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Infectious disease outbreak and trade policy formulation

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Abstract

This paper provides a framework to understand why a country might resort to a policy like an import ban when at risk from infectious disease outbreak overseas. Superior import-competing domestic production technologies, and over-reliance on taxing the public for government revenue, could lead to blocked trade. The results of the two-country political economy model lend support to the wide use of public health interventions to minimize infections, and highlight their role in promoting open trade policies.

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1. Introduction

Global commerce has been threatened quite regularly over the past couple of decades by frequent outbreaks and spread of infectious diseases. This has prompted many countries to respond by putting strict restrictions on imports from affected countries, often to the detriment of the parties involved, and at the expense of stability in the global trading system. Examples range from the recent Russian response to the *E. Coli* outbreak in Germany in the summer of 2011, to the draconian measures instituted by China (in addition to at least 15 other countries) to address the H1N1 virus in 2009, to the widespread import bans on poultry that devastated this industry in Asia in response to the avian influenza in 2004. It is no wonder that public anxiety is at new heights due to the frightening news reports on these and similar events. Policymakers have been scrambling to identify responses to these outbreaks that safeguard public health without unnecessary interference with international trade. This paper provides a framework that illustrates how global disease outbreaks interact with features of the domestic economy to generate trade policy. To add to the relatively sparse literature on this issue, the paper focuses on the role that the objectives of policymakers play in formulating a trade policy response, when faced with public health uncertainty in a trading partner. Understanding the underlying forces that give rise to a specific trade regime in this context is an important step toward avoiding undesirable health and economic outcomes.

The threat from infectious disease is not new. However, it has taken on global dimensions because international trade and travel make it easy for pathogenic microbes to spread to new populations. For some time now, public health scholars have been studying the globalization of infectious disease due to international trade, and health policies that could be effective in protecting populations. For example, Kimball (2006) focuses on health issues resulting from global trade, describes different kinds of pathogens, and discusses both fast-moving and long-incubation diseases. Much research has obviously been done in epidemiology to understand and analyze the spread of infectious disease in populations. Although economics has been relatively less involved in the conversation on the impact of infectious diseases, it has still made notable contributions. Roberts (2006) collects an impressive list of articles that bring an economics perspective to bear on the consequences of infectious disease. However, most of the economic epidemiology literature has centered on understanding the behavior of agents in order to design public health interventions (Gersovitz and Hammer, 2003). For example, Auld (2003) uses a dynamic model to study risky behavior during an epidemic. Chakraborty, et al. (2010) develops a general equilibrium model of infectious disease with a focus on prevention methods, while Momota, et al. (2005) and Mesnard and Seabright (2009) study the same in an overlapping-generations framework and a two-period model respectively. Other studies include the seminal work by Brito, et al. (1991) and its extension by Kureishi (2009).

Existing approaches in economics have not considered the consequences of the globalization of infectious disease on international commerce. While there is recognition of the importance of this issue in the public health community, interest has been confined to designing an adequate set of health policy responses. This paper adds an economic perspective to this discussion. It highlights the mechanics through which trade policy is formed in an environment fraught with uncertainty about vulnerability to infectious disease. Understanding these mechanics would contribute to the development of both effective trade and public health policies.

The paper uses a simple two-country political economy model with the policy-relevant country consuming a certain good which can either be produced domestically or imported from abroad. The government raises revenue through taxation of the local population and from tariffs on imports. In that sense, what the paper refers to as an open-trade policy is in fact a continuation of trade, even with tariffs on imports, rather than an outright import ban. An intuition-confirming finding of the paper is that an open trade regime is more likely—even in the face of an infectious disease outbreak in the exporting country—when the population in the importing country is not highly susceptible to the infection. The paper also finds that the likelihood of observing more trade openness is high when the domestic production technology is relatively inferior to its foreign counterpart. Interestingly, infectious disease outbreak overseas is more likely to prompt the importing country to block trade the more important domestic taxation is to government revenues.

2. The Model

We formulate a model with two countries, Home and Foreign. Home has consumers and a monopolist as two types of agents. The measure of consumers is normalized to one. There are two goods in the Home economy. These are denoted by x_1, which is produced competitively and the price of which is normalized to one, and x_2, which can either be produced domestically or imported from Foreign at an endogenously determined price p. Home is the only market for x_2. Consumer utility at Home is given by:

$$u(x_1, x_2) = x_1 + \frac{1}{a} x_2^a , \tag{1}$$

where $0 < a < 1$. Therefore, consumer demand for x_2 is:

$$x_2 = p^{-\frac{1}{(1-a)}} \tag{2}$$

Production of x_2 follows the function given by:

$$x_2 = \lambda x_1 \tag{3}$$

where λ is a technology that turns one unit of x_1 into λ units of x_2. We assume that Foreign has a comparative advantage in manufacturing x_2. Hence, the technology in Foreign ($\lambda = M$) is superior to the one in Home ($\lambda = N$), i.e. $M > N$.

The monopolist in Foreign also faces an ad valorem tariff, t, on its exports of x_2 to Home. Given the constant elasticity of demand for x_2 from Home, the monopolist in Foreign maximizes profits by using a constant markup over marginal cost. Hence, the profit-maximizing price and profits are given by:

$$p = \frac{1}{a(1-t)M} \tag{4}$$

$$\pi = (1-a)(1-t)^{\frac{1}{1-a}}(aM)^{\frac{a}{1-a}} \tag{5}$$

In addition to tariff revenue, the government in Home can also raise revenue through the lump-sum taxation of its citizens. This tax, *T*, can be chosen to be any amount from zero to $\overline{T}$. This tax allows us to track the importance of a healthy, and therefore taxable, domestic population to the government.

Consider now a situation where Foreign has an outbreak of infectious disease that has the potential of being transmitted to Home by being embedded in the imported good, x_2. We analyze the decision problem of the government in Home whose objective is to maximize its own payoff. This government faces the following four possibilities:

1) Keep trade open but face only low levels of infection
2) Keep trade open and become infected
3) Block imports and contain the infection at low levels
4) Block imports but still become infected. We assume that the infection can get in through other channels such as travel. The seriousness of infection when imports are blocked depends on how porous the other channels are.

As indicated in the introduction, an open trade regime simply refers to a continuation of trade as opposed to a complete ban on imports. Trade with tariffs is still considered to be a policy of openness for the purposes of this analysis.

Let α denote the probability of low infection when imports are blocked. This implies a probability $(1-\alpha)$ of a serious infection under a blocked-imports trade regime. Similarly, let β denote the probability of a limited infection when trade is left open, and $(1-\beta)$ the probability of a high level of infection under an open trade regime. To capture the idea that infections are more likely to be contained if infected goods are prevented from entering Home, we assume $\alpha \geq \beta$.

Let δ^i, $i = H, L$, be the infected proportion of the population in Home, with $\delta^H > \delta^L$, where δ^H is the proportion of the population that is infected when the infection rate is high. We now determine the payoffs, R_i, $i = 1,2,3,4$, of the Home government under the four possibilities enumerated above.

Case 1: Open trade regime and low levels of infection. The Home government imposes the maximum tax, $T = \overline{T}$, on its citizens. Hence, the government obtains:

$$R_1 = (1-\delta^L)\overline{T} + tpx_2 \tag{6}$$

For simplicity, assume $\delta^L = 0$. This allows us to rewrite (6) as:

$$R_1 = \overline{T} + t\frac{1}{a(1-t)M}\left[\frac{1}{a(1-t)M}\right]^{-\frac{1}{(1-a)}} = \overline{T} + t[a(1-t)M]^{\frac{a}{(1-a)}} \tag{7}$$

This implies a revenue-maximizing tax rate of $t = (1-a)$ making the optimal payoff:

$$R_1 = \overline{T} + (1-a)(a^2 M)^{\frac{a}{1-a}} \tag{8}$$

Case 2: Open trade regime and high levels of infection. This is similar to Case 1 except that a greater proportion of the population is infected. Government revenue is therefore:

$$R_2 = (1-\delta^H)\overline{T} + (1-a)(a^2 M)^{\frac{q}{1-a}} \tag{9}$$

Case 3: Blocked trade and low levels of infection. In this case, the government loses its tariff revenue. We assume that to replace lost imports in the short term, a domestic firm produces the good and the government levies a tax on this firm to enhance its revenue. Another approach could be to model the government engaging in the import-substituting production instead. In that case, since the government will not tax itself, the revenue equations below will not include tax revenue from domestic output of x_2. However, this does not affect the implications of the model. Proceeding with the assumption of a domestic firm producing x_2 and letting $\delta^L = 0$ as before, the government gets:

$$R_3 = \overline{T} + (1-a)(aN)^{\frac{a}{1-a}} \tag{10}$$

Case 4: Blocked trade and high levels of infection. Government revenue is similar to that in Case 3 except for the higher level of infection in this case, and is given by:

$$R_4 = (1-\delta^H)\overline{T} + (1-a)(aN)^{\frac{a}{1-a}} \tag{11}$$

3. Analysis

We can now use the expressions for government revenue in the four cases above to write down the expected returns to the government of maintaining open trade on the one hand, and shutting off imports from the infected country on the other. The expected payoff of keeping trade open is:

$$E(open) = \beta\left[\overline{T} + (1-a)(a^2 M)^{\frac{a}{1-a}}\right] + (1-\beta)\left[(1-\delta^H)\overline{T} + (1-a)(a^2 M)^{\frac{a}{1-a}}\right],$$

which simplifies to:

$$E(open) = \overline{T}(\beta\delta^H + 1 - \delta^H) + (1-a)(a^2 M)^{\frac{a}{1-a}} \tag{12}$$

When trade is blocked, the expected return becomes:

$$E(blocked) = \alpha\left[\overline{T} + (1-a)(aN)^{\frac{a}{1-a}}\right] + (1-\alpha)\left[(1-\delta^H)\overline{T} + (1-a)(aN)^{\frac{a}{1-a}}\right],$$

which can be written as:

$$E(blocked) = \overline{T}(\alpha\delta^H + 1 - \delta^H) + (1-a)(aN)^{\frac{a}{1-a}} \tag{13}$$

Therefore, the government will choose to import good 2 if and only if the following condition holds:

$$\overline{T}(\alpha\delta^H + 1 - \delta^H) + (1-a)(aN)^{\frac{a}{1-a}} < \overline{T}(\beta\delta^H + 1 - \delta^H) + (1-a)(a^2M)^{\frac{a}{1-a}},$$

which simplifies to:

$$(\alpha-\beta)\delta^H\overline{T} + a^{\frac{a}{1-a}}(1-a)\left[N^{\frac{a}{1-a}} - (aM)^{\frac{a}{1-a}}\right] < 0 \tag{14}$$

Here, $(\alpha-\beta)\delta^H\overline{T}$ can be interpreted as the lost expected tax revenue because of an infected, and therefore unhealthy and unproductive, population under an open trade regime. The government also fails to capture sales revenue equal to $(1-a)(aN)^{\frac{a}{1-a}}$ from the domestic manufacture and sale of x_2 in this case. It does, however, earn $(1-a)(a^2M)^{\frac{a}{1-a}}$ in tariff revenue. For sales revenue to be higher than tariff revenues, we must have $N > aM$, i.e., Home must have sufficiently better technology. This suggests that in the case where there is no danger of infection, i.e., $\alpha = \beta = 1$, Home would pursue a policy of openness whenever the technology of Foreign dominates that of Home. If, on the other hand, $\beta < 1$, i.e., Home is vulnerable to infection through international trade, then an open trade regime becomes less likely.

To sum up, openness to trade is more likely even in the face of an infectious disease outbreak in the trading partner when:

a) the prospects of the Home government earning significant revenue through sales of its own output are low, i.e., N is low;
b) the Home government is able to earn substantial revenue through tariffs on imports from its technologically superior Foreign competitor. In other words, M is high;
c) taxes raised from the local population are likely to be low, i.e., $\overline{T}$ is low;
d) the vulnerability to infection is relatively low, i.e., $(\alpha-\beta)$ is low.

4. Conclusion

International trade accounts for a significant portion of global economic activity. Economists and policy makers have long recognized the crucial role trade policy plays in the development and growth of poor nations. According to the World Trade Organization, the volume of global trade, in spite of the severe global contraction of 2008-09, was still in excess of $12 trillion. Nearly half of this was the share of developing countries. Infectious disease outbreak in one part of the world threatens the stability of the whole global economy because of the often surprising ease and speed with which deadly pathogens now travel the globe. For example, cross-border trade in seemingly innocuous products like used car tires has been identified as the culprit that disseminated mosquito vectors for dengue fever to tropical urban centers (Gubler, 1998). The magnitude of the problem and its potential to wreak havoc in the future can be gleaned from the fact that nearly a third of all deaths worldwide can be chalked up to infectious diseases. In 2003, SARS was responsible for a worldwide loss of $50 billion through its impact on global commerce, and this number is likely to multiply given the increasing types and outbreak frequency of infectious disease. According to the National Intelligence Estimate of the United States, infectious diseases could reduce GDP in some Sub-Saharan African countries by as much as 20 percent through their adverse effects on profitability and international investment. Research is needed to better understand the structure and scope of these risks. This paper provides a simple framework to organize our thinking on trade policy generation under the kind of exigent circumstances described above.

One intuitively appealing result of the paper is the tendency toward openness when the importing country is not highly susceptible to infection. The policy response to the avian influenza outbreak in 2004 appears to confirm this conclusion since import bans were mostly instituted by developing countries with weak public health systems while countries such as Canada employed a more nuanced import-inspection policy. Similarly, the Russian response to the *E. Coli* outbreak in Europe may also be viewed as an attempt to safeguard its population from disease, given that Russia overwhelmingly depends on food imports, especially from Germany, and hence has high susceptibility to infections from food sources. The result also confirms the value of the effort expended on identifying effective public health interventions to minimize vulnerability to disease and the potential success these interventions might have in maintaining trade openness.

The paper also underscores the importance of domestic economic features such as technological inferiority of the import-competing sector, and unreliability of the domestic tax base as a source of government revenue, in promoting open trade policies. The Chinese response to the H1N1 virus in 2009 suggests that the reliance of the government on the local population for income is indeed a factor affecting trade policy. In the Chinese case, the factory-of-the-world role of the country and the dependence on a healthy population to maintain and promote growth might be even more critical reasons for the excessively harsh policy response to public health risks from infectious disease. Reduced domestic investment in import-competing production technologies and less dependence on the domestic population as a source of government revenue are therefore likely to be successful in minimizing disturbances to the global trading system due to infectious disease outbreak.

As discussed earlier, economic epidemiology has been mostly limited to understanding the effects of public health interventions to address infectious disease spread (Philipson, 2000), perhaps because of its focus on the domestic economy. Open economy models that incorporate specific disease dynamics are needed to identify both effective trade and health policy responses to the varied courses different diseases take over time. Klein, et al. (2007) present many useful ideas to fuse the economic and epidemiological approaches with an eye toward improving the quality of infectious disease models. Although their main concern is with disease policy inside closed economies, many of their ideas can be gainfully adapted into open economy frameworks.

For example, they correctly point out the need to be attentive to the unique features of different diseases that govern disease epidemiology. This insight is incorporated into a model by Gersovitz and Hammer (2004), with the objective to specify optimal interventions for public health. Future research needs to combine these insights with open economy models to determine effective health as well as trade policies by taking into account the epidemiology unique to the various types of infectious diseases. Policy responses that are tailored to address specific disease outbreaks are most likely to be effective in safeguarding public health without unnecessary disruptions to the global trading system.

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