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PAVING THE PATHWAYS TO RESPIRATORY DISEASE ALLEVIATION: WHAT TRIGGERS TUBERCULOSIS PERVASIVENESS IN ASEAN+3?

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Abstract:

Tuberculosis is a prevalent cause of mortality and morbidity across countries in various income strata, but especially persistent in developing countries such as the Philippines. Thus it is of great significance to determine the various factors that contribute to the spread of this disease, as this may be the key to tuberculosis. This study aims to unearth the factors that contribute to the prevalence of tuberculosis in the member countries of the Association of Southeast Asian Nations and China, Japan and South Korea (ASEAN+3). We employed the Arellano-Bond dynamic panel regression model to determine the relationship of selected socio-economic, demographic and environmental determinants to the pervasiveness of tuberculosis. We have established that per capita gross domestic product and fertility rates posed a positive and significant relationship with tuberculosis pervasiveness, while carbon density exhibited a positive albeit weaker influence on the occurrence of tuberculosis.

Keywords: respiratory disease; carbon emissions; per capita GDP; fertility; Arellano-Bond Dynamic Panel Regression

1. INTRODUCTION

One of the primary culprits and the leading causes of mortality in the world are respiratory diseases, particularly tuberculosis. Tuberculosis is present across countries from broad income strata, but especially pervasive in developing countries such as the Philippines. As indicated by the World Health Organization [WHO] (2011), lower respiratory infections are accountable for numerous deaths across the globe. Lower respiratory infections ranked as the first leading cause of death in low-income countries; while it ranked fourth and fifth on medium- and high-income countries, respectively. These figures underscore that vast advancements in technological progress, it have not succeeded in mitigating respiratory diseases. Furthermore, tuberculosis, a particular sickness that involves an infection on the respiratory tract, is distinguished as another top cause of death. In the global scale, four out of the top ten causes of mortality are respiratory diseases. Lower respiratory infections account for 3.46 million deaths; chronic obstructive pulmonary diseases caused 3.28 million mortalities; trachea, bronchus and lung cancer is the

culprit for 1.39 million deaths; and tuberculosis caused 1.34 million deaths (WHO, 2011). These figures are alarming since health presents dire consequences on human capital and ultimately the overall economic well-being of a country.

Therefore, it is of great significance to pinpoint various determinants of health because knowledge of such could be the key in mitigating and alleviating the pervasiveness of respiratory diseases. It could be explicitly derived from the close examination of specific socio-economic, environmental, and demographic factors that directly have negative effects on human welfare and survival, which could stagnate a country's development.

An economic growth determinant, per capita Gross Domestic Product, could influence one's capacity to increase expenditure in health prevention and other health services. Another indicator of socio-economic growth, Foreign Direct Investments, has the capacity to influence growth in the macro-economy and has the capability to affect human capital and health. However, the inflow of investments could also result to congestion, increase in emissions, and destruction of the environment which would then tend to worsen morbidity. This unclear effect of Foreign Direct Investments towards morbidity and mortality makes it a variable of interest. Demographic indicators could also influence the prevalence of respiratory diseases. The importance of taking into account the concept of urban population and fertility rates stems from the fact that congestion of urban areas could increase the occurrence of respiratory diseases due to the greater chance that virus could be transmitted

Literature on respiratory disease, health, and their determinants has covered a wide range of topics, scenarios, and phenomena. However, we find that a gaping hole in the research is the neglect of socio-economic factors in determining the incidence of respiratory disease. No existing literature has aggregated different variables and correlated them in an attempt to pinpoint the determinants of respiratory diseases. A study wherein the determinants are correlated could foster for the more effective drafting and better implementation of relevant policies that could alleviate respiratory diseases.

2. METHODOLOGY

We adopted the modified health production model of Niringiye & Douglason (2010) to establish the the correlation between socio-economic, demographic, and environmental variables and respiratory sickness prevalence in the ASEAN+3 region, wherein tuberculosis would be a representation of respiratory diseases. Niringiye & Douglason (2010) used malaria incidence rate as their endogenous variable since this is the most prevalent disease in the region that they studied. Thus, in our case, we employed tuberculosis prevalence rate as the endogenous variable

since tuberculosis is one of the top causes of mortality in the world especially in poor and underdeveloped countries, as mentioned in the previous sections and is the variable of interest. The initial panel data model is as follows:

(Eq. 1)

Where:

$RDit$	=	respiratory sickness prevalence rate
CO_2D_{it}	=	yearly intensity of carbon density in a certain country
$PCGDP_{it}$	=	per capita GDP
FDI_{it}	=	FDI
FER_{it}	=	fertility rate
UP_{it}	=	urban population

However, the variables posed the problem of endogeneity for the reason that some of the exogenous variables are correlated. From the definition above, FDI is tantamount to an investment in capital; therefore, there would be a splurge of the establishment industrial factories that would emit more carbon into the atmosphere. On the other hand, it also has an effect on per capita GDP since the capital that is invested in the economy would create more jobs in the labor market, which would increase household income. This could also affect per capita GDP in a sense that household income would increase due to the increase in labor. In addition, per capita GDP is computed by dividing total aggregate income to total population, wherein total urban population is a percentage of total population. Thus, the succeeding model was the modified of the earlier model eliminate the problem of endogeneity. The model that would be used is as follows:

(Eq. 2)

Wherein,

The new variables and are predicted variables and that incorporate the variables foreign direct investments and urban population. Thus, endogeneity is accounted for. The following is the list of variables employed in this model and their corresponding a-priori expectations:

Table 1. A-priori expectations

Variable	Description	A- Priori	Source
CO_2D_{it}	Carbon Density	(+)	*Jacobson, 2010*
$PCGDP_{it}$	Per Capita GDP	(-)	*Aranha, Grisi & Escobar, 2011*
FDI_{it}	Foreign Direct Investment	(-)	*Ramanakumar & Aparajita, 2005*
FER_{it}	Fertility Rate	(+)	*Ait-Khaled, Enarson, & Bousquet, 2001*
UP_{it}	Urban Population	(+)	*Ramanakumar & Aparajita, 2005*

The Arellano-Bond estimator sets up a GMM problem in which the model is specified as a system of equations, one per time period, where the instruments applicable to each equation differ. The instruments include suitable lags of the levels of the endogenous variables, which enter the equation in differenced form, as well as the strictly exogenous regressors and any others that may be specified. This estimator can easily generate an immense number of instruments, since by period τ, all lags prior to, say (τ - *2*), might be individually considered as instruments (Baum, 2010).

3. RESULTS AND DISCUSSION

The factors for the incidence of respiratory diseases, through tuberculosis, were determined using the Arellano-Bond panel regression model. However, there was a need to lag and by one year. The very nature of carbon emissions make it susceptible to being carried in the air and are transported to different places other than that of the origin. Therefore, these gases that are emitted travel across the air which causes some time lag that can affect individuals. Similarly, an

increase in aggregate income in the contemporaneous period would not result to an immediate mitigation of respiratory diseases. This is because the additional income earned must be reinvested in facilities, medicines, vaccination programs and other activities that would lower respiratory diseases. The succeeding table shows the results of the Arellano-Bond Dynamic Panel Regression model on the variables after taking into account endogeneity.

Table 2. Arellano-Bond Regression on Determinants of Tuberculosis

Variable	Description	Coefficient	P- Value
	Carbon Density	0.06147	0.448
	Per Capita GDP	0.00092	0.014*
FER_{it}	Fertility Rate	1.39180	0.046*

*significant at $\alpha < 0.05$

Using the Arellano-Bond dynamic panel regression model, it was pointed out that carbon density, per capita GDP, and fertility rates all have positive effects on respiratory diseases. This is due to the fact that economic growth can release pollutants in the environment through urbanization and increase in capital investments that emit harmful substances in the atmosphere. Once an individual has more income, he or she has more money in order to engross in the holistic development of his or her lifestyle. However, this is only true to the middle- and high-income brackets in the population. On lower-income brackets, consumption and investment patterns resulting from an increase in income differ. These individuals put less premium on consumption and investment on goods and services that improve health since they prioritize the necessities such as food and shelter. Thus, the prevalence of respiratory diseases persists despite the increase in income. On the other hand, an increase in childbirth can cause congestion that can rapidly transfer significant viruses and bacteria and also increase the probability of transferring diseases through hereditary means. Finally, there exists a positive relationship between occurrences of respiratory diseases and carbon density but their relationship is of less significance. This is due to the fact that the composition of carbon comprises only an insignificant amount of harmful gases. Carbon emissions, being gaseous in nature, travels instantaneously across national boundaries. Also, although the ASEAN+3 region was chosen due to their proximity to reduce the effect of gas dispersion, it must be noted that China, Japan, and South Korea have extremely high carbon footprints compared to the ASEAN developing countries which weakened the relationship The lack of an effective means of measuring carbon emissions, regardless of origin, weakens the inference and presents difficulties of truly capturing the relationship

4. CONCLUSIONS AND RECOMMENDATIONS

The research reinforced the findings of the existing literature that socio-economic, demographic, and environmental factors do indeed contribute and affect respiratory disease prevalence. However, the results show that the level of significance of the effect of each variable is not uniform across all factors especially if the theories in the literature is applied to the

ASEAN+3 region. This is especially true for carbon emissions, which has long been targeted by the literature as the primary culprit of respiratory diease prevalence. Despite respiratory diseases being persistent in developing countries, we were able to show that mitigation of respiratory diseases is possible and achievable through careful drafting and implementation of policies which would have effects on specific socio-economic, demographic and environmental factors. The results also expose the need for a better, more consistent measure of variables such as carbon emissions to further improve the inference and for the collection of more specific variables in both the macro- and microeconomic levels for a more effective study to be conducted. we are able to provide an avenue into improving the economic well-being of countries by exposing factors that will contribute to the mitigation of respiratory diseases. We are also able to provide a study which could be the starting point of a bevy of future studies and research work since our study could be used by other regions and countries and could also be modified through adding or tweaking variables. Lastly, and perhaps most important, we are able to provide means of preserving the thousands of lives claimed by respiratory diseases.

With this, certain policies have to be implemented for a more sustainable form of economic development while mitigating the prevalence of respiratory diseases in the ASEAN+3 region. Government policies should be aimed to stabilize the spatial distribution by promoting internal migration from urban to rural areas. To strengthen this, policies must be aimed to increase incentives for individuals to return to the rural areas. Economic development in the regional level could attract people to shift from the already congested urban areas to the sparsely populated areas. A possible action of the government is to increase private-public partnership to provide progress and job opportunities in the rural areas. Currently, population density is skewed in the urban areas, increasing congestion and ultimately increasing incidence of disease. Thus, a policy would be to create and strengthen regional capitals so that urbanization would not be concentrated in just a small area of the country. This would spur development in the rural areas, improve infrastructures and its spillover would be to improve standard of living. However, such a development must be undertaken with precaution so as not to deplete the environment which would further exacerbate respiratory disease prevalence.

The results also show that socio-economic factors such as per capita GDP and FDI has an effect on respiratory disease prevalence. As such the thrust of the succeeding policies to be recommended shall focus on optimizing national income and income from FDI in order to mitigate respiratory diseases. Policies include incorporating environmental protection measures in free trade agreements, treaties and regional integration measures. Also, laws on harnessing national resources must be established so that these resources would not be depleted. Also, there must be a regional effort to regulate and review each member country's standards and must be kept globally competitive in order for the inflow of investment to improve standard of living. A regional overseeing body could suffice for that purpose.

A popular policy in the internalization of externalities is the imposition of Pigovian taxes and Pigovian subsidies (otherwise known as negative Pigovian taxes). However, inefficiencies arise by the imposition of such. First, a tax on direct amount of emissions per firm or per country would entail measurement of the amount of carbon emited, which would be costly. A Pigovian subsidy, on the other hand, would encourage lobbying to government regulators and other rent-seeking activities. Pigovian taxes also encourage underhanded and undetected means of disposing waste to minimizes the tax burden. Therefore, we propose a multi-part taxation instrument that will be imposed in a uniform manner throughout all the member countries. This tax instrument will include both a Pigovian tax and a Pigovian subsidy. Pigovian taxes must be imposed not on direct emissions but on market factors such as taxation on goods and services that resulted into carbon emissions. This way, a more efficient measure of the externality is arrived upon.

The role of consumers is also crucial in order to effectively mitigate tubercolosis and carbon emissions. A demand shift towards healthier products that do not aggravate or induce respiratory diseases especially tuberculosis is essential for this would disincentivise producers from producing environmentally and physiologically harmful products. Admittedly, health and eco-friendly products would tend to be more costly and thus have a difficulty in penetrating the market against cheaper albeit more harmful products. Therefore, what must be done is a subsidy from the government for such producers so that they can penetrate the market.

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