ELIT
Economic Laboratory Transition Research
Podgorica, Montenegro

Montenegrin Journal of Economy

For citation:

Wongsaen, C., Dheera-Aumpon, S., Punyasavatsut, A. (2023), "Economic Recession from Household Responses to an Epidemic and Consumption Stimulus Measures in Thailand",
Montenegrin Journal of Economics, Vol. 19, No. 2, pp. 7-20.

Economic Recession from Household Responses to an Epidemic and Consumption Stimulus Measures in Thailand

CHIRAPORN WONGSAEN[1] ***(Corresponding author)***, SIWAPONG DHEERA-AUMPON[2] and ARUNEE PUNYASAVATSUT[3]

[1] PhD student, Department of Economics, Kasetsart University, Thailand, e-mail: chiraporn.w@ku.th
[2] Associate Professor, Department of Economics, Kasetsart University, Thailand, e-mail: fecospd@ku.ac.th
[3] Associate Professor, Department of Economics, Kasetsart University, Thailand, e-mail: fecoand@ku.ac.th

ARTICLE INFO

Received May 17, 2022
Revised from June 18, 2022
Accepted July 17, 2022
Available online September 15, 2023

JEL classification: E13; E21; E62.

DOI: 10.14254/1800-5845/2023.19-2.1

Keywords:

Household responses,
COVID-19,
consumption stimulus measures.

ABSTRACT

This paper aimed to study the economic recession from household responses to the epidemic and consumption stimulus policies in Thailand using the macroeconomic general equilibrium model simulation method. Simulation results show the household responses. The epidemic situation caused the households to decrease consumption, working hours, and investment in order to prevent infection. These steps led to a contraction of the economy. Furthermore, the households responded to the measures by sharply reducing investment so as to increase consumption during the implementation period, especially in the first week. Changes in the opposite direction between consumption and investment imply the crucial role of government spending to drive the households' consumption. At first glance, it may seem that the government's consumption stimulus policies made the economy and the epidemic situation even worse because of the sharp decline in GDP per capita, investment, and working hours. Moreover, they have accelerated the COVID-19 epidemic to a peak more rapidly and intensely. An approach that will allow us to assess the effectiveness of policies would be to take the change in GDP per capita over the periods that cover the policy action. The calculation of the net change in GDP per capita shows that the policies introduced by the government to boost consumption helped mitigate a total annual economic loss of $36.88 and $26.26 per capita in the perfect and imperfect competition models respectively, compared with the case of no policies.

INTRODUCTION

Since 2020, the world has been faced with an unexpected outbreak situation of the coronavirus 2019 disease. Its impact has not only caused chaos in the public health system, but it has also escalated to economic shutdowns to control the disease. Many papers have discussed the impact of COVID-19 on demand and supply, including the effects of a prolonged epidemic. Moreover, the containment measures might reduce consumer confidence in spending, and lead to pessimism about long-term economic prospects. The phenomenon of a delayed return to work will continue, and the construction period of infrastructure projects will be significantly affected (Mohsin et al., 2021, Philipp et al., 2020a; 2020b). The economic agents adopt a "wait-and-see" attitude when there is less confidence in the economic climate (Baldwin, 2020). The decrease in labor productivity and supply adversely affects firm revenue and bring down the financial market. (Elenev et al., 2020).

Thailand is one of the developing countries that is inevitably affected by COVID-19. Although the outbreak did not seem to be severe at first, this emerging disease went on to cause panic among all sectors. The first confirmed COVID-19 case was reported on 12 January 2020. After an initial peak of transmission (188 cases in a day) on 22 March 2020, infections were contained after the government action with community-based contact tracing and quarantine measures. The epidemiological characteristics by age group show that individuals in the 20-29 and 30-39 age groups became the most infected, respectively. At that time, Thailand was praised by the World Health Organization for dealing with the epidemic (National News Bureau of Thailand, 2020). It cannot be denied, however, that this outbreak had a huge effect on the Thai economy. The GDP per capita growth rate was noted to have a negative growth rate of 9.82% at the end of the first quarter of 2020 (CEIC, 2021). While the government devoted both human resources and the budget to address this unprecedented outbreak, households made a surprising drop in spending. The decline in the household consumption growth rate from this epidemic was greater than for any crisis in the past 20 years, with a decline of up to 12.95% (CEIC, 2021), corresponding with the Consumer Confidence Index shown in the current economic situation averaging its lowest in 10 years at 27.90 (UTCC Center for Economic and Business Forecasting, 2021). On the supply side, the unemployment rate spiked to 1.95% in the second quarter of 2020 before a slight decline (Bank of Thailand, 2021). As mentioned above, the COVID-19 outbreak has sorely affected the Thai economy, especially in the area of household consumption. This should be the focus because it reflects the well-being of the household, and the goal of the initial government policy responses to the outbreak should be to protect vulnerable households in terms of income.

During the COVID-19 epidemic, households may voluntarily stay at home to protect themselves from the virus or in compliance with government measures to contain the outbreak. In response to this situation, the economy was affected by household decisions and government policies. During the past two years, there have been papers suggesting that household consumption spending declined in response to the epidemic and negative income shock, especially on goods and services whose supply was restricted by government transport limitation measures (Anderson et al., 2020; Christelis et al., 2021). Therefore, the government should be concerned about the size and nature of the consumption response. The paper of Kim et al., 2021 also points out that the reduction in consumption spending is associated with the lockdown policy, heightened economic uncertainty, and reduced income. Furthermore, several studies examined the impact of the cash transfer scheme on consumption in various countries such as Japan, the US, and China (Hattori et al., 2021; Kubota et al., 2021; Baker et al., 2020; Chen et al., 2020) using survey transaction data in different payment channels, and difference-in-difference approaches in order to represent the heterogeneous effect. These studies suggest that households responded rapidly to the stimulus payment, with large increases in spending on food, even if this was mainly in the short term. The consumption responses, however, were related to households' financial status. Low-wage individuals who have high MPCs out of income and high debt would spend their stimulus payment on loan repayments instead. This tends to reduce the policy effectiveness. Although many countries use fiscal policies to stimulate household consumption through cash or cheque transfer payments, another method available is via consumption tax: VAT. In the short run, COVID-19 had a significant effect on aggregate demand shock, implying that COVID-19 can be thought of as a "tax" on consumption. However, the economy can bounce back sharply when these taxes are gone. In addition, based on the Solow model, when the investment rate declines or the capital stock depreciates without being replaced, output could fall below its steady state and take a while to return, implying long-term effects on the economy (Jones, 2021). To increase aggregate demand during economic downturns, a change in the tax on consumption can be implemented quickly, and easily (Belsie, 2022).

The contribution of this research is the experiment simulating the Thai economy, which is a developing country, under the first wave of the COVID-19 outbreak in 2020. By applying the macroeconomic general equilibrium models integrated with the SIR-macro model provided by Eichenbaum et al. (2020a), the author introduced the two reality consumption stimulus policies: the schemes titled "We Do Not Leave Each Other", and "50:50 Co-Payment" in terms of negative consumption taxes into the models. This approach allowed the models to represent the nature of households in responding to these measures. Alignment with the objectives of the schemes to help vulnerable members of the population by increasing their purchasing power in consumption could be achieved through money transfers to PAOTANG: an application that operates on any electronic devices that allows the applicant to manage the transfer of funds, receive funds, or make a payment for goods/services, as well as any other financial services that are available on the PAOTANG application services provided by the Krung Thai Bank.

Simulation results show the household decisions and the response to both the epidemic situation and the consumption stimulus measures. The epidemic situation caused households to decrease consumption, working hours, and investment in order to prevent infection. These steps led to a contraction of the economy.

Furthermore, the household responded to the measures by sharply reducing investment so as to increase consumption during the implementation period, especially in the first week. Changes in the opposite direction of investment and consumption imply the crucial role of government spending to drive the households' consumption. Although the simulation results may not be compared with the real situation because of the overestimation in the epidemic situation, it could help in the interpretation of the households' behavior and the economic contraction where the factual observations can be compared to the limitations of the model.

The rest of this paper consists of Section 1 describing the models; Section 2 presenting the model parameterization; Section 3 discussing the simulation results, and Section 4 presenting the conclusion.

1. THE MODELS

The simulations of the economic recession due to the epidemic are based upon three general equilibrium macroeconomic models: the neoclassical competitive model, the Neoclassical imperfect competitive model, and the New Keynesian model integrated with the SIR-macro model provided by Eichenbaum et al. (2020a). Because the economy of interest is Thailand, for simplicity, the assumption of a small-closed economy is used. The consumption stimulus policies in terms of the negative consumption tax are added into the model to assess the effectiveness of the Thai government's public policies in response to the COVID-19 outbreak. The model setup, therefore, is as follows.

1.1 The Neoclassical Model

1.1.1 Households

A continuum of representative households maximizes their utility by making decisions on consumption and the labor supplied to firms. A household's lifetime utility is given by:

$$U=\sum_{t=0}^{\infty}\beta^t\left\{s_t\left[\log(c_t^s)-\frac{\theta}{2}(n_t^s)^2\right]+i_t\left[\log(c_t^i)-\frac{\theta}{2}(n_t^i)^2\right]+r_t\left[\log(c_t^r)-\frac{\theta}{2}(n_t^r)^2\right]\right\}, \quad (1)$$

subject to the budget constraint:

$$s_t(1\text{-}\mu_j)c_t^s+i_t(1\text{-}\mu_j)c_t^i+r_t(1\text{-}\mu_j)c_t^r+x_t+\psi=w_t(s_tn_t^s+i_tn_t^i+r_tn_t^r)+r_t^kk_t+\varphi_t, \quad (2)$$

where the parameter β^t denotes the discount factor, and θ denotes the scaling parameter for the disutility of supplying labor. The variables s_t, i_t, and r_t denote respectively the fraction of household members who are susceptible, infected, and recovered at time t. The consumption and hours worked of each group of members are denoted by (c_t^s,c_t^i,c_t^r) , and (n_t^s,n_t^i,n_t^r), respectively. The variables φ_t, and ψ denote respectively profits from the monopolistically competitive (intermediate input) firms and lump-sum taxes. Then, μ_j is the consumption stimulus policy by the government where j denotes the schemes titled 1) We Do Not Leave Each Other, and 2) 50:50 Co-Payment. The household investment is denoted by x_t. The real wage and the rental rate of capital are denoted by w_t , and r_t^k, respectively.

The household decisions on investment and capital supplied to firms are governed by the law of motion for the stock of capital:

$$k_{t+1}=x_t+(1-\delta)k_t, \quad (3)$$

where k_t is the capital stock at time t, and δ denotes the depreciation rate of capital.

Furthermore, the decisions of representative households are also subject to the number of newly infected people and the equations that govern the health status of the household members, especially during an epidemic outbreak.

The number of newly infected people at time t is as follows:

$$\tau_t=\pi_1s_tc_t^s(I_tC_t^I)+\pi_2s_tn_t^s(I_tN_t^I)+\pi_3s_tI_t, \quad (4)$$

where τ_t denotes the number of newly infected people at time t. The variables π_1, π_2, and π_3 denote both the amount of time spent and the probability of becoming infected as a result of economic activities: consumption, work, and non-economic activity, respectively. The household can affect this probability through its choice of c_t^s and n_t^s. The household, however, takes economy-wide aggregate $I_t C_t^I$ and $I_t N_t^I$ as given.

The fraction of initial household members at time $t+1$ is given by:

$$s_{t+1} = s_t - \tau_t, \tag{5}$$

$$i_{t+1} = i_t + \tau_t - (\pi_r + \pi_d) i_t, \tag{6}$$

$$r_{t+1} = r_t + \pi_r i_t, \tag{7}$$

$$d_{t+1} = d_t + \pi_d i_t. \tag{8}$$

Here, the π_r and π_d denote the infected-recovered and infected-fatality rates, respectively. On the part of the household, members have rational expectations so they are aware of infection and realize the law of motion governing population health status.

The timing convention in the model is weekly. In each period t, s_{t-1} is pre-determined and s_t is the stock of susceptible people to be determined at the end of period, which is decreased by the number of newly infected people in that period. Also, at the end of each period t, the amount of capital to accumulate into the period $t+1$ is k_{t+1}.

1.1.2 Production

There are two categories of firms in the economy: one produces final goods, and the other produces intermediate goods. The final goods firms are modeled as competitive firms that take price and do not face price rigidities. On the other hand, the intermediate goods firms are monopolistically competitive firms that set prices but face price rigidities. A representative final goods firm produces the final output in a competitive market using CES technology:

$$Y_t = \left(\int_0^1 Y_{i,t}^{\frac{1}{\gamma}} di \right)^{\gamma}, \gamma > 1, \tag{9}$$

where Y_t denotes the final goods which are produced from intermediate input $i \in [0,1], Y_{i,t}$. Note that the unit of final goods is numerical. The parameter γ denotes the elasticity of substitution between different intermediate goods.

The profit maximization of the competitive final goods firm is governed by the intermediate input demand:

$$Y_{i,t} = P_{i,t}^{-\frac{\gamma}{\gamma-1}} Y_t, \tag{10}$$

where $P_{i,t}$ denotes the price of the intermediate input.

A monopolist firm produces intermediate goods according to the Cobb-Douglas technology:

$$Y_{i,t} = A K_{i,t}^{1-\alpha} N_{i,t}^{\alpha}, \tag{11}$$

where $K_{i,t}$ and $N_{i,t}$ denote the capital and labor inputs. The parameter α denotes the labor income share.

The intermediate goods firm maximizes profits:

$$\pi_{i,t} = P_{i,t} Y_{i,t} - mc_t Y_{i,t}, \tag{12}$$

subject to the conditional intermediate input demand equation (10).

The mc_t is the real marginal cost at time t:

$$mc_t = \frac{w_t^{\alpha}(r_t^k)^{1-\alpha}}{A\alpha^{\alpha}(1-\alpha)^{1-\alpha}}. \quad (13)$$

The optimal price is as follows:

$$P_{i,t} = \gamma mc_t. \quad (14)$$

This equation implies that the firms set their price as a fixed markup, γ, over the real marginal cost.

The simulation of standard Neoclassical model (perfect competition) corresponds to the special case where $\gamma = 1$, and $\gamma > 1$ in the case of the norm (imperfect competition).

1.1.3 Fiscal policies

The government finances a stream of government spending and subsidies with lump-sum taxes:

$$\psi = G + \mu_j(s_t c_t^s + i_t c_t^i + r_t c_t^r), \quad (15)$$

where G denotes the government spending.

1.2 The New Keynesian model

The New Keynesian model is different from the Neoclassical model as the monopolist faces competition as the intermediate goods firms are facing nominal price rigidity. The model setup, therefore, has changed as follows:

1.2.1 Household

Household's lifetime utility is as equation (1) subject to the budget constraint:

$$B_{t+1} + P_t(s_t(1-\mu_j)c_t^s + i_t(1-\mu_j)c_t^i + r_t(1-\mu_j)c_t^r + x_t) + \Psi = R_{t-1}^b B_t + W_t(s_t n_t^s + i_t n_t^i + r_t n_t^r) + R_t^k k_t + \Phi_t \quad (16)$$

where B_t is the nominal bond holding, and R_t^b is the return on bonds. The variables W_t and R_t^k denote the nominal wage and the nominal rental rates. P_t is the consumer price index. Furthermore, the utility maximization is also subject to the law of motion, and the equations that govern the health status of the household members as in the Neoclassical model.

1.2.2 Production

The profit maximization of the final goods firm is governed by the intermediate input demand:

$$Y_{i,t} = \left(\frac{P_{i,t}}{P_t}\right)^{-\frac{\gamma}{\gamma-1}} Y_t. \quad (17)$$

The price of final goods is given by:

$$P_t = \left(\int_0^1 P_{i,t}^{-\frac{1}{\gamma-1}} di\right)^{-(\gamma-1)}. \quad (18)$$

The intermediate goods firm maximizes profits:

$$\pi_{i,t} = P_{i,t}Y_{i,t} - P_t mc_t Y_{i,t}, \quad (19)$$

subject to the conditional intermediate input demand equation (10). In this model, the monopolist firm sets its price to follow Calvo (1983) price-setting. The firms reoptimize their price with probability $1-\xi$ and keep it the same with probability ξ.

$$\max_{\tilde{P}_t} \sum_{j=0}^{\infty} (\xi\beta)^j \lambda_{t+j}^b \left(\tilde{P}_t Y_{i,t+j} - P_{t+j} mc_{t+j} Y_{i,t+j}\right) \quad (20)$$

subject to the conditional intermediate input demand equation (10).

The real marginal cost at time t is given by:

$$mc_t = \frac{W_t^{\alpha}(R_t^k)^{1-\alpha}}{P_t A\alpha^{\alpha}(1-\alpha)^{1-\alpha}}. \quad (21)$$

1.2.3 Monetary and fiscal policy

The central bank controls the nominal interest rate according to the Taylor rule:

$$\log\frac{R_t^b}{R^b} = \theta_\pi \log\frac{\pi_t}{\pi} + \theta_y \log\frac{Y_t}{Y_t^f}, \quad (22)$$

where R^b is the nominal interest rate at equilibrium. The variables π_t and π denote the inflation rate and the target inflation rate, respectively. The flexible-price output in equilibrium is denoted by Y_t^f. The parameters θ_π and θ_y denote the weighted coefficients of inflation and output, respectively.

The government budget constraint is given by:

$$\Psi_t = P_t G + \mu_j P_t(s_t c_t^s + i_t c_t^i + r_t c_t^r + x_t). \quad (23)$$

1.3 Equilibrium

In equilibrium, the markets for goods and labor are clear. The households and firms solved their maximizing problems by satisfying the first-order conditions. The representative agents have rational expectations. The government and the central bank follow the fiscal and monetary rules. Since the closed-form solutions of the models are difficult to find, these simulations, therefore, rely on the list of the model's equilibrium conditions as given in appendix.

2. MODEL PARAMETERIZATION

There are, in general, two methods for parameterizing the models: calibration and estimation. Most of the parameters used in these models are estimated. Some parameters, however, need to be calibrated by selecting based on the empirical findings that can characterize the Thai economy. The parameters are summarized in Table 1.

Table 1. Steady State Parameters

Parameter	*Value*	*Description*
β	0.9994	Discount factor (weekly)
π_d	0.0043	Probability of dying (weekly)
π_r	0.4957	Probability of recovering (weekly)
ε_0	0.0010	Initial infection
δ	0.0009	Capital depreciation rate (weekly)
α	0.70	Labor income share
γ	1.2310	Gross price markup
ξ	0.6750	Calvo core prices
θ_π	1.3590	Taylor rule coefficient inflation
θ_y	0.0225	Taylor rule coefficient output gap (weekly)
η	0.17	Government consumption share of output
n	35	Hours worked (weekly)
y	150	Income per capita (USD) (weekly)

Source: author (2022)

Details on the steady state parameters are as follows: The weekly discount factor, β, is 0.9994 implying a steady state annualized real interest rate of 3.11 percent in 2019 (pre-epidemic). The weekly hours worked, n, is 35, indicating the full-time hours worked in a week from the National Statistical Office of Thailand. The government consumption share of output, η, and the weekly income per capita, y, are 0.17 and 7,817/52, respectively. Both values are from World Bank (2019) data.

The initial population is normalized to one, and the number of initial infected people, ε_0, is 0.001. Since it takes on average 14 days to become either recover or die from the infection and the timing convention of the model is weekly as in Eichenbaum et al. (2020a), the parameters governing the household's dynamic health status are as given: $\pi_r + \pi_d = 7/14$. The mortality rate for people younger than 60 years is 0.86 percent (the number of the young infected is 3,833 divided by 33 young people who are dead from infection) implying $\pi_d = 7 \times 0.0086/14$. The probabilities of dying, π_d, and recovering, π_r, are equal to 0.0043 and 0.4957, respectively. These values are based on Thailand's epidemiological characteristics from the first wave of the COVID-19 outbreak data reported by the Disease Control Department, Ministry of Public Health (1 January – 14 December 2020).

The parameters of firms are as follows: the capital depreciation rate, δ, is equal to 0.0009. This value corresponds to the average annual depreciation rate between 1990 and 2019 of 4.6 percent. It is calculated as the annual total depreciation divided by gross capital stock (at the 2002 price) from CEIC (2021) data which is then converted into a weekly rate. The labor income share, α, is 0.70 from Tanboon (2008). The markup, γ, is 1.231. This mean value is consistent with descriptive statistics of Thai firms ($n = 1,787,393$) in Apaitan et al. (2020). The Calvo price stickiness, ξ, is 0.675, which corresponds to the mean of Calvo core prices in prior information from Phrommin (2018) which is based on Bayesian inference.

The monetary policy parameters including Taylor rule coefficients of inflation, θ_π, and the weekly output gap, θ_y, are equal to 1.3590 and 0.0225, respectively. These values are converted from the 'forward looking' Taylor-type equation in the benchmark model from Luangaram and Sethapramote (2016).

The calibration targets for shares of π_1, π_2, and π_3 in the transmission function in the SIR-macro model using homotopy calculations, i.e., increase parameter values stepwise until imposing their final desired values as follows:

$$\frac{\pi_1 C^2}{\pi_1 C^2 + \pi_2 N^2 + \pi_3} = 1/5 \tag{24}$$

$$\frac{\pi_1 N^2}{\pi_1 C^2 + \pi_2 N^2 + \pi_3} = 1/5 \tag{25}$$

These equations imply that at the beginning of the pandemic, 1/5 of the virus transmissions come from consumption, 1/5 come from work, and 3/5 come from non-economic activities. This calculation is based on 35 working hours per week and supposes and equal time for consumption. The time in the rest of the week is for non-economic activities.

Furthermore, the models with exogenous policy variables, the rate and periods of implementation are specified as in Table 2.

Table 2. The Rate Range and Period of the Policy Implementation

Policy variable	*Description*	*Rate range (percent)*	*Period of implementation*
μ_1	The rate of government subsidies in the "We Do Not Leave Each Other" scheme	38-46	3 months (Apr-Jun 2020)
μ_2	The rate of government subsidies in the "50:50 Co-Payment" scheme	7-8	3 months (Oct-Dec 2020)

Source: Author (2021, 2022)

Suppose that households spend the same average amount of government subsidy in each period. Details on the policy variables are as follows. First, for the scheme entitled "We Do Not Leave Each Other", the people who have registered for the program will receive a government subsidy of 5,000 baht for three months (April to June 2020) with total of 15,000 baht. The amount converted to USD per week by the exchange rate of 2020 is equal to $37.22. In the other scheme, the "50:50 Co-Payment", the people who have registered for the program will receive a government subsidy of 150 baht per day for three months (October to December 2020) with a total of 3,000 baht. The amount converted to USD per week by the exchange rate of 2020 is about $7.44. To put these values into the model, they must be converted to a percentage of the consumption in the case without policy, ensuring that they imply the constant amount of policy variables. Therefore, the rate of consumption taxes could vary in each period of policy implementation.

3. SIMULATION RESULTS AND DISCUSION

The simulations to mimic the steady state of the Thai economy before the COVID-19 outbreak in 2019 are shown in Table 3 by comparing the simulated parameters and variables in the three general equilibrium macroeconomic models.

Table 3. The Steady-State Parameter and Variable Values

Parameter/Variable	*Neoclassical*		*New Keynesian*
	Perfect Competition	*Imperfect Competition*	
	Parameters in the transmission function in the SIR-macro model		
π_1	1.58×10^{-5}	1.42×10^{-5}	1.42×10^{-5}
π_2	1.22×10^{-4}	1.22×10^{-4}	1.22×10^{-4}
π_3	0.4498	0.4498	0.4498
	Parameters in the production function		
A	0.5651	0.6015	0.6015
θ	8.79×10^{-4}	6.79×10^{-4}	6.79×10^{-4}
	Value of life (in USD/annual)		
VoL	6.57×10^{5}	7.21×10^{5}	7.21×10^{5}
	Key variables in the macroeconomic model (in USD)		
y	150	150	150
c	97.5068	102.572	102.572
x	26.9932	21.9281	21.9281
g	25.5000	25.5000	25.5000
k	29,992.5	24,364.6	24,364.6
	Key variables in the macroeconomic model (in proportion to GDP)		
c/y	0.65	0.68	0.68
x/y	0.18	0.15	0.15
g/y	0.17	0.17	0.17
	Annual capital-output ratio		
k/y	3.84519	3.12366	3.12366
	Return of labor supply, capital supply, and bond holding		
w	2.99997	2.43704	2.43704
r^k	0.0015	0.0015	0.0015
R_b	1.0006	1.0006	1.0006
Inflation			
π	1	1	1
Marginal cost			
mc	0.99999	0.81235	0.81235
	Lagrange multipliers		
λ^b	0.010256	0.009749	0.009749
λ^τ	-58.9234	-57.8934	-57.8934

Source: author, 2021.

Suppose that after reporting the first confirmed case of the COVID-19 in Jan 2020, the Thai government expected that, in the absence of a vaccine, almost 60 percent of the population would be infected and transform to recovered or deceased eventually.

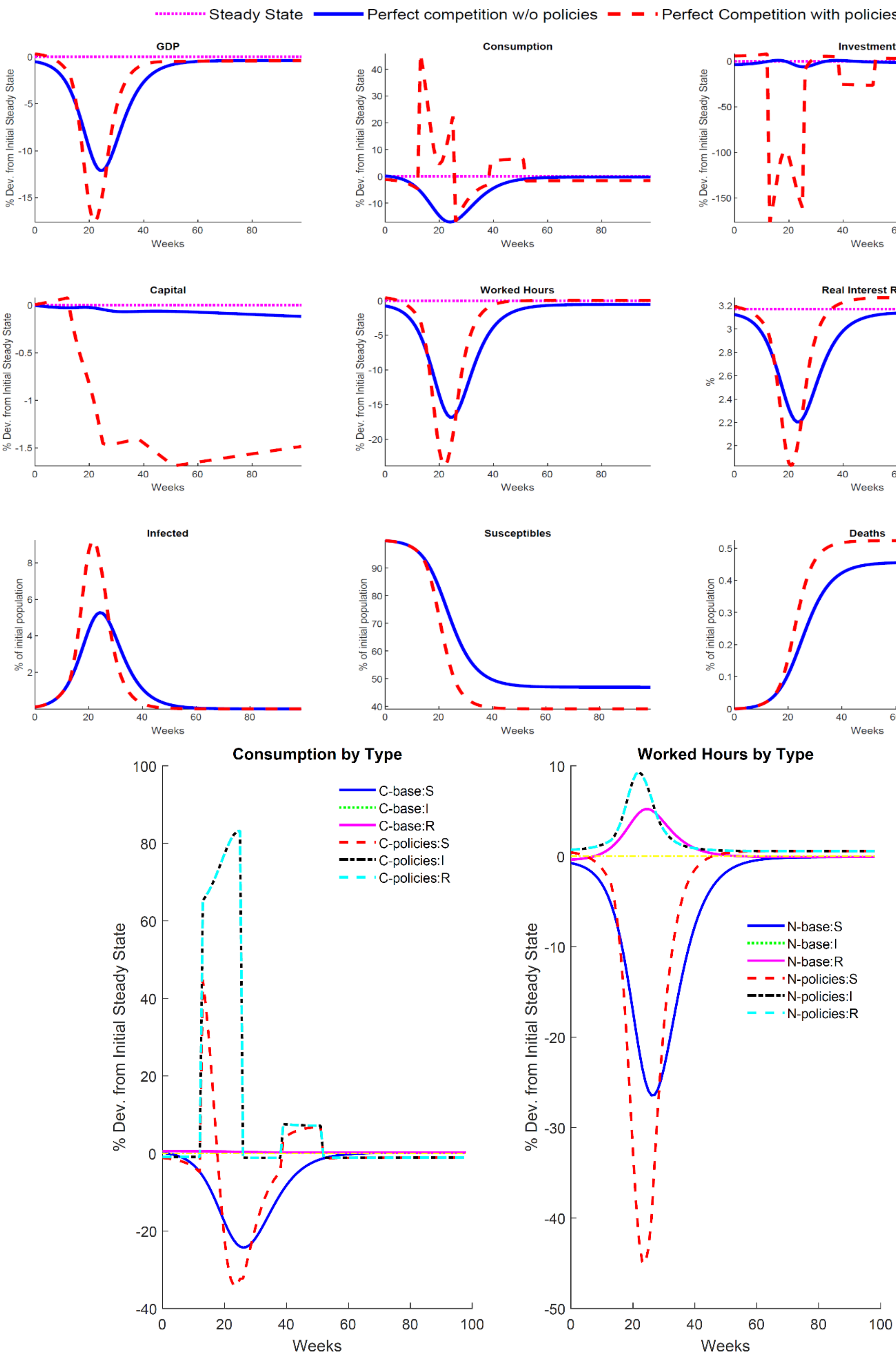

Figure 1. The Thai economic recession due to the COVID-19 outbreak in the Neoclassical (perfect competition) model

Source: author, 2022.

According to data on the mortality and recovery rates in the first wave, the simulation result shows that COVID-19 affected the economy through the household decisions on consumption and work as demonstrated in Figures 1 and 2 (in solid and dotted lines). In the case of perfect competition, aggregate consumption reached its lowest point at $80.90 (-17.03% from the initial steady state) in the 25th week, while the minimum point of worked hours is 29 hours (-16.82%). These recessions imply household responses to the aggravated situation of the COVID-19 outbreak tin which active cases increased to a peak of 5.27% of the initial population in the 24th week. In addition, household investment dropped to $25.44 (-5.76%), and the real interest rate reached its lowest point at 2.21%. The overall economy was stunted to a trough at $131.84 (-12.10%). Considering by type of household member, both the consumption and working hours of susceptible people shrunk to $74.72 (-23.37%) and 26.29 hours (-24.89%), respectively, while the infected and recovered people kept the consumption level close to the steady state but raised worked hours to 36.82 hours (+5.21%).

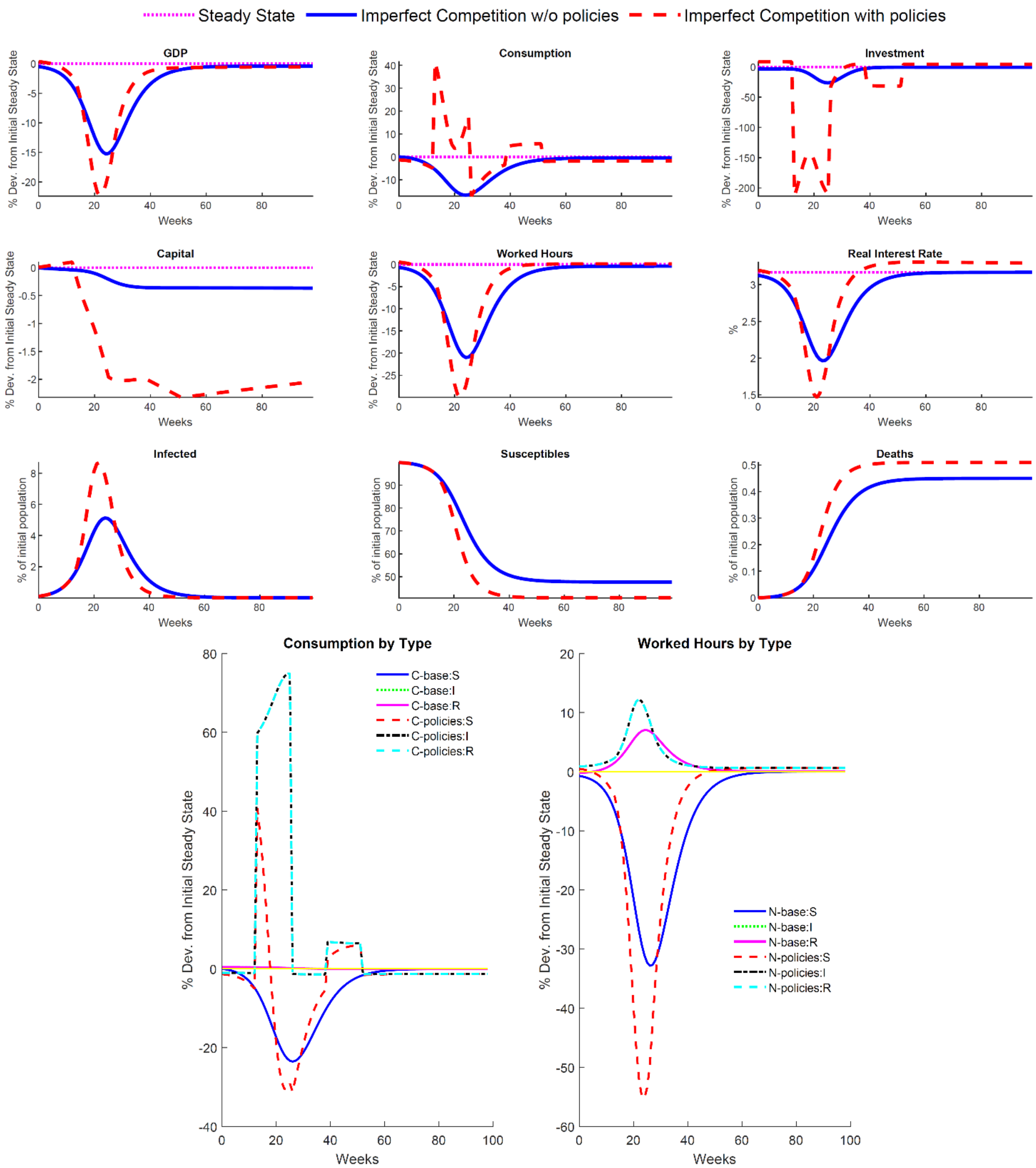

Figure 2. The Thai economic recession due to the COVID-19 outbreak in the Neoclassical (imperfect competition) and New Keynesian (sticky price) models

Source: Author (2022)

Simulation results for the imperfect competition (flexible price) and new Keynesian (price stickiness) models are very similar. They reflect the severe effect of COVID-19 more than the case of perfect competition, with the lowest point of worked hours at 27.66 hours (-20.98%) in the 25th week, while the aggregate consumption decreased to $85.40 (-16.74%), and the peak of active cases was 5.12% of the initial population, which is very similar to perfect competition. In this case, household investment and the lowest real interest rate decreased to $16.2 (26.0%) and 1.97%, respectively. The overall economy was stunted to reach a trough at $127.1 (-15.2%). Considering by type of household member, both the consumption and working hours of susceptible people declined to $79.2 (-22.75%) and 24.1 hours (-31.1%), respectively, while the infected and recovered people kept the consumption level close to the steady state but raised worked hours to 37.46 hours (+7.0%).

After this, suppose that the government is concerned about the worsening situations above if no fiscal policy is implemented. Therefore, the government's consumption stimulus policy was issued: 1) "We Do Not Leave Each Other" scheme, and 2) "50:50 Co-Payment" scheme, in different amounts and periods of the epidemic. The consumption stimulus policies can affect the economy through the household decisions by changing the amount of the government transfer in terms of the negative consumption tax rate. This tax rate varied in each period of the policy implementation to keep a constant amount of transfer and match the actual objectives of the schemes.

The effects of the policies are demonstrated in previous figures (dash and dash-dotted lines). For the 1st scheme, although the aggregate consumption in the perfect competition models reached its highest point at 142.09 (+45.73% from the initial steady state) in the 1st week of the policy implementation (the 14th week of the model's simulation), it continued to decline after that because the susceptible people were aware and avoided being infected. In addition, household investment dropped to -$20.6 (-176.4%), and the real interest rate was lowest at 1.83%. After the active case increased to a peak of 9.21% of the initial population in the 22nd week, the worked hours declined to a trough of 26.66 hours (-23.84%) in the 23rd week. Then the aggregate consumption slightly increased corresponding to the lower severity of the outbreak between the 23rd week to 26th week. In this case, the worked hours of susceptible people sharply reduced to a minimum at 19.25 hours (-45%), in the 25th week, while the infected and recovered people increased the consumption to its highest level at 178.65 (+83.22%) as worked hours rose to 38.25 hours (+9.30%).

There is a tiny difference between the imperfect competition and the New Keynesian model simulation results: the lower decline of investment and real interest rates in the case of the New Keynesian model. This reflects a serious effect of COVID-19 on the economy more closely than the perfect competition model with the slump in worked hours to 24 hours (-30%). On the other hand, the aggregate consumption and active cases showed the highest increase to $145 (+41.6%) and 8.7% of the initial population, respectively. Furthermore, household investment dropped to -$25.44 (-214%), and the real interest rate was at its lowest at 1.5%. Considering by type, the consumption and worked hours of the susceptible people were reduced to their lowest at $71 (-30.5%) and 15.7 hours (-55%), respectively, while the infected and recovered people kept the consumption level close to the steady state but worked hours rose to 39 hours (+11%).

In summary, the "We Do Not Leave Each Other" scheme affected the macroeconomic variables, especially consumption and investment. Changes in the opposite direction of investment and consumption imply the crucial role of government spending to drive the households' consumption. While the 2nd scheme (50:50 Co-Payment) was implemented when the economy was returning to its initial steady state, its consequences were unaffected by the infection situation because the outbreak was over as the number of infected people approached zero. As in the first scheme, the distortion of government spending incentives caused households to cut back on investment to increase consumption, but the effect was minimal with a smaller amounts involved. Overall, this scheme had no significant impact on worked hours and GDP.

At first glance, it may seem that the government's consumption stimulus policies have made the economy and the epidemic situation even worse because of the sharp decline in GDP, investment, and working hours. Moreover, it has accelerated the COVID-19 epidemic to a peak more rapidly and intensely. An approach that will allow us to assess the effectiveness of policies would be to integrate GDP changes over the periods that cover policy action. The calculation of net change in GDP per capita shows that the two policies introduced by the government to boost consumption helped mitigate a total annual economic loss of $36.88 and $26 per capita in the perfect and imperfect competition models, respectively, compared with the case of no policies.

CONCLUSION

Simulation results show the household responses. The epidemic incident caused the households to decrease consumption, work hours, and investment in order to prevent infection. These steps led to a contraction of the economy. Furthermore, the households responded to the measures by sharply reducing investment so as to increase consumption during the implementation period, especially in the first week. Changes in the opposite direction between consumption and investment imply the crucial role of government spending to drive the households' consumption.

In reality, the government recognized that the cost to reduce economic losses would be more people dying from infections. Therefore, the government has implemented a combination of other containment policies such as a partial lockdown, social distancing to limit physical contact activities, and vaccination, which can help to mitigate the loss of human life.

REFERENCES

Andersen, A.L., Hansen, E.T., Johannesen, N., Sheridan, A. (2020), ,,Consumer responses to the COVID-19 crisis: Evidence from bank account transaction data", SSRN 3609814.

Apaitan, T., Banternghansa, C., Paweenawat, A., Samphantharak, K. (2020), "Common Ownership, Domestic Competition, and Export: Evidence from Thailand", *Working paper*, No. 140, Puey Ungphakorn Institute for Economic Research.

Baker, S.R., Farrokhnia, R.A., Meyer, S., Pagel, M., Yannelis, C. (2020), "Income, Liquidity, and the Consumption Response to the 2020 Economic Stimulus Payments", *Working paper*, No. w27097, National Bureau of Economic Research.

Baldwin, R. (2020), "Keeping the Lights on: Economic Medicine for a Medical Shock", VoxEU, org, 13.

Bank of Thailand (2021), ,,Unemployment rate by Region (Whole Kingdom) Q1:2013-Q4:2020", https://www.bot.or.th/App/BTWS_STAT/statistics/ReportPage.aspx?reportID=638&language =eng (accessed 20 August 2021).

Belsie, L. (2022), ,,German Consumption-TaxCut Boosted Spendingduring Pandemic", https://www.nber.org/digest-202201/german-consumption-tax-cut-boosted-spending-during-pandemic, (accessed 5.10.2021).

Carlsson-Szlezak, Philipp, R.M., Swartz, P. (2020a), "Understanding the Economic Shock of Coronavirus", *Harvard Business Review*, Vol. 27.

Carlsson-Szlezak, Philipp, R. M., Swartz, P. (2020b), "What Coronavirus Could Mean for the Global Economy". *Harvard Business Review*, Vol. 3, No. 10.

Chen, H., Qian, W., & Wen, Q. (2021, May), "The Impact of the COVID-19 Pandemic on Consumption: Learning from High-Frequency Transaction Data" in AEA Papers and Proceedings, Vol. 111, pp. 307-311.

Christelis, D., Georgarakos, D., Jappelli, T., Kenny, G. (2021), "How has COVID-19 Crisis Affected Different Households' Consumption in the Euro Area", *ECB Research Bulletin*, Vol. 84.

Department of Disease Control, M. o. P. H. (2020), ,,COVID-19 Infected Situation Updated Daily 12/1/2020-31/12/2020", http://ddc.moph.go.th/covid19-dashboard (accessed 12 August 2021).

Eichenbaum, M. S., Rebelo, S., & Trabandt, M. (2020a), "Epidemics in the neoclassical and new Keynesian models", Working paper, No. w27430, National Bureau of Economic Research.

Elenev, V., Landvoigt, T., Van Nieuwerburgh, S. (2020), ,,Can the COVID bailouts save the economy?", *Working paper*, No. w27207, National Bureau of Economic Research.

Jones, C.I. (2021), *COVID-19 and the Macroeconomy, Supplement to Macroeconomics*, 5th edition, https://web.stanford.edu/~chadj/Macroeconomics_Covid.pdf, (accessed 15.12.2021).

Kim, S., Koh, K., Zhang, X. (2020), "Short-term impact of COVID-19 on consumption spending and its underlying mechanisms: Evidence from Singapore", *Canadian Journal of Economics*, Vol. 5, No. 2, pp. 115-134.

Kubota, S., Onishi, K., Toyama, Y. (2021), "Consumption responses to COVID-19 payments: Evidence from a natural experiment and bank account data", *Journal of Economic Behavior & Organization*, Vol. 188, pp. 1-17.

Luangaram, P., Sethapramote, Y. (2016), *Central bank communication and monetary policy effectiveness: Evidence from Thailand*, Puey Ungphakorn Institute for Economic Research.

Mohsin, A., Hongzhen, L., Hossain, S.F.A. (2021), "Impact of COVID-19 Pandemic on Consumer Economy: Countermeasures Analysis", *SAGE Open*, Vol. 11, No. 2, 21582440211008875.

National Economic and Social Development Council (2021a), ,,GDP: 2002p: CVM: PFCE: Household (HH) 2000-2020", https://www.ceicdata.com/ (accessed 15 August 2020).

National Economic and Social Development Council (2021b), ,,Gross Domestic Product: 2002p: Chain Volume Measures (CVM) Q4:2000-Q4:2020", https://www.ceicdata.com/, (accessed 15 August 2020).
National Economic and Social Development Council (2021c), ,,Population: Whole Kingdom 2000-2020", available at: https://www.ceicdata.com/ (accessed 15 August 2020).
National News Bureau of Thailand. (2020), ,,WHO praises Thailand for COVID-19 effort", https://thainews.prd.go.th/en/news/detail/TCATG201115175046592, (accessed 20 June 2021).
Office of the National Economic and Social Development Council. (2021a), ,,Depreciation Capital Stock (DCS): 2002: Total", https://www.ceicdata.com/, (accessed 15 August 2020).
Office of the National Economic and Social Development Council. (2021b), ,,Gross Capital Stock (GCS): 2002: Total", https://www.ceicdata.com/(accessed 15 August 2020).
Phrommin, K. (2018), "Monetary policy analysis under headline and core inflation targeting in Thailand", *Thailand the World Economy*", Vol. 36, No. 2, pp. 1-31.
Takahiro, H.A.T.T.O.R.I., Norihiro, K.O.M.U.R.A., Takashi, U.N.A.Y.A.M.A. (2021), "Impact of Cash Transfers on Consumption during the COVID-19 Pandemic: Evidence from Japanese Special Cash Payments", *Discussion paper*, No. 21043, Research Institute of Economy, Trade and Industry.
Tanboon, S. (2008), ,,The Bank of Thailand Structural Model for Policy Analysis", www.bot.or.th/Thai/MonetaryPolicy/MonetPolicyKnowledge/Documents/32dp122008th_surach.pdf (accessed 15 August 2020).
UTCC Center for Economic and Business Forecasting (2021), ,,Average Consumer Confidence Index Q1:2010-Q4:2020", http://cebf.utcc.ac.th/(accessed 11 July 2021).
World Bank (2019a), ,,GDP per capita (current USD) 2019-2020", https://data.worldbank.org/indicator/NY.GDP.PCAP.CD, (accessed 12 April 2021).
World Bank (2019b), ,,General government final consumption expenditure (% of GDP) 2019-2020", https://data. worldbank.org/indicator/NE.CON.GOVT.ZS (accessed 12 April 2021).

APPENDIX

Appendix table. The list of equilibrium conditions

Equilibrium condition	*Description*
$y_t = \breve{p}_t A k_t^{1-\alpha} n_t^{\alpha}$	Production function
$mc_t = \dfrac{w_t^{\alpha}(r_t^k)^{1-\alpha}}{A\alpha^{\alpha}(1-\alpha)^{1-\alpha}}$	Marginal cost
$w_t = mc_t \alpha A n_t^{\alpha-1} k_t^{1-\alpha}$	Cost minimizing inputs
$k_{t+1} = x_t + (1-\delta)k_t$	Law of motion of capital
$y_t = c_t + x_t + g$	Aggregate resources
$n_t = s_t n_t^s + i_t n_t^i + r_t n_t^r$	Aggregate hours worked
$c_t = s_t c_t^s + i_t c_t^i + r_t c_t^r$	Aggregate consumption
$\tau_t = \pi_1(s_t c_t^s)(i_t c_t^i) + \pi_2(s_t n_t^s)(i_t n_t^i) + \pi_3(s_t i_t)$	Newly infected
$s_{t+1} = s_t - \tau_t$	Total susceptibles
$i_{t+1} = i_t + \tau_t - (\pi_r + \pi_d)i_t$	Total infected
$r_{t+1} = r_t + \pi_r i_t$	Total recovered
$d_{t+1} = d_t + \pi_d i_t$	Total deceased
$pop_{t+1} = pop_t - \pi_d i_t$	Total population
$\dfrac{1}{c_t^s} = \lambda_t^{\sim b}(1-\mu_j) - \lambda_t^{\tau}(i_t c_t^i)$	F.O.C. for consumption of susceptibles
$\dfrac{1}{c_t^i} = \lambda_t^{\sim b}(1-\mu_j)$	F.O.C. for consumption of infected

$\frac{1}{c_t^r} = \lambda_t^{\sim b}(1-\mu_j)$	F.O.C. for consumption of recovered
$\theta n_t^s = \lambda_t^{\sim b} w_t - \lambda_t^r \pi_2 (i_t n_t^i)$	F.O.C. for hours worked of susceptibles
$\theta n_t^i = \lambda_t^{\sim b} w_t$	F.O.C. for hours worked of infected
$\theta n_t^r = \lambda_t^{\sim b} w_t$	F.O.C. for hours worked of recovered
$\lambda_t^{\sim b} = (r_{t+1}^k + 1 - \delta)\beta \lambda_{t+1}^{\sim b}$	F.O.C. for capital
$\lambda_t^i = \lambda_t^s + \lambda_t^r$	F.O.C. for new infected
$\log(c_{t+1}^s) - \frac{\theta}{2}(n_{t+1}^s)^2 + \lambda_{t+1}^r \left[\pi_1 c_{t+1}^s (i_{t+1} c_{t+1}^i) + \pi_2 n_{t+1}^s (i_{t+1} n_{t+1}^i) + \pi_3 i_{t+1}\right] + \lambda_{t+1}^{\sim b}\left[w_{t+1} n_{t+1}^s - (1-\mu_j) c_{t+1}^s\right] - \frac{\lambda_t^s}{\beta} + \lambda_{t+1}^s = 0$	F.O.C. for susceptibles in the next period
$\log(c_{t+1}^i) - \frac{\theta}{2}(n_{t+1}^i)^2 + \lambda_{t+1}^{\sim b}\left[w_{t+1} n_{t+1}^i - (1-\mu_j) c_{t+1}^i\right] - \frac{\lambda_t^i}{\beta} + \lambda_{t+1}^i (1 - \pi_r - \pi_d) + \lambda_{t+1}^i \pi_r = 0$	F.O.C. for infected in the next period

Equilibrium condition	*Description*
$\log(c_{t+1}^r) - \frac{\theta}{2}(n_{t+1}^r)^2 + \lambda_{t+1}^{\sim b}\left[w_{t+1} n_{t+1}^r - (1-\mu_j) c_{t+1}^r\right] - \frac{\lambda_t^r}{\beta} + \lambda_{t+1}^r + \lambda_{t+1}^r = 0$	F.O.C. for recovered the next period
$\lambda_t^{\sim b} = \beta r r_t \lambda_{t+1}^{\sim b}$	F.O.C. for bonds
$rr_t = \frac{R_t^b}{\pi_{t+1}}$	Real interest rate
$K_t^f = \gamma mc_t \lambda_t^{\sim b} y_t + \beta \xi \pi_{t+1}^{\frac{\gamma}{\gamma-1}} K_{t+1}^f$	Nonlinear price setting 1
$F_t = \lambda_t^{\sim b} y_t + \beta \xi \pi_{t+1}^{\frac{1}{\gamma-1}} F_{t+1}$	Nonlinear price setting 2
$K_t^f = F_t \left(\frac{1-\xi \pi_t^{\frac{1}{\gamma-1}}}{1-\xi}\right)^{-(\gamma-1)}$	Nonlinear price setting 3
$\breve{p}_t = \left[(1-\xi)\left(\frac{1-\xi \pi_t^{\frac{1}{\gamma-1}}}{1-\xi}\right)^{\gamma} + \xi \frac{\pi_t^{\frac{\lambda}{\gamma-1}}}{\breve{p}_{t-1}}\right]^{-1}$	Price dispersion
$\log \frac{R_t^b}{R^b} = \theta_\pi \log \frac{\pi_t}{\pi} + \theta_y \log(\frac{y_t}{y_t^f})$	Taylor rule

Source: author, 2021.