SIR Model and Macroeconomics of COVID-19

Introduction to the special issue “SIR Model and Macroeconomics of COVID-19”

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This is the second of two special issues on the economics of COVID-19.¹ The first special issue covered the impacts of COVID-19 on various dimensions of the Japanese economy such as the macroeconomy, individual behavior, consumption, labor market, education, and firm activities. This special issue focuses on the application of an epidemiological model (the most frequently used model is SIR (susceptible–infected–recovered) model) to macroeconomic analyses of COVID-19.

Actual policy discussions have referred extensively to the projections of new COVID-19 cases that come from SIR models; therefore, these projections have influenced many important decisions. Japan is no exception. While such projections depict the situation from an “epidemiological” point of view, depicting the situation in terms of an “economic” point of view is also important, because COVID-19 and countermeasures against it have caused enormous economic downturns. Evidently, there have been active discussions on how a policy against COVID-19 results in the costs and benefits from the epidemiological and economic viewpoints. A policy may achieve a better outcome from both viewpoints, or it may achieve a better outcome from only one viewpoint while worsening an outcome with the other one. Thus, scholars, especially in the field of economics, need to integrate epidemiological and economic models so that we can discuss the trade-off (if any) between health and economy.

Fortunately, with the recent advancement in academic research, many economists have been working on the application of the SIR model to macroeconomic analyses and have been explicitly examining the status of the trade-off. The purpose of this special issue is to overview the methodology and the literature of macroeconomics

¹ The three guest editors from Japanese Economic Association COVID-19 Working Group (WG) are assigned for those two volumes of the special issues. Please see the introduction to the first special issue (Iwamoto, Miyakawa and Ohtake 2021) for the background information of the WG.

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on epidemics and to showcase some of the recent empirical studies that succeed in such an attempt.² For the first purpose, we include two review articles that show the current status of the research on epidemics in economics and mathematical epidemiology, respectively. Then, for the second purpose, we have added three studies that use the SIR model to explicitly examine the trade-off between health and economy in the context of Japan.

The five studies in this special issue are as follows: Iwamoto's "Welfare economics of managing an epidemic: An exposition" provides a detailed survey of the recent studies on the normative analysis of private and governmental countermeasures against infectious diseases. Iwamoto summarizes the basics of the model that relates economic activity to epidemics and highlights the key results of the studies that attempt to solve for a socially optimal policy. Among various issues, this paper has an intensive discussion on the importance in how we measure the value of a statistical life and the possible targeted policy.

Kuniya's "Structure of epidemic models: Toward further applications in economics" is a mathematical epidemiologist's guide to epidemic models that is useful for economists to learn about the frontier of the discipline. A basic SIR model ignores various aspects that economists think are important. For example, economists emphasize behavioral responses to the prevalence of epidemics (Philipson, 2000). In this regard, this paper shows that mathematical epidemiologists have in fact already incorporated them in the epidemic model and likened them to the existence of sustained periodic solutions that may explain the recurrent epidemic waves. Another direction of the extension is to account for the heterogeneity of the population by building a multidimensional model. Kuniya also explains useful measures in the multidimensional model to understand the effect of interventions: control reproduction number and type reproduction number. Mathematical epidemiologists have also developed models with age structure, seasonality, spatial diffusion, mutation, and reinfection. Economists will find that epidemiologists have tackled common problems in different ways. In this sense, Kuniya's paper will be an important step in building a bridge between epidemiologists and economists.

Fujii and Nakata's "COVID-19 and output in Japan" presents the progress of their unique research project. While studies using the SIR model have provided projections of the spread of COVID-19 in Japan, the trade-off between health and economy had not been rigorously treated until their simulation analysis appeared in January 2021. They updated the model weekly and have provided a timely analysis of policy issues, for example, when the State of Emergency (SOE) should be lifted, how the Tokyo Olympic Games would affect new infections, and how the delta variant could change the course of the pandemic. About the timing of lifting the SOE, they find that if the SOE were lifted too early, the number of new cases would surge and another SOE would be needed that could result in worse economic and health outcomes. As a timely study that depicts the economic costs and health outcomes of alternatives, the media has frequently reported and presented these analyses to policymakers on many occasions. In this paper, they explain the technical details of their model and insightful findings about the various issues.

² Other recent studies in this direction include Hosono (2021) and Fukao and Shioji (2021).

Kubota's "The macroeconomics of COVID-19 exit strategy: The case of Japan" is a study on Japan's soft lockdown policies in 2021 that uses a SIR-Macro model. As a unique feature, it provides the result of the study of Japan's second soft lockdown policy from January to March 2021, which was done by the author in February 2021, and then evaluates that policy from an *ex post* perspective in July 2021. It shows that the model broadly captures the realized consequences of the second soft lockdown and the subsequent paths that to some extent validate the usefulness of the model. Given that the model works properly, the simulation to the end of the pandemic and some discussions on specific policy interventions such as the inverse lockdown are also analyzed.

Hoshi, Kasahara, Makioka, Suzuki, and Tanaka's "Trade-off between job losses and the spread of COVID-19 in Japan" examines how job losses and the case growth rate are related to people's mobility. They use an empirical specification from the social planner's resource constraint under the SIRD (susceptible–infected–recovered–deceased) model and Japanese prefecture-level panel data to report the following results. First, a decrease in mobility that is driven by containment policies is associated with an increase in involuntary job separation but high tele-workability mitigates the negative effect of decreased mobility on job losses. Second, the case growth rate is positively related to an increase in people's mobility but negatively associated with past confirmed cases. Third, the trade-off between job losses and the case growth becomes substantially worse in the longer run that reflects the exponential case growth when the people's mobility is high. This is a good example of recent studies applying the epidemiological model to macroeconomic analysis and explicitly analyzing the status of the trade-off between health and economy.

As the guest editors of this special issue, we want to thank again Professor Hidehiko Ichimura, the editor of *The Japanese Economic Review*, for providing another publishing opportunity. We also greatly appreciate anonymous referees for their productive comments and suggestions that were necessary to insure the quality of the studies. We hope this special issue facilitates the chance for both academic researchers and practitioners to better understand the interaction between epidemiologic and economic analysis that contributes to ongoing academic and policy discussions in the current and possible future pandemics.

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