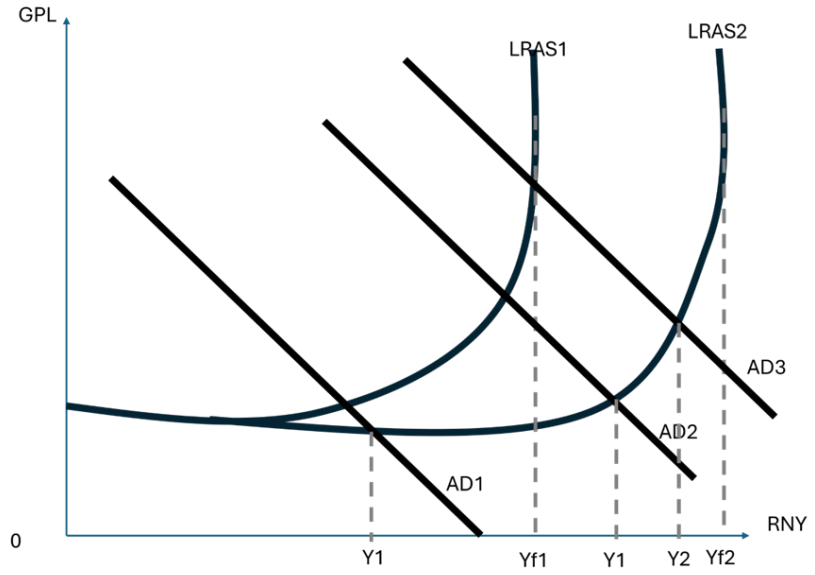
When the Singapore government has considered when deepening AI adoption 'to power Singapore's future' through initiatives such as NAIS 2.0, the government would have considered the **key rational decision-making factors such as its objectives, benefits, costs and unintended consequences**. Decision making is based on **the marginalist principle, where marginal benefits outweigh the marginal costs** for the government to proceed.

R1: Some factors that the Singapore government has considered is the objectives and benefits of deepening AI adoption.

As from the preamble, Singapore was one of the first countries in the world to introduce a national AI strategy to **power Singapore's future.** It represents the next phase of the **country's economic transformation and growth**. This means that the key benefit of deepening AI adoption was for **future economic growth**, which allows the government to fulfil its objective of maximizing social welfare.

Firstly, deepening AI adoption allows Singapore to achieve potential economic growth in the future. With "enhanced capabilities", AI technology could improve the efficiency and hence quality of Singapore's factors of production, such as labour and capital, for example, the automation of routine tasks so that our workers can focus on higher value work. This means there can be more output per input. This then expands the productive capacity of Singapore economy, which is reflected in a rightwards shift of LRAS from LRAS1 to LRAS2 in Diagram (c) below. When all resources are fully utilized, the Singapore economy can produce a higher level of maximum output from Yf1 to Yf2. This is potential economic growth.

Diagram (c): Singapore future growth (PEG and AEG)



There will also be **actual growth in the future.** As the Singapore government has invested "more than $500 million has been invested in research and development" in the AI industry, there is likely a continued rise in G in future. Moreover, firms will be incentivised with future profit prospects as the new AI industry continues to grow and lead transformations in other industries, as AI technologies could generate higher revenue and lower costs, resulting in higher potential profits. This means FDI will rise in the future. Moreover, with "new products and transformative interactions", Singapore can strengthen its comparative advantage in high-value added productions and export more competitively in terms of both price and quality. This means a rise in export revenue. As G, FDI and X revenue are components of AD, there will be a rise in AD from AD1 to AD2 to AD3 in the future, leading to multiplied rise in RNY from Y1 to Y2 to Y3, hence actual economic growth. This is because the rise in AD → unplanned fall in inventories → signal firms to produce more → firms hire more FOPs, including labour → rise in income → rise in induced consumption → leads to many subsequent rounds of rise in income and induced consumption → hence initial rise in AD leads to multiplied rise in RNY, hence actual economic growth.
With both potential and actual economic growth in the future, residents in Singapore can have a higher level of national income in future, higher spending power, consume more goods and services, hence higher material SOL and higher social welfare.

IEV1
Evaluate the limitations of benefits in Singapore context
However, one of the limitations of the benefit analysis is investment in new technologies such as AI **takes time**. As from Extract 3, the deepening of AI adoption in Singapore took "years of planning and investment". This means that the benefits will not be seen in the short-term, but in the long-term. This is because the Singapore government may face imperfect information, especially with new technologies, where R&D may require many rounds of trial and error before it is effective and efficient. Hence the increase in LRAS and potential EG, as well as

		the increase in AD and actual EG may be limited in the short-term, and more significantly in the long-term. **R2: Other factors that the Singapore government has considered is the costs, constraints and unintended consequences.** For a start, Singapore government needs to consider factors such as **direct costs, constraints and opportunity costs.** The **direct costs** refer to the "more than $500 million has been invested in research and development". This could include payments made to various FOPs, such as skilled labour in terms of researchers and AI data and prompt engineers, as well as machinery and equipment for AI and data centers. And when the government spends, it needs to consider **its fiscal budget constraints.** There is a limited fiscal budget and unlimited areas that require spending as the government needs to balance its revenue with its expenditure to ensure fiscal sustainability to meet current and future needs. For Singapore, we have limited revenue because we need to ensure our tax rates are competitive globally and avoid the need to raise taxes unless necessary. We have unlimited areas that require spending as we face new challenges such as ageing population and higher healthcare spending. This means that when we choose to invest in AI technologies, we will incur **an opportunity cost**, which is the value forgone from spending on the next best alternative. Given the urgency of our ageing population and rising healthcare costs, the next best alternative is to spend on building more healthcare facilities and the value forgone is better health, higher life expectancy, hence higher non-material SOL and higher social welfare. Another factor to consider are the unintended negative consequences. Based on the preamble, with the rise of AI technologies, there are issues with rising electricity and energy cost, rising structural unemployment and rising environment pollution with the use of fossil-fueled data centers. For instance, with the environment pollution, Singapore may suffer from **unsustainable economic growth** in the future. With the "rising carbon emissions and environment degradation", the quantity of natural resources is reduced for future generations, for example, we lose fertile land for agriculture. With less resources, the productive capacity of our economy shrinks. This is reflected in a leftwards shift in Diagram (c) above, where LRAS falls from LRAS2 to LRAS1. When all resources are fully utilized, the Singapore economy can produce only a lower level of maiximum output from Yf2 to Yf1. This is negative potential economic growth. **This is unsustainable economic growth, as the environment degradation causes future generations have less resources and less potential output.** So they may have to consume less goods and services and see a worsening of material SOL. Moreover, as the environment is polluted, there will be more health issues, lower life expectancy, hence lower non-material SOL. With a lower material and non-material SOL, there is a loss of social welfare. **IEV2** **Evaluate the limitations of costs in Singapore context** **However, some of these costs can be reduced by the Singapore government.** As from Extract 3, the Singapore government has the Singapore Green Plan 2030 to reduce carbon emissions and pollution through carbon taxes. Such carbon taxes force producers and consumers to internalize the external costs, reduce production and consumption that generate carbon emission, and switch to cleaner energy.

		This reduces carbon emission, improve the quality of the environment, leading to better health, higher life expectancy and higher non-material SOL. **<u>Summative EV</u>** Overall, as Singapore has invested heavily in AI technologies, it is **likely that benefits has outweighed costs and negative consequences** in the Singapore context. This is because of the **nature of Singapore economy**. As we are a **developed country that is highly reliant on exports and FDI for our economic growth**, we need to invest in AI to strengthen our comparative advantage in high value-added exports such as advanced machinery and financial services to boost our exports and FDI. We are also less concerned with the high costs due to **Singapore strong fiscal budget surplus from prudent spending and substantial fiscal reserves built over the years**. Similarly, we are in a good position to tackle environment issues and ensuring sustainable economic growth as **we have in place multi-pronged policies for Singapore Green Plan 2030**. Besides carbon taxes, we also have many years of planning and investments in renewable energy such as solar power to reduce our reliance on fossil fuels and reduce carbon emissions. **Mark Scheme**

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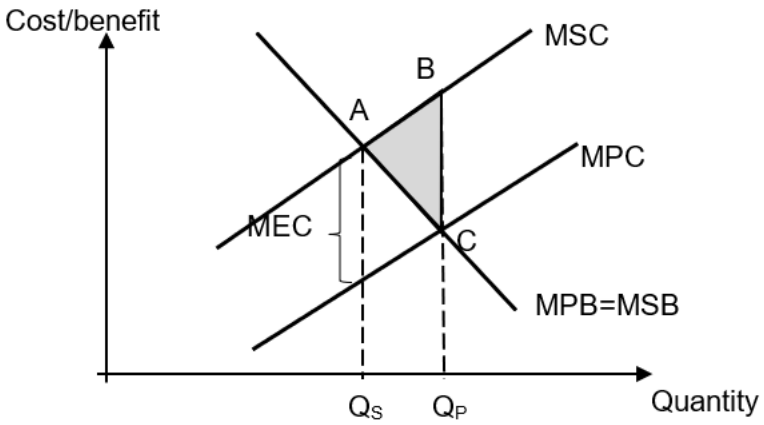
		Levels / **Knowledge, Understanding, Application, Analysis** / **Marks** **L2** / For an answer that shows a well-developed explanation of the key decision-making factors that Singapore government has considered for the deepening of AI, namely objectives and benefits, as well as costs, constraints and negative consequences • Relevant, thorough and balanced response that makes reference to extract material • Strong ability to apply theory to the questions and the context, and the analysis is clear with illustrations (e.g. graphs) / 4-6 **L1** / For an answer that shows an under-developed explanation • Some ability to apply theory to the question and the context, but the analysis lacks clarity, depth and/or scope • Shows some knowledge but has not properly grasp the requirements of the question • Mostly irrelevant and contains a few valid points made incidentally in an irrelevant context • Have basic errors of theory / 1-3 **Levels** / **Evaluation** / **Marks** **E2** / For an answer that builds on appropriate analysis and evaluate the assumptions and relevance, and synthesizes economic arguments to arrive at well-reasoned judgements on the relative importance of the factors that Singapore government has considered in deepening AI adoption in the given context(s) i.e. likely benefits outweigh costs / 2 **E1** / For an answer that gives a superficial evaluative statement without supporting analysis and elaboration / 1
(f)	**(i)**	Explain why the operations of fossil fuel-powered data centers are not socially optimal. [4]
		No separate mark for diagram. If drawn, it will be part of the analysis. Diagram (fi): Production by fossil fuel-powered data centers



1m for explaining negative externalities with definition and example

The operation of data centers powered by electricity generated from fossil fuels leads to market failure due to **negative externalities in production**. For example, these data centers, especially those supporting energy-intensive AI applications, drive a significant rise in electricity generation using fossil fuel. In Extract 3, U.S. data centers consumed 147 TWh of electricity—56% of which was derived from fossil fuels (40% from natural gas and 16% from coal), releasing CO_2 emissions equivalent to Brazil's annual output (435 million metric tons).

These fossil fuel emissions **impose external costs on third parties** by contributing to climate change**,** air pollution**,** heatwaves, and rising sea levels. These effects harm third parties not involved in the data center operations, such as nearby communities in terms of healthcare costs or repair costs from damages caused by climate change.

1m for explaining divergence of MSC>MPC due to MEC

In a free market, the operators of data centers only consider the marginal private cost (MPC) of their operations, i.e., the price they pay to utilities, not the marginal external cost (MEC) borne by society. This causes the marginal social cost (MSC = MPC + MEC) to be higher than the MPC**,** as shown in the diagram.

1m for explaining over-production by fossil fuel data centers

As a result, the market equilibrium output (Qp)**,** where MPB = MPC**,** is greater than the socially optimal output **(**Qs)**,** where MSB = MSC. This leads to over-production of fossil fuel-powered electricity and over-operation of such data centers**.**

1m for explaining deadweight loss and allocative inefficiency

For the units that are over-produced, Qs to Qp, the MSC>MSB. This means that for every extra unit, the additional cost to society is higher than additional benefit. The shaded triangle ABC thus represents the deadweight loss (DWL) to society,

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resulting in allocative inefficiency. Therefore, the operations of data centers dependent on fossil fuel-generated electricity exceed the socially optimal level.

(ii) Discuss the view that carbon taxes by Singapore is a better approach than the tax credits by the US to improve social welfare in the operations of fossil fuel-powered data centers. [10]

Question Analysis

Approach	
Command	Discuss – two-sided explanation with a well-reasoned evaluation -7m Explain R1 + R2 -3m Evaluation
Context	The market of fossil fuel-powered data centers
Start Point	Policies -Carbon taxes by Singapore -Carbon credits by the US
End Point	How each policy works to improve social welfare = Achieve Qs, no DWL, allocative efficient

Content

	Requirement 1	**Requirement 2**
Explain	Carbon taxes by Singapore can improve social welfare by getting producers to internalise the negative externalities, achieve Qs, remove DWL and achieve allocative efficiency.	Carbon credits by US can achieve improve social welfare by incentivising producers to adopt cleaner ways of production, reduce MEC, achieve Qs, remove DWL and achieve allocative efficiency.
Evaluate	**IEV1** Evaluate the limitations of the policy in the given context(s)	**IEV2** Evaluate the limitations of the policy in the given context(s)
	SEV Make a stand and justify it on whether carbon taxes or carbon credits would be better to improve social welfare in the market of fossil fuel-powered data centers, given each policy has its limitations and in the given context(s).	

Introduction

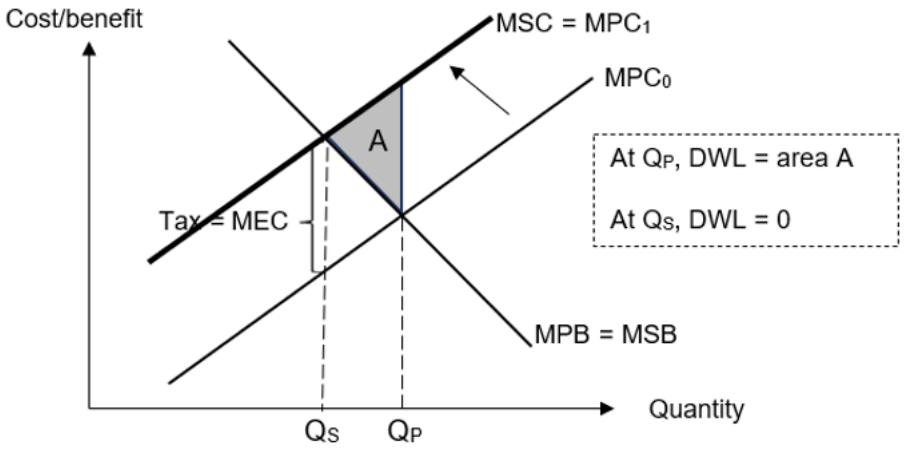
This essay discusses the relative effectiveness and limitations of Singapore's carbon tax and US carbon credits, and evaluate whether carbon taxes or carbon credits would be better to improve social welfare in the market of fossil fuel-powered data centers, given each policy has its limitations and in the given context(s).

R1: Carbon taxes by Singapore can improve social welfare by getting producers to internalise the negative externalities, achieve Qs, remove DWL and achieve allocative efficiency.

Carbon taxes directly target the source of negative externalities by **internalizing external costs**, thereby aligning private decision-making with social costs.

A carbon tax raises the Marginal Private Cost (MPC) of producers by an amount equivalent to the Marginal External Cost (MEC). As noted in Extract 3, Singapore's carbon tax, introduced in 2019 and one of Asia's first, targets large emitters, including over 70 data centers, many of which host AI operations. This tax internalizes the environmental cost of carbon emissions, This causes the MPC curve to shift upward toward the Marginal Social Cost (MSC) curve, reducing output from the market equilibrium quantity (Qp) to the socially optimal quantity (Qs), where MSC = Marginal Private Benefit (MPB). This eliminates the deadweight loss caused by overproduction.

Diagram (fii/1): Carbon taxes in fossil fuel-powered data centers to correct negative externalities



By making polluters bear the full social cost of their emissions, carbon taxation helps achieve allocative efficiency and improves societal welfare through the elimination of the deadweight loss in the operations of data centers.

IEV1

Limitations of carbon taxes in the Singapore context

Carbon taxation has practical limitations that may reduce its effectiveness in improving welfare.

The effectiveness of a carbon tax depends on accurate valuation of the external cost, which is difficult to estimate. If the tax is set too low, it fails to close the gap between MPC and MSC; if too high, it may create disruptions on businesses and households (Extract 3). Especially for Singapore, the data centers are critical to its role as a global tech hub. Overly aggressive taxation could discourage tech investment or raise operational costs in a price-inelastic energy market, where firms cannot easily cut back on electricity use.

Moreover, compliance and monitoring costs may arise, and firms may pass on higher costs to consumers, reducing consumer surplus.

R2: Carbon credits by US can achieve improve social welfare by incentivising producers to adopt cleaner ways of production, reduce MEC, achieve Qs, remove DWL and achieve allocative efficiency.

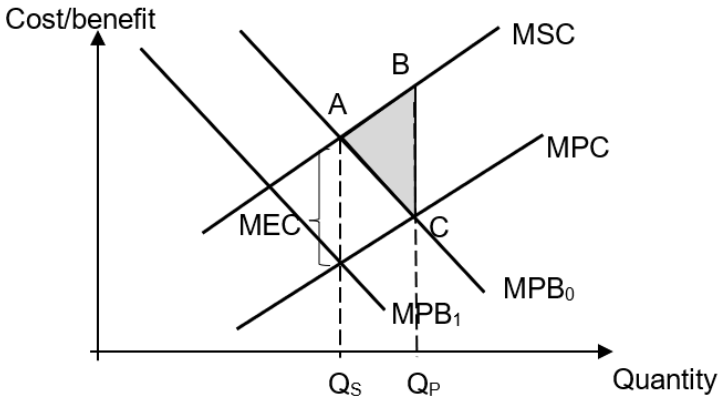
Tax credits aim to reduce negative externalities indirectly by lowering the relative attractiveness of fossil fuel-powered data centers and encouraging a shift toward renewable energy sources.

By subsidizing clean energy, tax credits make renewable electricity more cost-effective, incentivizing firms to switch away from fossil fuels. According to Extract 3, in the US, the Investment Tax Credits and Production Tax Credits cover up to 30% of the cost of solar and wind projects. This led tech giants like Google and Microsoft to invest over $15 billion in 2023 to power AI data centers sustainably, allowing AI development to expand without a proportional rise in carbon emissions. As renewable energy becomes more competitive, the perceived private benefit of continuing to operate fossil fuel-powered data centers decreases. This causes the marginal private benefit (MPB) curve for fossil fuel energy use to shift leftward from MPB_0 to MPB_1, reflecting firms' reduced willingness to rely on high-emission energy sources.

At the new equilibrium, production moves from the over-consumption level Q_0 to the socially optimal quantity Qs, where MSB = MSC. This eliminates the deadweight loss, ensuring that resources are allocated efficiently, and societal welfare is maximized.

Thus, by making clean energy more attractive and fossil fuel use relatively less beneficial, tax credits reduce the marginal private benefit of polluting activities, correcting the market failure and driving a transition toward sustainable energy use.

Diagram (fii/2): Carbon credits in fossil fuel-powered data centers to correct negative externalities



IEV2

Limitations of tax credits in US context

Tax credits to promote clean energy may not be effective because there is no guarantee that companies will fully replace fossil fuel operations with clean energy, especially in high-demand scenarios where renewable capacity cannot meet AI data centre loads immediately, given that they are not reliable 'when the wind is not blowing and when sun is not shining' (Extract 3).

Moreover, tax credits do not penalize polluters, allowing fossil fuel-based production to continue unchecked. This may result in a dual-track system, where both green and polluting technologies coexist. Furthermore, tax credits involve significant government expenditure and may be subject to political lobbying, misallocation, or "greenwashing," where firms receive subsidies without real emission reductions.

Summative Evaluation

Both policies aim to improve societal welfare, but carbon taxation is a more direct and theoretically efficient tool for correcting market failure.

Carbon taxes align private and social costs by internalizing externalities and directly reducing overconsumption of electricity from polluting sources. While implementation challenges exist, the carbon tax sends clear market signals and discourages pollution at its source.

In contrast, tax credits work indirectly by incentivizing cleaner production but do not raise the cost of pollution, meaning the externality may persist. Tax credits can promote innovation and long-term energy transformation, but on their own, they are less effective in achieving allocative efficiency in the short run.

Therefore, while tax credits are politically more acceptable and supportive of long-term green transition, carbon taxation is a more effective and welfare-maximizing approach, especially in correcting current market failure associated with fossil fuel-powered data centers. In the context of Singapore, where emissions per unit of GDP must be tightly managed, carbon taxation is a stronger and more targeted tool to ensure sustainable AI-driven growth.

Mark Scheme

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Levels	Knowledge, Understanding, Application, Analysis	Marks
L2	For an answer that shows a well-developed explanation of how both carbon taxes and carbon credits may help achieve allocative efficiency in the market of fossil fuel-powered data centers • Relevant, thorough and balanced response that makes reference to extract material • Strong ability to apply theory to the questions and the context, and the analysis is clear with illustrations (e.g. graphs)	4-6
L1	For an answer that shows an under-developed and/or one-sided explanation • Some ability to apply theory to the question and the context, but the analysis lacks clarity, depth and/or scope • Shows some knowledge but has not properly grasp the requirements of the question • Mostly irrelevant and contains a few valid points made incidentally in an irrelevant context • Have basic errors of theory	1-3
Levels	**Evaluation**	**Marks**
E3	For an answer that builds on appropriate analysis and evaluate the assumptions and relevance, and synthesizes economic arguments to arrive at well-reasoned judgements on whether carbon taxes or carbon credits would be better to improve social welfare in the market of fossil fuel-powered data centers, given each policy has its limitations and in the given context(s).	3
E2	For an answer that gives two superficial evaluative statement and/or at least one reasoned evaluation with some supporting analysis	2
E1	For an answer that gives a superficial evaluative statement without supporting analysis and elaboration	1

[Total: 30]

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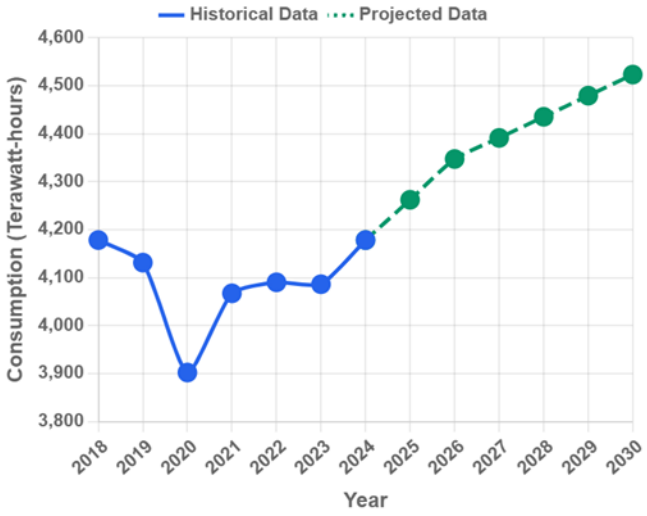
Question 1: Artificial intelligence (AI) and data centers

Figure 1: Total electricity consumption in the United States (US) from 2018 to 2030



Source: statista.com, accessed 1 July 2025

Extract 1: AI is pushing data center energy demands through the roof

The rapid rise of artificial intelligence (AI), catalyzed by OpenAI's ChatGPT launch in November 2022, has transformed the digital landscape, driving an unprecedented surge in electricity consumption by US data centers. The primary driver is the proliferation of AI workloads, particularly generative AI models, which rely on energy-intensive graphics processing units (GPUs) that consume up to 10 times more power than traditional servers.

The International Energy Agency (IEA) projects that US data center electricity demand could triple to 606 terawatt-hours (TWh) by 2030, equivalent to the annual power needs of 56 million households. This growth is fueled by the expansion of hyperscale data centers operated by tech giants like Google, Microsoft, and Amazon, which are investing heavily in AI infrastructure. As a result, electricity prices across the US rose by 4.5% in 2023. Supply constraints, such as limited grid capacity and long lead times for new power infrastructure, have also intensified electricity price increases. This increase in electricity prices does not only have cost implications for operators of data centers; it also impacts the households. Households across the country are now grappling with noticeably higher electricity bills. Some families are beginning to reduce their electricity usage, such as limiting the use of high-energy appliances by delaying laundry cycles or turning to LED lighting that is more energy efficient. Other families may need to adjust their overall consumption patterns, so that they can pay for the higher electricity bills yet keep to their budget.

Source: Adapted from Forbes, 31 May 2024

Extract 2: First time that AI has been blamed for layoffs

The advent of artificial intelligence (AI) has significantly disrupted the US labor market, with automation increasingly replacing human workers in various sectors. In May 2023, the US Labor Department reported that approximately 3,900 workers lost their jobs explicitly due to AI-driven automation, marking the first instance where AI was officially cited as a cause of unemployment in government data. This figure represents a small but growing share of the 236,00 recorded that month, underscoring the rapid integration of AI tools by major co . Microsoft, Meta, and IBM. These firms have adopted generative AI technologies, such as ChatGPT, to automate tasks in customer service, data entry, content creation, and even software development. The International Monetary Fund (IMF) notes that 60% of jobs in advanced economies, including the US, are exposed to AI, with entry-level roles most vulnerable due to their routine nature.

But analysts note that as with previous technologies that have replaced human workers, generative AI technologies are already creating new jobs, and the emerging industry is just getting started. According to a report by the US Chamber of Commerce, demand for AI-related roles, such as machine learning engineers, AI ethicists, prompt engineers, and data annotators, has surged, particularly in the technology, healthcare, and finance sectors. Companies are also providing AI courses for existing employees, allowing them to take on higher-value roles that require human judgment, creativity, and oversight of automated systems.

Source: Adapted from CBS News, 3 June 2023

Extract 3: Benefits and costs of AI

In 2019, Singapore was one of the first countries in the world to introduce a national AI strategy to power Singapore's future. It represents the next phase of the country's economic transformation and growth. More than $500 million has been invested in research and development through the national research programme AI Singapore since 2019. Now known as National AI Strategy 2.0 (NAIS 2.0), the new plan is needed to gear the nation to deepen AI adoption across many sectors while mitigating its risks. Since then, Singapore has witnessed significant breakthroughs in AI, resulting in the development of enhanced capabilities, new products and transformative interactions. The influx of AI tools in industry transformation, healthcare, education, security and other sectors is "not by chance" but comes on the back of years of planning and investment.

One of the risks is the rapid expansion of data centers. It poses a severe threat to global climate goals due to their heavy reliance on fossil fuels. In 2023, US data centers consumed approximately 147 terawatt-hours (TWh) of electricity. Of this, 56% were powered by fossil fuels, with 40% from natural gas and 16% from coal, according to the International Energy Agency (IEA). This fossil fuel dependency resulted in carbon dioxide emissions equivalent to Brazil's annual output, estimated at 435 million metric tons, contributing to significant environmental degradation given the increasing local air pollution and greenhouse gas emissions. This perpetuation of fossil fuel reliance exacerbates climate-related damage, such as rising sea levels and heatwaves.

The most ambitious legislative effort to combat environmental damage through clean energy initiatives by the US include the Investment Tax Credit (ITC) and Production Tax Credit (PTC), which offer a 30% cost deduction for eligible solar and wind projects for clean energy production. These tax credits have catalyzed significant private sector investment, with companies like Google and Microsoft committing over US$15 billion in 2023 to new solar and wind projects to power their AI-driven data centers. While this is a good start, these sources of energy are intermittent, and data centers will still require energy to continue processing when the wind is not blowing and the sun is not shining.

Similarly, Singapore's Green Plan 2030, launched in 2021, represents a comprehensive strategy to incentivise clean energy. A cornerstone of the Green Plan is the carbon tax. It targets large emitters, including Singapore's 70 over data centers, which are critical to the city-state's role as a global tech hub hosting AI operation for companies like Google and Amazon. To enable a smooth transition to a low-carbon future, Singapore plans to raise the carbon tax levels progressively to send the right price signal and minimize possible disruptions to businesses and individuals as they reduce their carbon footprints.

Sources: Adapted from The Straits Times, 4 Dec 2023
TIME, 3 March 2024
National Climate Change Secretariat, 12 April 2024

Questions

(a) Describe the trend in the actual total electricity consumption in the US from 2018 to 2023 **and** in the projected consumption from 2024 to 2030 in Figure 1. [2]

(b) With reference to Extract 1:

(i) Explain the likely value of the price elasticity of supply (PES) of electricity in the US market. [2]

(ii) Using the PES concept **and** a diagram, explain why increasing electricity prices have intensified in the US market. [4]

(c) Discuss the factors that the Singapore government has considered when deepening AI adoption 'to power Singapore's future' through initiatives such as NAIS 2.0. [8]

(d) **(i)** Explain why the operations of fossil fuel-powered data centers are not socially optimal. [4]

(ii) Discuss the view that carbon taxes by Singapore is a better approach than the tax credits by the US to improve social welfare in the operations of fossil fuel-powered data centers. [10]

[Total: 30]

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2025 EJC Prelim Exam H2 Econs Paper 1 CSQ2
Question 2: Government Spendings and Debts
SAMS (Suggested Answer & Mark Scheme)

(a)	With reference to Table 1, explain which country performed better from 2021 to 2023, in terms of real economic growth **and** fiscal debt.	**[4]**
	1m for identifying country **3m for making reference to Table 1 indicators to explain economic performance**	
	Malaysia performed better in terms of real economic growth and fiscal debt. Malaysia enjoyed faster rate of real economic growth compared to Singapore which is experiencing a slowdown. While both countries experienced an increase in fiscal debt as a proportion to GDP, Singapore had a greater fiscal debt compared to Malaysia.	
(c)	Explain why the statement in Extract 4 that 'The city-state has no net debt' is a positive one.	**[2]**
	1m for defining positive statement **1m for explaining why it is a positive statement**	
	Positive statement refers to a fact/an objective statement that is supported by evidence. The debt can be verified through the statements published by the government, hence supported by evidence, for example in Extract 4, it states that 'While Singapore's gross debt-to-GDP ratio may appear large on its own, it does not consider Singapore's sizeable asset position. Singapore's financial assets are well more than its debt.	
(d)	With reference to Extract 5:	
	(i) Explain the likely value for the price elasticity of demand (PED) for high-speed rail travel for an average consumer in Malaysia.	**[2]**
	1m for stating and explaining likely value for PED **1m for explaining PED factor**	
	Demand for high-speed rail travel for an average consumer in Malaysia is price elastic (i.e. PED>1) as a rise in price will lead to a more than proportionate fall in Qd. This is because a high-speed travel ticket (USD47) takes up a significant proportion (5%) of the monthly income (USD948) for an average Malaysian, hence	

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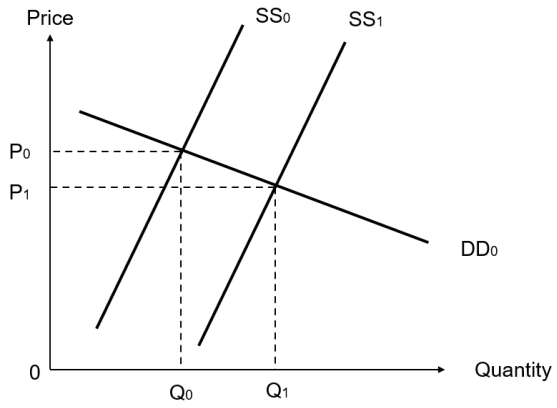
	when price rises, consumers will be more responsive as it affects their budgeting more.	
	(ii) Using the PED concept **and** a supply and demand diagram, explain the pricing strategy that you would recommend to the private rail companies in Malaysia.	**[4]**
	1m for a well-labelled diagram **1m for stating pricing strategy with reference to PED value** **2m for explaining impact of pricing strategy on Qd and TR**	
	Since PED >1, rail prices should be lowered. This is because when prices are lowered, quantity demanded will increase more than proportionally. Hence the total revenue gained from the increased in quantity exceeds the total revenue loss from the fall in price. Diagrammatically, area reflecting total revenue $0P_1E_1Q_1$ is greater than $0P_0E_0Q_0$. Diagram (dii): Application of PED to increase TR in rail travel market  	
(e)	Discuss the possible effects of the high-speed railway (HSR) on the living standards of Malaysians.	**[8]**

Question Analysis		
Framework		**Details**
Approach	**Command word**	Discuss: - 6m explain R1/2 - 2m EV
	Context	Malaysia's economy
	Start point	High-speed railway (HSR)
	End point	Malaysians' living standards ➔ Link to ADAS → BUGPEES → for S=SOL (material and non-material aspects)

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Content		**R1: HSR project will be able to boost the standard of living of Malaysians, (material and/or non-material).**	**R2: Living standards of Malaysians are made worse (material and/or non-material).**
	Explain	• HSR improves geographical mobility which allows worker to find better paying jobs in the city • HSR increases G/I and hence AD, increasing RNY and improving mSOL. • With less stressful travel experience and carbon emissions, nmSOL improves.	• Might warrant an increase in taxes in the long run which decreases disposable income of Malaysians, decreasing mSOL • Incurs opportunity cost as lesser funds can be channelled to other social causes or building of other infrastructure like hospitals, decreasing nmSOL.
	IEV	IEV1 Evaluate the limitations of the improvement of SOL in the Malaysian context	IEV2 Evaluate the limitations of the worsening of SOL in the Malaysian context
	SEV	Make a stand and justify it on whether overall, the HSR would increase or decrease Malaysians' SOL	

R1: HSR project will be able to boost the standard of living of Malaysians, (material and/or non-material).

- The project can boost the **material standard of living** by improving labour mobility and creating economic opportunities. HSR will allow better transport connection between KL and SG. By drastically reducing travel time between Kuala Lumpur and Singapore, the HSR overcomes **geographical immobility**. This allows Malaysian professionals and skilled workers to access the higher-paying job market in Singapore while still residing in Malaysia, leading to an increase in their wages and disposable income. This enhanced income allows them to increase their purchasing power and hence afford a greater quantity and quality of goods and services, **hence improving material SOL.**

- Furthermore, the construction and operation of the HSR itself constitutes **government expenditure and AD will increase.** Firms see unplanned fall in inventories and hence increase production. There will be rise in derived demand for labour and rise in factor income. The rise in AD then leads to a multiplied rise in RNY through the multiplier process so the initial rise in AD leads to many subsequent rounds of rise in income and rise in induced consumption, but each round gets smaller due to withdrawals. AD rises from AD0 to AD1 with a multiplied rise in RNY from Y0 to Y1. This also in turn generates thousands of jobs, further **boosting national income** and consumption of goods and services, **hence improving material SOL.**
- The HSR can also improve the **non-material standard of living**. The improved connectivity provides a viable alternative to air and road travel, which can help to reduce traffic congestion on the North-South Expressway and flight delays at airports. This leads to time savings for commuters, a **less stressful travel experience, and a reduction in carbon emissions**, all of which contribute to a higher quality of life. The increased interaction and tourism between the two countries can also foster greater social and cultural exchange, further enriching the non-material aspects of life.

IEV1

However, the improvement in SOL might be limited because of several factors. For instance, beyond building the HSR infrastructure, the systems and the processes need to be consistently maintained. **Given Malaysian's fiscal budget constraints,** they might not have funds to maintain the HSR systems and processes, leading to the return to congested traffic and long waiting time, and less effective in easing geographical immobility.

R2: Living standards of Malaysians are made worse (material and/or non-material).

- The HSR project may worsen fiscal position drastically, causing taxes to increase in the long run to finance the debt. HSR projects are notoriously expensive, and financing such a mega-project could require the Malaysian government to take on significant debt. To service this debt in the long run, the government may be forced to **increase taxes** or reduce other areas of public spending. An increase in income or consumption taxes would lower the disposable income of households, reducing their purchasing power and ability to afford goods and services and thus worsening their **material standard of living**.
- Furthermore, a severely compromised fiscal position creates a significant **opportunity cost**. If government funds are diverted to finance the HSR's debt, there will be fewer resources available for essential public

	services like **healthcare and education**. A reduction in spending in these areas could lead to lower quality healthcare and educational outcomes, which would directly diminish the **non-material standard of living** for the broader population, particularly for lower-income groups who rely heavily on public services. **IEV2** **However, the worsening in SOL can be managed and reduced because of several factors.** For instance, Malaysia could avoid the need to raise taxes if the government manages to attract private investments, with some government subsidies for land acquisition and maintenance (Extract 5). Such indirect subsides can reduce unit cost of production for firms, increase their potential profits and incentivize them to invest in the HSR. Then the Malaysian government can reduce govt. spending, avoid the need to raise taxes, and households have more disposable income to spend on G&S, maintaining/increasing their SOL. **Summative Evaluation** In conclusion, whether the standard of living for Malaysians improves with the HSR is dependent on the Malaysian government's ability to manage the project's massive costs without compromising its long-term fiscal health. The Malaysian government has to consider fiscal sustainability of the project and how to optimise their budget without necessitating future austerity or burdensome tax hikes. Ultimately, the HSR's success in improving the standard of living will be determined by whether its economic benefits can be realized without imposing an unsustainable financial burden on the nation and its citizens.	
	Mark Scheme	

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Levels	Knowledge, Understanding, Application, Analysis	Marks
L2	For an answer that shows a well-developed explanation of how the HSR project affects Malaysia residents' standard of living (SOL) • Relevant, thorough and balanced response that makes reference to extract material • Strong ability to apply theory to the questions and the context, and the analysis is clear with illustrations (e.g. graphs)	4-6
L1	For an answer that shows an under-developed explanation • Some ability to apply theory to the question and the context, but the analysis lacks clarity, depth and/or scope • Shows some knowledge but has not properly grasp the requirements of the question • Mostly irrelevant and contains a few valid points made incidentally in an irrelevant context • Have basic errors of theory	1-3
Levels	**Evaluation**	**Marks**
E2	For an answer that builds on appropriate analysis and evaluate the assumptions and relevance, and synthesizes economic arguments to arrive at well-reasoned judgements on whether the HSR project will improve the SOL of Malaysia residents	2
E1	For an answer that gives a superficial evaluative statement without supporting analysis and elaboration	1

(f) With reference to Table 2, discuss the extent of the effectiveness of infrastructure stimulus in Singapore given that it is open to trade and relies on debt-financing mechanism. **[10]**

Question Analysis			
Framework		**Details**	
Approach	**Command word**	Discuss the extent of: - 7m explain R1/2 - 3m EV	
	Context	Singapore's economy	
	Start point	Macroeconomic conditions/ characteristics of Singapore's economy	
	End point	Effectiveness of infrastructure stimulus	
Content		**R1: Openness to trade reduces the effectiveness of**	**R2: The debt-financing mechanism can enhance the**

	infrastructure stimulus	**effectiveness of the infrastructure stimulus**
Explain	Proportion of (X-M) compared to G means that external conditions affects SG's economy extensively, offsetting initial increase in G/I.	• Enhances confidence in SG's economy, increasing C/I, and LRAS with capital accumulation • Avoids tax-financing which potentially decreases C/I
IEV	Evaluate the extent to which the effectiveness of policy is diminished by openness to trade in the Singapore's context	Evaluate the extent to which the effectiveness of policy is enhanced by the debt financing mechanism in the Singapore context
SEV	Make a stand and justify it on whether infrastructure stimulus is overall more or less effective in Singapore	

Introduction

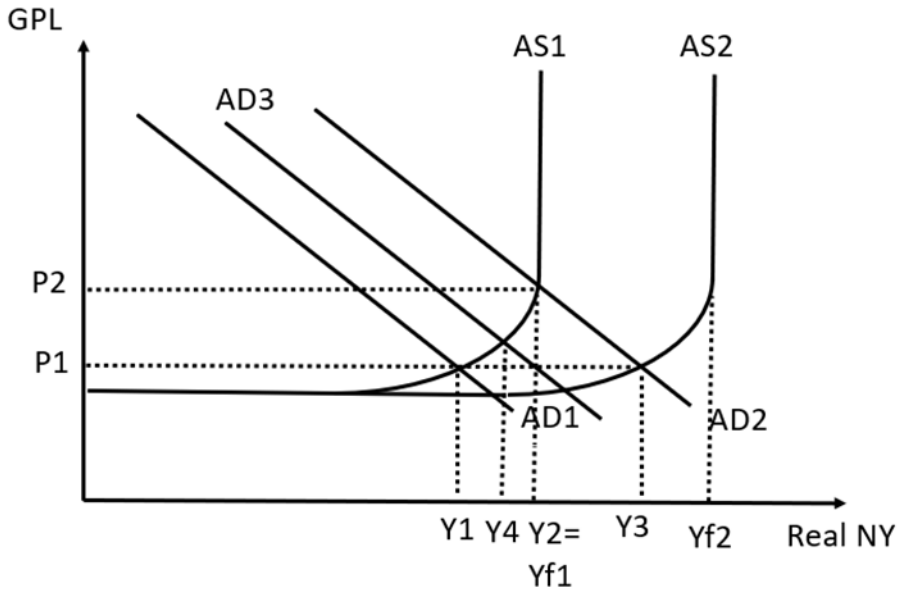
- An infrastructure stimulus, a form of expansionary fiscal policy, involves increasing government expenditure (G) on capital projects to boost Aggregate Demand (AD) and stimulate economic growth.
- While this can be a powerful tool, its effectiveness in Singapore is shaped by two key characteristics: its extreme openness to trade, which tends to limit its impact, and its prudent use of a debt-financing mechanism, which, if managed correctly, can enhance its effectiveness.
- Overall, while Singapore's openness presents significant challenges, its strategic approach to financing allows infrastructure stimulus to be a highly effective tool for long-term growth, though its role in the short-term remains limited.

R1: Openness to trade reduces the effectiveness of infrastructure stimulus

- An economy that is open to trade relies on trade for growth. And so, net export revenue tends to take on a bigger proportion of the GDP/AD. An example would be Singapore, with its economy being small and open.
- **Should external economies, especially across several large trading partners face a recession, Singapore will be affected negatively suggesting that external factors like contagion effect of high unemployment in trade partners economies will adversely affect domestic economy through falls in (X-M).**

- **Even if the government increases spending on infrastructure, the uncertainty in (X-M) may affect the eventual outcome on AD and therefore RNY. This is exacerbated by the fact trade (exports and imports, ie. Volume of trade) takes up a significant proportion (300%) of Singapore's GDP.**
- The fall in (X-M) leads to a fall in AD. This is because there is an unplanned rise in inventory and firms will hence decrease production levels. Firms will employ less factor inputs and hence will pay households less factor income. When households' income falls, they will decrease consumption expenditure. This leads to a fall in induced consumption expenditure and hence further fall in AD. Firms will employ even less factor inputs from households to further decrease production and hence will pay households even less factor income. This process will then continue, with each round of increase becoming smaller; until the rise in income is too small to generate any further consumption. Through this reverse multiplier process, the initial decrease in (X-M) would lead to an eventual multiplied decrease in national income. Graphically, this increase in investment expenditure leads to a multiplied fall in national income from Y1 to Y2 and negative actual growth.
- **In such instance, the infrastructure stimulus may only cushion the fall in AD and lead to a smaller fall in RNY instead of raising RNY to desired level, hence limiting the effectiveness of the policy.**

Diagram (f): Reduce effectiveness of infrastructure stimulus



IEV1

- However, while Singapore's openness makes it vulnerable to the initial shock of falling exports, this same characteristic, specifically the high

marginal propensity to import (MPM) also limits the severity of the fall in RNY.

- As a small nation with few natural resources, Singapore imports a vast proportion of its raw materials and capital equipment. This high MPM results in a small multiplier (k), where k = 1/MPW. Because the import leakage is so large, the (reverse) multiplier effect is dampened.
- When an external shock causes a fall in export revenue and a corresponding fall in national income, a large portion of the subsequent reduction in spending is on imports, not on domestically produced goods and services. This means the negative impact on domestic firms and employment in each round of the reverse multiplier is smaller.
- Essentially, the high import leakage acts as stabilizing condition and reduces the effectiveness of infrastructure stimulus to a smaller extent.

R2: The debt-financing mechanism can enhance the effectiveness of the infrastructure stimulus.

- Contrary to the conventional view that debt-financing leads to crowding-out, Singapore's specific debt-financing mechanism, when used for long-term infrastructure, can enhance the effectiveness of the stimulus by allowing the government to pursue expensive infrastructural projects and ensuring inter-generational equity.
- By borrowing for major, long-term infrastructure projects, they are paid for over their lifespan by the generations who will benefit from them.
- This avoids tax hikes and crowding out of current spending. By borrowing for these specific projects, the government avoids having to fund them through immediate, sharp increases in taxes or by cutting spending on other essential services like healthcare and education. This prevents a contractionary fiscal effect that would otherwise offset the stimulus. It allows the full intended increase in 'G' to be injected into the economy without simultaneously reducing consumption (C) or other vital public services.
- This also maintains investor confidence and prevents capital flight: Singapore's borrowing is backed by its strong credit rating and substantial reserves. This approach to debt ensures that the borrowing does not create fears of fiscal unsustainability. It helps maintain both domestic and foreign investor confidence, preventing the capital flight or the rise in interest rates that might occur in countries with less credible fiscal frameworks. This stable environment ensures that private investment (I) is not "crowded out" and can even be "crowded in" as businesses invest to take advantage of the new infrastructure.
- Hence infrastructure spending will be able to achieve the desired level of increase in RNY via both actual and potential growth.

In this way, the debt-financing mechanism, by ensuring fiscal stability and predictability, creates a supportive macroeconomic environment that enhances

	the overall effectiveness of the infrastructure spending. The government can increase G without increasing taxes hence there is no contractionary effect. **IEV2** • The perspective that Singapore's debt-financing mechanism enhances effectiveness must be placed in the unique context of its net asset position. Unlike nearly every other country, Singapore has no net debt, as mentioned in Extract 4. The sustainability of the no net debt status hinges on the assumption that Singapore's assets continuously generate returns and hence will be unlike other economies which are plagued by the common problems of debt financing when they incur a positive net debt. • Should a prolonged global downturn severely diminish the returns on these assets, and thereby result in a positive net debt, this would force the government to confront the same trade-offs as other nations, potentially limiting its capacity to fund future stimulus and thereby reducing the long-term effectiveness of this policy of infrastructure stimulus. **Summative Evaluation** In the short run, infrastructure stimulus in Singapore as a demand management tool is limited by the high import leakage characteristic of its open economy. However, in the long run, its overall effectiveness is enhanced by its strategic debt-financing mechanism, which avoids the typical pitfalls of fiscal crowding-out and maintains macroeconomic stability, unless affected by investor confidence due to imperfect information as per Extract 4 (i.e.. the media painting a picture of Singapore's significant indebtedness). Ultimately, infrastructure stimulus is most effective not only as a short-term stimulus in terms of actual growth but as a long-term investment in the nation's productive capacity. While the small multiplier will always moderate its immediate impact on AD, the prudent financing framework and the powerful supply-side benefits ensure that infrastructure spending remains a highly effective and indispensable tool for securing Singapore's sustained growth.	
	Mark Scheme	

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Levels	Knowledge, Understanding, Application, Analysis	Marks
L2	For an answer that shows a well-developed explanation of how the two factors of how Singapore is open to trade and relies on debt-financing mechanism affects the effectiveness of infrastructure stimulus • Relevant, thorough and balanced response that makes reference to extract material • Strong ability to apply theory to the questions and the context, and the analysis is clear with illustrations (e.g. graphs)	4-6
L1	For an answer that shows an under-developed and/or one-sided explanation • Some ability to apply theory to the question and the context, but the analysis lacks clarity, depth and/or scope • Shows some knowledge but has not properly grasp the requirements of the question • Mostly irrelevant and contains a few valid points made incidentally in an irrelevant context • Have basic errors of theory	1-3
Levels	**Evaluation**	**Marks**
E3	For an answer that builds on appropriate analysis and evaluate the assumptions and relevance, and synthesizes economic arguments to arrive at well-reasoned judgements on the extent to which the two factors of how Singapore is open to trade and relies on debt-financing mechanism affects the effectiveness of infrastructure stimulus	3
E2	For an answer that gives two superficial evaluative statement and/or at least one reasoned evaluation with some supporting analysis	2
E1	For an answer that gives one superficial evaluative statement without supporting analysis and elaboration	1-2