

Does Green Investment Tax Exemption Drive Malaysia towards Green Economy?

(Adakah Pengecualian Cukai Pelaburan Hijau memacu Malaysia ke arah Ekonomi Hijau?)

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ABSTRACT

This study explores whether Green Investment Tax Exemption (GITE) policy may effectively guide Malaysia towards a green economy by balancing carbon emission reductions with economic growth. Despite growing empirical studies on tax incentives, integrating GITE with macroeconomic dynamics remains limited in Malaysia. This paper addresses this gap by developing New Keynesian Dynamic Stochastic General Equilibrium (NK-DSGE) model tailored to Malaysia's green economy scenario under the GITE policy through incorporating households, low-carbon firms, banking green sector, government, and central bank. The model simulates the macroeconomic and environmental impact of GITE. Simulation results demonstrate that GITE enhances green investment, reduces loan demand, increases capital accumulation, employment, and GDP, while reducing carbon emissions in the long-term. However, the rise in wages leads to a temporary decline in consumption driven by intertemporal substitution. Policy implications suggest that while GITE is effective in promoting the transition to low-carbon economy, it incurs fiscal costs and limits government revenue and spending capacity. Policymakers are thus encouraged to implement complementary policies to support GITE in order to reduce the reliance on tax incentives and foster public-private partnership. Such integrated policy approach ensures Malaysia stays on track towards achieving its Net-Zero 2050 commitment and long-term sustainability objectives.

Keywords: New keynesian DSGE model; green tax exemption rate; low carbon economy; fiscal incentive

ABSTRAK

Kajian ini meneroka adakah Dasar Pengecualian Cukai Pelaburan Hijau (GITE) memacu Malaysia ke arah ekonomi hijau dengan keseimbangan pengurangan pelepasan karbon dan pertumbuhan ekonomi. Walaupun peningkatan dalam kajian terhadap insentif cukai, kajian dari sudut integrasi GITE terhadap dinamik makroekonomi masih terhad di Malaysia. Kajian ini membangunkan model Keseimbangan Umum Stokastik Dinamik Keynesian (NK-DSGE) disesuaikan dengan senario ekonomi hijau Malaysia, di bawah dasar GITE iaitu melibatkan isi rumah, firma karbon rendah, sektor perbankan, kerajaan, dan bank pusat. Model ini mensimulasikan kesan GITE terhadap pembolehubah makroekonomi dan pelepasan karbon. Hasil simulasi menunjukkan GITE berpotensi meningkatkan pelaburan tenaga boleh baharu (TBB), tingkat modal, dan menyediakan peluang pekerjaan baharu. Disamping mengurangkan pelepasan karbon, dan meningkatkan pertumbuhan ekonomi dalam jangka panjang. Walau bagaimanapun, keadaan ini memberi kesan kepada penurunan sementara dalam penggunaan agregat atas faktor intertemporal. Implikasi dasar mencadangkan walaupun GITE berkesan menggerakkan ekonomi ke arah rendah karbon, namun terdapat kesan fiskal yang menghadkan pendapatan dan perbelanjaan kerajaan. Penggubal dasar adalah perlu mempunyai dasar bersepadu bagi menyokong GITE dan mengurangkan pergantungan insentif cukai dan menggalakkan model

perkongsian awam-swasta supaya sasaran komitmen Malaysia dalam mencapai ekonomi rendah karbon seiring matlamat pembangunan mampan tercapai menjelang 2050.

Kata kunci: Model DSGE Keynesian baharu; kadar pengecualian cukai hijau; ekonomi rendah karbon; insentif fiskal

INTRODUCTION

The increase in greenhouse gases (GHGs) in the atmosphere, particularly carbon dioxide (CO₂), has become a significant concern in the 21st century due to its impact on climate change caused by human activities, which include the burning of fossil fuels and deforestation (Ferrante & Fearnside 2019). Climate change has emerged as the most critical global challenge, which requires worldwide efforts to reduce carbon intensity and mitigate environmental consequences aligned with global green economy aspirations. According to the United Nations (2017), green economy is defined as an economy that is low in carbon, resource-efficient, and socially inclusive. It aims to reduce environmental risks and ecological scarcities while achieving sustainable development without degrading the environment. In ASEAN, the Global Renewables and Energy Efficiency Pledges endorsed by five ASEAN Member States including Malaysia, aimed to triple renewable energy capacity and double the rate of energy efficiency improvements by 2030 compared to 2020 levels.

In Malaysia, addressing climate change, followed by global warming, and regional target is crucial. Government initiatives are crucial to ensure that these challenges do not negatively impact the human environment. According to the Twelfth Malaysia Plan (RMKE-12), Malaysia has targeted to enhance economic development by focusing on green technology investment. However, most firms remain marginally exposed to these technologies (World Bank Group 2022) due partly to high initial capital costs in investments (Backler et al. 2024), and long pay-back periods (Razak & Ali 2023). Nevertheless, the Malaysia government has introduced various initiatives to promote green technology investments, primarily via the Green Investment Tax Exemption (GITE). In Tier 1¹, the GITE for solar leasing projects with installed capacities between 10MW to 30MW are eligible for 70% tax exemption on statutory income for 10 years. In Tier 2, solar projects with capacities between 3MW and 10MW receive a 70% exemption for five years.

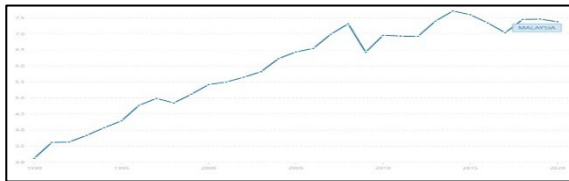


FIGURE 1. Malaysia carbon emissions (metric tons per capita)

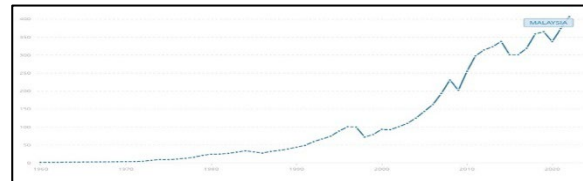


FIGURE 2. Malaysia GDP (Current US\$)

As part of the commitment to the Sustainable Development Goals (SDG), most countries, including Malaysia, have pledged to reduce carbon intensity per unit of Gross Domestic Product (GDP) by 45% by 2030 (Susskind et al. 2020). Malaysia, as a developing nation, faces challenges in balancing economic growth with environmental sustainability. Statistics show that economic growth, as represented by GDP, is positively related to carbon emissions as shown in Figures 1 and 2.

Figures 1 and 2 indicate the trends in carbon emissions and Malaysia's GDP from 1990 to 2022. Carbon emissions have steadily risen from 3.1 metric tons per capita in 1990 to 7.4 metric tons per capita in 2020. Simultaneously, the recorded GDP in 1970 is US\$ 1.92 billion and up to US\$407.03 billion in 2022. This proves that income growth is associated with rising GHG emission, as supported by previous studies (Raihan et al. 2022; Waheed et al. 2019; K. Wang et al. 2022).

In 2014, the Malaysia government has introduced the GITE to encourage firms to purchase green technology equipment or assets and qualify for income tax exemption (MIDA 2020) as benefit for adopting green practices. Despite the government promoting these incentives, empirical evidence on the macroeconomic and environmental impacts of this instrument remain unclear. Most existing studies globally focused on green policy tools such as carbon taxes (Ahmadi et al. 2022; Hu et al. 2023; Roach 2021), Net Energy Metering (NEM) (J. Ros Agustin & Sai Shetty Sai 2023; Sergici et al. 2019; Sobri et al. 2022), and emission trading (Chen & Hibiki 2022; Lin & Jia 2017; Takarada et al. 2022; Yu et al. 2022). In Malaysia, carbon and energy taxes (Yahoo & Othman 2017), and fossil fuel subsidies (Ginn 2024) have been empirically examined. However, knowledge gap exists due to the specific lack of research on environment and macroeconomics dynamic responses to GITE. This gap posits the question of whether GITE can potentially achieve balanced economic growth while reducing emissions? This paper aims to assess GITE effectiveness in Malaysia concerning economic growth and carbon emissions, through

adoption of a theoretical New Keynesian Dynamic Stochastic General Equilibrium (NK-DSGE) model. This study contributes to the growing literature on green fiscal policy within the DSGE modelling framework, focusing on the Malaysia scenario.

The remainder of this paper is organised as follows: Section 2 provides a brief review of the related literature. Section 3 describes and explains the structure and specification of the model. Section 4 analyzes the results of the simulations, and Section 5 concludes.

LITERATURE REVIEW

TAX INCENTIVES, ECONOMICS GROWTH AND CARBON EMISSIONS

Tax incentives have emerged as an effective tool to promote environmentally sustainable investments with substantial impact on both sectoral and firm levels (K. Chang et al. 2021). Nel & Du Plooy (2013) demonstrated that incentivizing tax burden of firms through tax reductions can effectively reduce carbon emissions. Tax-based incentives can shift consumer behavior towards more environmentally friendly products, and contribute to reducing the overall emissions (Lo et al. 2021). Several studies argue that tax incentives not only help reduce emissions, but also improve firms' financial performance (Picas et al. 2021), encourage renewable energy investment (Nwokoye et al. 2023), and promote public spending (Seydou 2021).

Recent study on tax incentives have focused on macroeconomic outcomes, proving that such policies increase energy usage efficiency, reduce fossil fuel consumption costs, and enable surplus capital to be directed towards labor wages, thereby raising productivity (Zhao et al. 2023). The increase in energy usage efficiency contributes to higher aggregate investment, particularly in renewable energy, while simultaneously promoting government spending and green economic growth Yuan et al. (2023), and reducing carbon emissions (Qiu et al. 2020). However, these findings contrast with micro-level studies. For instance, tax incentives designed to encourage business investment in research and development (R&D) aim to promote long-term firm growth (A. C. Chang 2018). Cansino et al. (2010) advocated the use of tax incentives linked to company taxable profits, which led to increased investment in electric vehicles and, consequently, renewable energy. However, such tax incentives often focus on domestic firms with greater capacity and capital. Shafi et al. (2023) highlighted that only domestic producers with greater capacity and capital are positioned to fully benefit from the system. This is confirmed by MIDA (2020), which states that incentives provided by the Malaysian government are limited to new or existing companies registered under the Companies Act 2016, domiciled in Malaysia, and verified by SEDA.

While existing literature provides valuable insights into tax incentives at both micro and macro levels, there are limited studies that have attempted to model these incentives within a dynamic general equilibrium framework. Most empirical studies rely on econometric methodology that do not account for consumer behavior, firm dynamics, fiscal constraints, or banking sector interactions. This create a gap in understanding how green tax incentives influence macroeconomic variables such as consumption, labor supply, capital, investment, government spending, renewable energy, bank reserves, and capital under uncertainty. From a methodological perspective, although existing DSGE models have explored environmental taxation (Angelopoulos et al. 2010; Chan 2019; Dissou & Karnizova 2016; Hu et al. 2023; Niu et al. 2018) they rarely incorporate tax incentives as policy instruments, especially in the Malaysian context. This study includes five economic agents; comprising households, intermediate green firms, final goods firms, banking sector, and the government, including the central banks, as Figure 3.

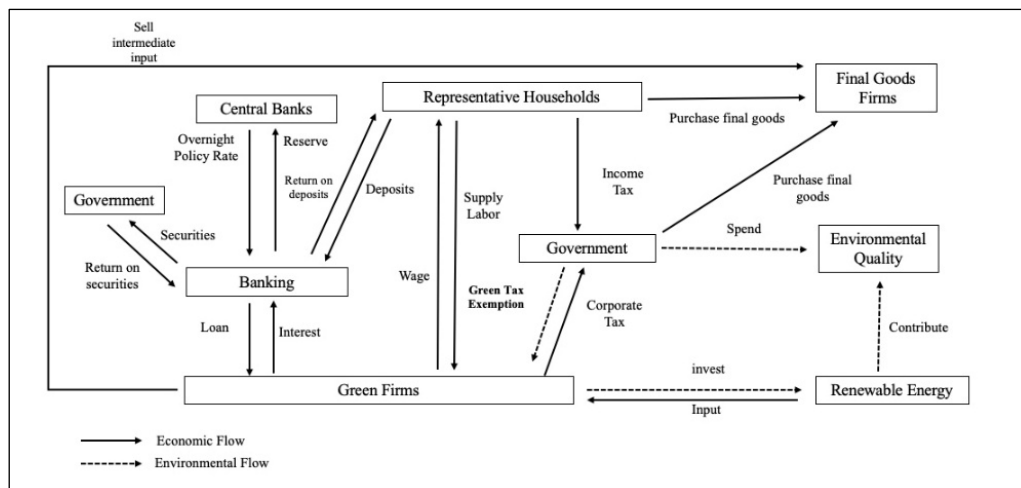


FIGURE 3. GITE - DSGE Malaysia model

The GITE - DSGE Model for Malaysia explains the link between economic agents and environmental quality. Generally, households provide labor services to firms in exchange for income, which is used to purchase final products from final goods firms. Households also pay for income tax subject to their income levels and deposits money into banking institutions, receiving returns in the future. Intermediate green firms produce inputs by using labor, capital and renewable energy to reduce carbon emissions. These firms earn revenue from selling inputs to final goods firms and incur expenses including labor cost, capital rental, interest payments, and corporate tax, subject to profits before tax.

The Malaysia government purchases final goods and collects tax revenue from households and firms. To initiate Net Zero Carbon goals, the federal government offers GITE to intermediate green firms that invest in renewable energy technologies. The banking sector provides loans facility to firms to fund their investment activities, allocates a portion of household deposits as a reserve with the the central bank, and purchases securities to meet capital requirements. The central bank sets the Overnight Policy Rate (OPR) which influences borrowing costs. The detailed expression of the equation for each economic agent is represented below.

THEORETICAL MODEL

TABLE 1. Name of Variables

Variables	Descriptions	Variables	Descriptions
C_t	Households Consumption	A_t	Productivity
N_t	Labor Supply	RE_t	Renewable energy technology
W_t	Wage rate	$Y_{i,t}$	Intermediate input
r_t^d	Interest on deposits	PRE_t	Price of Renewable Energy
D_t	Households Deposits	L_t	Loan demand
P_t	Price level	$r_{L,t}$	Interest on loan
P_t^w	Wholesale price	π_t	Firms profit
R_t	Rental rate of capital	I_t	Investment
Y_t	Final output	Rsv_t	Bank Reserve
Em_t	Environmental Quality (Emissions)	SC_t	Securities
K_t	Capital	BK_t	Bank Capital
ict_t	Income tax	$r_{S,t}$	Securities return
t_t	Government transfers	\bar{P}_t	Target inflation
G_t	Government spending	\bar{Y}_t	Targeted output

REPRESENTATIVE HOUSEHOLD'S

The homogenous group of infinitely-lived households maximizes their utility through consumption and labor supply. This model is adapted from Sims et al. (1977), incorporating household consumption and labour supply. It is further developed by Liu & He (2021) to express representative households and intertemporal optimization model as expressed in Equation (1) below:

$$\max_{C_t, N_t, D_{t+1}} E_t \sum_{t=0}^{\infty} \beta_t \left(\frac{C_t^{1-\sigma}}{1-\sigma} - \eta \frac{N_t^{1+\varphi}}{1+\varphi} \right) \quad (1)$$

C_t and N_t denote consumption and labor supply respectively. D_{t+1} represents intertemporal decisions over time from current period, $t = 0$ to ∞ depending on time preferences as denoted by discounting factor parameter (β_t^h) which indicates the degree to which households value future utility relative to current utility. This value lies between zero to one and is strictly positive, $0 < \beta_t^h < 1$. When β_t^h approaches the value of one (1) future household consumption will equal to current consumption. Conversely, as β_t^h approaches zero, households heavily discount future consumption, thus placing greater value on current consumption relative to the future.

Households consumption (C_t) depends on relative risk aversion, represented by parameter σ . When $\sigma > 0$, household is risk-averse (concave), when $\sigma < 0$, it is risk-seeking (convex), and when $\sigma = 0$, it is risk-neutral. Labor supply (N_t) depends on parameter η which indicates the disutility of labor supply and φ represents its elasticity. Higher η indicates greater elasticity in labor supply. In addition, higher (low) φ signifies labor supply is more elastic (less elastic), and on the increase (decrease). To conclude, as φ rises, the disutility of labor similarly increase, resulting in decreasing supply of labor.

The household's budget constraint is shown in Equation (2). On the left side of the equation is the household source of revenues, while on the right hand side is its expenditure at time t .

$$W_t N_t + (1 + r_t^d) D_t = P_t C_t + D_{t+1} + (W_t N_t) \tau_{ict,t} \quad (2)$$

Households receive wages $W_t N_t$ from labor supply, and earn interest on deposit r_t^d affected by OPR set up by the Central Bank (Dittmann 2016). The total return on deposits (D_t) that were held at the beginning of period

t , is $(1 + r_t^d)D_t$. Households spend income on consumption $P_t C_t$ and deposited money as savings D_{t+1} in commercial banks. Therefore, D_{t+1} represents households choice to allocate part of income for future savings, to balance the current consumption and future wealth, influenced by deposit rate (r_t^d) and discount factor (β_t^d). They are also committed to pay income tax to the federal government $(W_t N_t)\tau_{ict,t}$ at the rate $\tau_{ict,t}$.

GREEN PRACTICE FIRMS

Assumed that firms adopt renewable energy technology as assets, and obtain loans from banking to produce constant return to scale output. The production function, adapted from Xiao et al. (2021), extends renewable energy input as represented in Equation (3) below:

$$Y_{i,t} = A_t K_t^\alpha N_t^{\alpha_N} E N_t^{\alpha_{EN}} R E_t^{1-\alpha-\alpha_{EN}-\alpha_N} \quad (3)$$

where, $Y_{i,t}$ is intermediate goods produced by green practices firms, using input from capital (K_t), labor (N_t), non-renewable (EN_t), and renewable energy assets denoted as (RE_t). (α) denotes share of capital, (α_N) the share of labor, and $1 - \alpha - \alpha_{EN} - \alpha_N$, the share of renewable energy which represents the constant return to scale.

Equation (4) expresses the total renewable energy RE_t generation which is determined by the level of output production of intermediate firms ($Y_{i,t}$) (Ahmad & Majeed, 2022). The parameter ψ_{re} measures the efficiency of renewable energy development such as the use of solar or clean technology through the production process. A higher $\psi_{re} (> 0)$, indicates more efficient energy use.

$$RE_t = \psi_{re} Y_{i,t} \quad (4)$$

Where,

$\psi_{re} Y_{i,t}$ is an energy capacity factor from renewable energy demand to generate intermediate goods. The objective function of green practice firms is subjected to profit function expressed in Equation (5). The firm income statement is:

$$\pi_t = (P_t^w Y_{i,t} - W_t N_t - R_t K_t - PRE_t RE_t - L_t r_{L,t}) (1 - g\tau_t(1 - \tau_{c,t}))^{2,3} \quad (5)$$

Where,

The firm's profit (π_t) is calculated by revenue from selling goods or services ($P_t^w Y_{i,t}$) minus operational expenses which include wages paid ($W_t N_t$) to households from labor supply, and rental of capital ($R_t K_t$), renewable energy investment ($PRE_t RE_t$), and interest of expenses ($L_t r_{L,t}$). $\tau_{c,t}$ is corporate tax rate compulsory for Malaysian companies, and $g\tau_t$ is green tax exemption rate of 70% offered by the Malaysia government (MIDA 2020). Since green practice firms are perfectly competitive, P_t^w is set as equal to marginal cost MC_t .

The level of capital accumulation for green practice firms follows the law of motion as determined by Equation (6):

$$K_t = IN_t + (1 - \delta_t)K_{t-1} \quad (6)$$

where, the current level of capital (K_t) used by firms is influenced by new investments (IN_t) injected and the previous level of capital (K_{t-1}), accounting for depreciation rate $(1 - \delta_t)$, over time.

BANKING SECTOR

Malaysia banks are assumed to operate under monopolistic competition, and have some power setting interest rates as suggested by Said (2012), aimed at maximizing compliance with Basel capital requirements as outlined by Bank Negara Malaysia (BNM 2023). The bank's balance sheet equation (Said 2012), is shown below in Equation (7):

$$Rsv_t + L_t + SC_t = D_t + BK_t \quad (7)$$

The assets include bank reserves (Rsv_t), the total loans (L_t) offered to low-carbon (L) firms, and the bank's securities holdings (SC_t). Liabilities include household deposits (D_t) with commercial banks at time t , and bank's equity (BK_t).

The bank is required to hold a statutory reserve ratio (γ_R) of the deposits received from households (Bitar 2020) as mandated by Bank Negara Malaysia (BNM), and shown below in Equation (8):

$$Rsv_t = \gamma_R D_t \quad (8)$$

where Rsv_t represents the total reserves held by the bank, and $\gamma_R D_t$ is the amount of reserves mandated by Bank Negara Malaysia (BNM), and set at 2% of total deposits. This requirement is aimed at managing liquidity in the banking system (Idris 2020). It is assumed that the bank receives deposit demand from households amounting to D_t . The total deposits received by the bank are expressed in Equation (9) given below:

$$D_t = d_0 - d_1 r_t^d + \varepsilon_{D,t} \quad (9)$$

D_t represents the total deposits received from households, d_0 is a constant denoting the amount of deposits received when unaffected by other factors, and d_1 reflects the sensitivity of deposits to changes in the interest rate. The amount of deposits and the interest rate has a negative relationship as confirmed by Wijaya et al. (2022). The study noted that high deposit interest rates tend to encourage households to engage in speculative behaviour, withdrawing and investing their money in assets that offer higher returns. This is consistent with the theory of speculative demand for money (Glazyev 2016). $\varepsilon_{D,t}$ is the error term, representing other factors influencing the total bank deposits.

It is assumed that banks hold government securities to ensure compliance with Basel requirements. The return on these securities is expressed in Equation (10) as:

$$r_{S,t} = r_0 + r_{s,1} OPR_t + \varepsilon_{s,t} \quad (10)$$

where $r_{S,t}$ refers to the rate of return derived from holding government securities, while $r_{s,1}$ represents the sensitivity of the return rate due to the changes in Overnight Policy Rate (OPR). The negative symbol ‘ - ’ indicates that there is a positive relationship between return rate on government securities and OPR. An increase in OPR will enhance returns and generate profits for banks, to ensure their equity requirements are met.

The above equation is subjected to the capital requirement constraints of banks, as outlined by Said (2012) and shown in Equation (11) below:

$$BK_t \geq \kappa(Rsv_t + \gamma_{SC} SC_t + \gamma_L L_t) \quad (11)$$

where κ represents the minimum percentage of capital required to be held as reserves, securities, and loans, as per the Basel capital requirements. γ_{SC} and γ_L denote the risk percentages for securities and loans, where $\gamma_{SC}, \gamma_L > 1$.

Commercial banks utilize household deposits, D_t as capital to offer loans and, L_t^L to green practice firms. This study was extended by including the model from Li et al. (2018), using firm production model ($Y_{i,t}$) which indicates that the green loans offered by government could incentivise enterprise and produce positive impact to boost cleaner production. The loan demand equation relationship is expressed in Equation (12) as follows:

$$L_t = b_L - b_{L,1} r_t + b_{L,2} Y_{i,t} + \varepsilon_{L,t} \quad (12)$$

where,

$L_{L,t}$ represents the demand for loans, b_0 is a constant that indicates the total demand for loans in the absence of other influencing factors. b_L represents the sensitivity of loan demand to lending rate, r_t . $\varepsilon_{L,t}$ is expressed as white noise.

FINAL GOODS FIRMS

Final goods firms operate under monopolistic competition and purchase differentiated intermediate inputs supplied by green intermediate firms. This paper adopted the production framework from Dixit Avinash K. & Stiglitz Joseph E. (1977), Annicchiarico & Di Dio (2015a) and Liu & He (2021). The production function is specified in Equation (13) below:

$$Y_t = \left[\int_0^1 Y_{i,t}^{\frac{\xi-1}{\xi}} di \right]^{\frac{\xi}{\xi-1}} \quad (13)$$

Y_t denotes the total output produced in the economy and ξ is the elasticity of substitution, which is the indicator of how easily one input can be substituted for another due to price change. When the value of ξ is high, substitution between inputs is easy making the impact of price dispersion (changes in current price level compared to previous price level) is minimal, since substitution is easy and inexpensive. Conversely, when the value of ξ is low, substitution becomes costly, resulting in larger impact due to price dispersion.

The price level of final goods, following Calvo (1983) is represented in Equation (14) below:

$$P_t = (1 - \eta)\hat{P}_t^{1-\xi} + \eta P_{j,t-1} \quad (14)$$

P_t denotes the overall price level. ηP_{t-1} is the probability that firms have no power to adjust price and thus maintain their previous price level, due to labor price agreements or price control policy from government (Litsios et al. 2021). Conversely, $1 - \eta$ is the probability that firms have market power to change their price level to \hat{P}_t at a certain period.

PRICE SETTING

Final goods firms cannot freely adjust their prices at each period. If they have the opportunity to set a new price \hat{P}_t , the firms will take into account the expected future profit. Therefore, the firms aim to maximise the expected present value of future profits, by taking into account the probability that they cannot change prices. The objective function for firm's optimal pricing is expressed in Equation (15):

$$\max_{P_{j,t}} E_t \sum_{k=0}^{\infty} (\eta\beta)^k [P_{j,t} Y_{t+k} - MC_{t+k} Y_{t+k}] \quad (15)$$

Where, $P_{j,t}$ is sales price of the final goods produced by specific final goods firm j .

Equation (15) expressed firm's problem of choosing an optimal price $P_{j,t}$ to maximize its expected discounted profits over time, taking into account the probability of the firms being unable to adjust prices η and discount factor β . $P_{j,t} Y_{t+k}$ is the total expected future revenue of the firms at period k when firms set up price $P_{j,t}$, and $MC_{t+k} Y_{t+k}$ is the total expected cost during that period.

ENVIRONMENTAL QUALITY

The measurement of carbon intensity level in Malaysia is adopted from Angelopoulos et al. (2010) and Annicchiarico & Di Dio (2015) as an indicator of environmental quality. This model is extended by adding (RE_t), the renewable energy adoption, as suggested by Pirgaip et al. (2023), which indicates that the adoption of renewable energy can reduce emission levels, as expressed in Equation (16) below:

$$Em_t = \psi_{em} Y_{i,t} - RE_t - G_{E,t} \quad (16)$$

Em_t is the total emissions in Malaysia, ψ_{em} is the natural emissions decay rate per annum without government intervention, and $G_{E,t}$ is government spending on environmental quality.

CENTRAL BANK OF MALAYSIA (BNM)

The Central Bank of Malaysia launched a low-carbon transition facility for firms to promote sustainable development, and achieve net zero carbon. The interest rate rule governs the Overnight Policy Rate (OPR) to control the level of loan demand at the national level, as represented in Equation (17) below:

$$OPR_t = (1 - \delta_{OPR}) [\zeta + \omega_p (P_t - \bar{P}_t) + \theta_y (Y_t - \bar{Y}_t)] \quad (17)$$

Where,

OPR_t is overnight policy rate, δ_{OPR} is smoothing behaviour, ω_p and θ_y is the coefficient of the inflation and output gap. The value of smoothing behavior is between range $0 < \delta_{OPR} < 1$. If δ_{OPR} is close to one, the central bank will gradually adjust OPR allowing for more stable policy rate. Conversely, a low δ_{OPR} will result in quicker adjustment, making monetary policy more responsive and volatile.

ζ is the baseline or long-term target OPR. $\omega_p(\theta_y)$ is inflation (output) sensitivity due to price (output) deviation. If $P_t > \bar{P}_t$ ($Y_t > \bar{Y}_t$), inflation (output) is above target and CB should raise value of $\omega_p(\theta_y)$ to control inflation (output) gap.

FEDERAL GOVERNMENT

It is assumed that the Malaysian government collects revenue from income tax $(W_t N_t)\tau_{ict,t}$ imposed on representative households (Taha & Loganathan, 2008) and from corporate tax, $(P_t^w Y_{i,t} - W_t N_t - R_t K_t - P_{E,t} RE_t)\tau_{c,t}$ imposed on firms (Azlan Annuar et al. 2018). The total revenue is denoted by ict_t as presented in Equation (18):

$$ict_t = (W_t N_t)\tau_{ict,t} + (P_t^w Y_{i,t} - W_t N_t - R_t K_t - P_{E,t} RE_t)(1 - \tau_{c,t}) \quad (18)$$

where ict_t represents the total government revenue from taxation systems, derived from the sum of income tax paid by households $(W_t N_t)\tau_{ict,t}$ and $(P_t^w Y_{i,t} - W_t N_t - R_t K_t - P_{E,t} RE_t)\tau_{c,t}$ corporate tax paid by firms.

The government budget constraint equates government revenue equivalent to government expenditure, as represented in Equation (19) below:

$$ict_t = gy_t Y_t \quad (19)$$

The left-hand side of Equation (19) indicates government revenue, ict_t , collected from representative households and firms through the taxation systems. The right-hand side represents government spending on final goods, $gy_t Y_t$, with gy_t denoting the share of output allocated to total government expenditure.

INTRODUCTION TO SHOCKS

A Tax Exemption shock is introduced as a demand-side shock, into this model as represented in Equation (20), following autoregressive process AR(1).

Demand Side Shocks (Tax Exemption Shocks)

$$g\tau_{t,t} = \rho_{\tau_t} g\tau_{t,t-1} + \epsilon_{\tau_t,t} \quad (20)$$

Equation (20) represents tax shock ($g\tau_{t,t}$) at time t, which depends on its previous value ($g\tau_{t,t-1}$), with ρ_{τ_t} denoting the coefficient of persistence of the shock. If the persistence value $0 < \rho_{\tau_t} < 1$, is close to one, the tax shock is highly persistent over time, with current tax shocks being correlated with past shocks. If ρ_{τ_t} is close to zero, the shock is temporary and quickly dissipates. $\epsilon_{\tau_t,t}$ captures random or unexpected disturbances that affect tax shocks.

MARKET-CLEARING CONDITIONS

In equilibrium, all factor and goods markets must clear. The resource constraint of the economy is expressed as:

$$Y_t = C_t + I_t + G_t \quad (21)$$

Equation (18) states that the total supply side simultaneously equals the demand side.

PARAMETERIZATION, CALIBRATION AND ESTIMATION

This section summarises the parameterisation of the model which is consistent with the existing literature. Table 2 lists the choice of parameter values for the baseline model. The parameters in the theoretical model are determined by the combination of calibration and estimation. The discount factor β_t can be derived as $\frac{1}{1 + OPR_t}$, where OPR_t is the Malaysian OPR, an official interest rate that influences bank lending, financing rates, as well as deposit rates (BNM 2024). The current OPR rate has remained constant from May 2023 up to July 2024, at 3.00%, as decided by the Monetary Policy Committee. The discount factor is: $\beta_t = \frac{1}{(1 + OPR_t)} = \frac{1}{(1 + 0.03)} = 0.992$. The corporate tax rate is set at 0.15. Capital share and depreciation rate are calibrated from standard macroeconomics, at 0.33, and 0.025 respectively. The government spending-to-output ratio is at 0.1. ψ_{em} is

emissions intensity set at 0.2 (Annicchiarico & Di Dio 2015). All equilibrium equations are implemented in Dynare and computed using the ‘steady’ command.

TABLE 2. Parameterization, calibration and estimation value

No	Symbol	Description	Value	Source
1	β_t	Discount factor	0.992	Annicchiarico & Di Dio (2015) Author Estimation
2	σ	Relative risk aversion	2	Angelopoulos et al. (2010) Liu & He (2021)
3	φ	Labour disutility parameter	2.0	Xiao et al. (2021)
4	η	Labor disutility curvature	1.0	Xiao et al. (2021)
5	α	Share of capital	0.33	Annicchiarico & Di Dio (2015)
6	α_{RE}	Share of renewable energy	0.13	Xiao et al. (2021)
7	α_{EN}			
8	ψ_{re}	Renewable energy efficiency parameter	0.05	Angelopoulos et al. (2010)
9	η^p	The probability that firms cannot change prices	0.75	Annicchiarico & Di Dio (2015)
10	ψ_{em}	Emissions Intensity per unit output	0.2	Annicchiarico & Di Dio (2015)
11	δ_{OPR}	Smoothing behaviour	0.8	Sahminan et al. (2017)
12	ω_p	Response parameters from deviations of price level	1.5	Sahminan et al. (2017)
13	θ_y	Response parameters from deviations of the output gap	0.5	Sahminan et al. (2017)
14	$\tau_{ict,t}$	Income Tax Rate	0.15	LHDN (2023)
15	gy_t	Proportion of government spending on final output	0.1	DOSM (2024)
16	δ	Depreciation rate	0.025	Annicchiarico & Di Dio (2015)
17	γ	Emissions naturally decay rate	0.45	Annicchiarico & Di Dio (2015)
18	$prod_a$	Productivity parameter	0.5	Author Estimation
19	γ_{rsv}	Required Reserve Ratio	0.2	Bank Negara Malaysia (2024)
20	d_0	Baseline of households deposits	0.145	Bank Negara Malaysia (2024)
21	d_1	Sensitivity of households deposits towards interest rate	0.078	Bank Negara Malaysia (2024)
22	κ	Based capital requirements	0.2	Bank Negara Malaysia (2024)
23	γ_{sc}	Weight of risk securities	0.02	Author Estimation
24	γ_L	Weight of risk on loan	0.1	Author Estimation
25	SC_0	Baseline on securities return	0.212	Bank Negara Malaysia (2024)
26	SC_1	Security of interest rate on securities return	0.0223	Bank Negara Malaysia (2024)

THEORETICAL RESULTS

This section reports on impulse responses to an exogenous GITE shock as shown in Figure 4. The results demonstrate interlinkages highlighting the dynamic responses of macroeconomic variables. In the Malaysian context GITE policy is implemented by the government aimed at promoting environmental sustainability and simultaneous incentivise businesses to increase green investment.

GITE STEADY-STATE RESULTS

This study evaluates the effects GITE within a general equilibrium perspective. The steady-state values of the main variables are shown in Table 3. This study indicates that there is a balanced outcome between the emission reduction targets and economic growth, suggesting that GITE can support a sustainable transition.

The GITE policy implemented by the Malaysia government, aimed at reducing tax burden on individuals and intermediate firms, and designed to encourage green technology adoption. Most macroeconomic variables show positive changes. Consumption shows a 4.17 percent rise influenced by reduced tax burdens that stimulate demand and increase employment by 6.90 percent. The rise in renewable energy investment by 1.15 percent contributes to increase in capital by 2.23 percent leading to greater investment in renewable technology and a corresponding increase by 1.15 percent in low-carbon output. Since tax incentives are specifically focused on low-carbon sector, production by high-carbon firms declines by 0.06 percent, as consistent with national objectives to reduce non-renewable sources and mitigate climate change. The allocation of 70 percent GITE towards government spending leads to an estimated 0.16 percent rise in fiscal expenditure, representing the cost of policy implementation. However, the overall expansion in economy activity results in GDP increase by 0.25 percent, alongside emissions reduction by 0.08 percent.

TABLE 3. Steady-state results for GITE

Variables	BAU	Public Policy	
		Tax Incentives	Change
Consumption	0.4784	0.4984	4.17%
Labor Supply	0.1665	0.1780	6.90%
Capital	5.6655	5.7916	2.23%
Renewable Energy	0.0330	0.0335	1.55%
GDP	0.6602	0.6679	1.17%
Emissions	0.5416	0.5179	-4.38%
Price Level	0.2260	0.2270	0.43%
Government Spending	0.0151	0.0177	17.15%

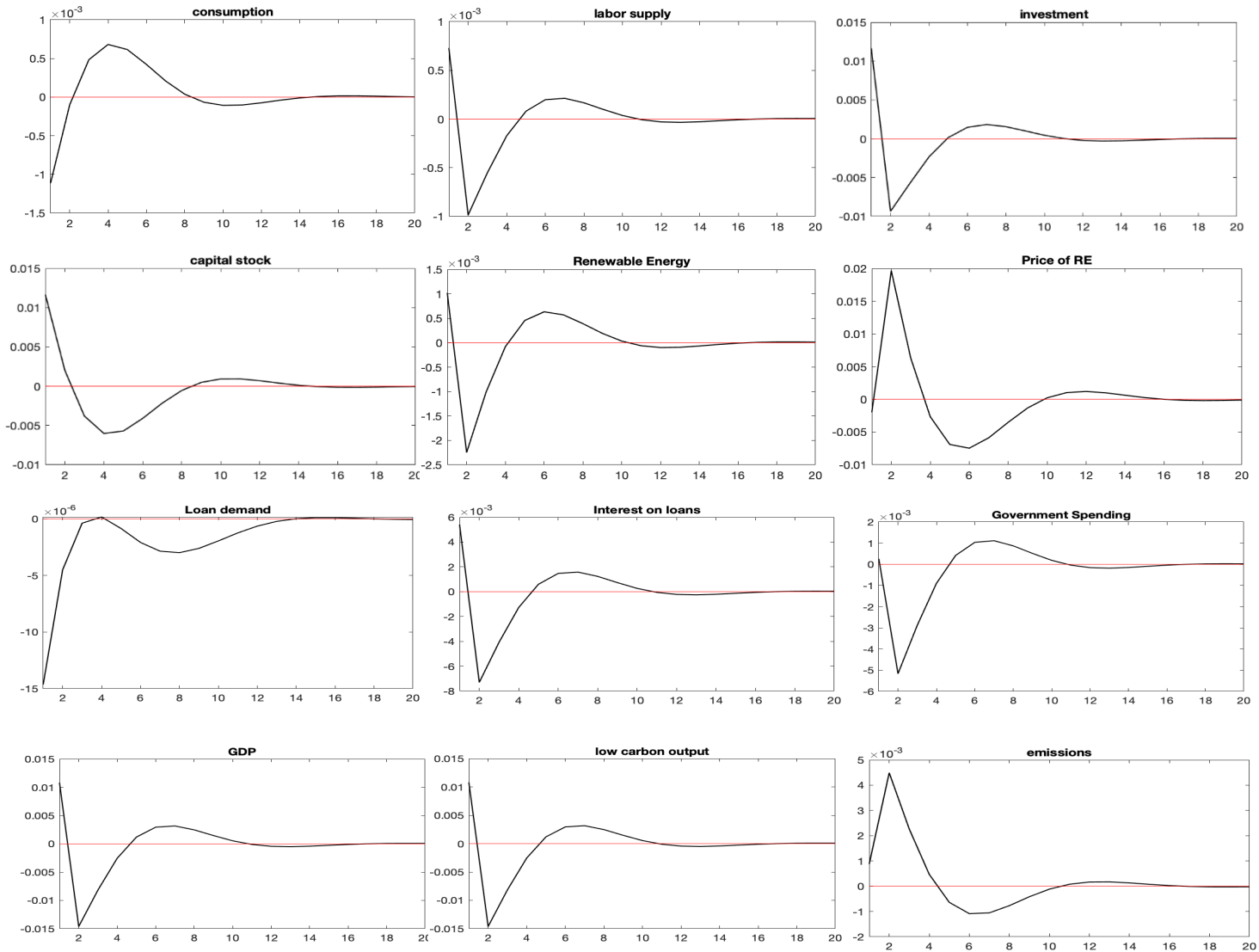


FIGURE 4. Dynamic Responses of green tax exemption shock

DYNAMIC RESPONSES UNDER GITE SHOCK

A 1 percent rise in GITE leads to a 0.01 percent RE usage, 0.08 percent RE demand, and 1 percent expansion in low-carbon output – results that are consistent with empirical studies. Aghion et al. (2012) highlight that fiscal incentives stimulate RE investment by lowering capital costs. Fiscal incentives also lead to reallocation of production towards cleaner sectors (Aghion et al. 2012; Annicchiarico & Di Dio 2015a). The respective 0.17 percent and 0.07 percent rise in wage and labor supply, supported by the International Labour Organization (2018), highlights demand by firms for labor with expertise in RE skills. Firms operating in low carbon are more likely to engage in green innovations when provided with preferential tax policies, suggesting that tax incentives stimulate not only environmental quality (C. Wang et al. 2022), but also new job creation in green technology fields. This allows for firms to reallocate more resources toward research and development (R&D) subsequently driving employment growth (Xu et al. 2023).

GITE stimulates broader macroeconomic dynamics. RE expansion contributes 0.58 percent rise in productivity, and 0.07 percent in wages. However, due to a low return on deposit, households prefer saving over consumption, anticipating higher returns in the future. This results in a temporary drop in consumption in the first period. As deposit returns improve in the next period, households increase consumption and withdraw savings due to higher returns. This reflects on intertemporal substitution driven by forward looking precautionary behavior.

With increase in RE demand investment rises slightly by only 0.03 percent while capital stock improves by 1.1 percent. Government spending increases by a minimal 0.02 percent due to 0.1 percent decline in tax revenue, which continue to fall by 0.06 percent in the subsequent period. In the banking sector, GITE responds by a 1.46 percent drop in loan demand. Han et al. (2015) highlight that tax incentives reduce investment cost, resulting in firms not borrowing from financial institutions, but use their own funds (internal financing) more efficiently, decreasing dependence on bank loans. GITE shock delays response in carbon emissions, but shows positive reactions. In the first year, emission level drops slightly by 0.002 percent and shows a 0.004 percent temporary rise. The decline in emissions continues over five years, reaching a steady-state level. Overall, GDP rises by about 1 percent, confirming earlier findings by Yuan et al. (2023) that financial incentives, such as tax exemption efficiently reduces environmental deterioration, improves resource utilization, positively contributing to green economic growth and encourage investment in sustainable practices.

To respond to the research questions, the simulation results conclude that the GITE is effective in promoting both emissions reduction and economic growth. In the short run, this is evident from the significant increase in renewable energy demand, productivity, and capital stock, alongside improvements in employment, wages, and production of output in green sector output. Although household consumption temporarily falls due to intertemporal substitution and precautionary savings, it subsequently rebounds as deposit returns improve. In terms of environmental outcomes, GITE results in a modest initial reduction in carbon emissions, followed by a steady decline over a five-year horizon. Overall, GITE contributes to sustainable economic growth while facilitating Malaysia's transition to a low-carbon economy.

CONCLUSION AND POLICY RECOMMENDATIONS

This study evaluates the impact of GITE in Malaysia under general equilibrium framework, and reveals that it successfully balances economic growth with CO₂ reduction. In steady state, macroeconomic indicators show overall improvement. Reduced tax burdens on firms stimulate consumption and employment. These incentives encourage greater investment in renewable energy, which in turn increases capital accumulation and supports low-carbon production. While government spending slightly rises due to the fiscal cost of implementing tax incentives, this is however offset by improved economic activity, which boosts overall GDP while reducing CO₂ emissions. This reflects a positive shift towards sustainable and inclusive growth.]

On the other hand, a 1 percent rise in GITE increased renewable energy usage and demand, along with an expansion in clean sector output. These developments enhance productivity and wages, particularly in green-skilled occupations, which further support household consumption. However, the growth in investment is modest, and capital stock increases more gradually. Reduction in tax revenue limits government ability to spend. The banking sector experiences a reduction in loan demand, as firms rely more on internal financing, made more viable by the tax incentives. Emission decline take effect gradually, showing a delayed but consistent downward trend over time.

In conclusion, GITE is an effective policy tool for supporting the transition to a low-carbon economy. It fosters green technology adoption, creates new employment, and stimulates economic growth, and contributes to long-term emissions reduction, with prudent fiscal management. This study however has several limitations. First, it is focused on a closed economy framework, while it could be more robust with incorporation of external sectors. Second, the model mainly focuses on green firms, without capturing sectoral heterogeneity. Lastly, the environmental impact is proxied only by aggregate CO₂ emissions, without considering biodiversity loss or broader

ecological concerns. Robust evaluation and strategic plan are essential to support current green policies to ensure Malaysia stays on track to meet its net zero carbon and Sustainable Development Goals (SDG).

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NOTES

1. According to MIDA (2020), Tier 1 firms are those that lease green technology, such as solar systems, and are capable of producing between 10MW and 30MW of power. These firms will receive 70% tax exemption for up to 10 years. Tier 2 firms are those that generate between 3MW and 10MW and receive the same exemption rate, but for up to 5 years only.
2. Assume the profit before tax is 1,000. Taxable profit is calculated by $(1 - 0.56) \times 1,000 = 440$. Company profit after tax is 440, accounting for 70% exemption rate and income tax 20%.
3. If green tax exemption rate is 70% and corporate income tax is 20%, this means that profit after tax will be $1000(1 - 0.7(1 - 0.2))$. We first calculate effective tax rate after tax exemption is applied. $0.7(1 - 0.2) = 0.7 \times 0.8 = 0.56$. This means that company tax is 0.56 after considering exemption.

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