CHAPTER 6

DISCUSSION

This chapter looks at the reliability of the equations 5.9 and 5.11 for forecasting purposes and then the economic implications of the two functions developed as far as malaria control activities are concerned in Thailand assuming similar situations for all the endemic areas in the country.

6.1 The Reliability of the Regression Equations

We examine the equations (5.9 and 5.12) in turn for purposes of convenience.

The precise equation taken from equation (5.9) is

$$Q_{ij} = 13.17 + 0.33S_{ij} - 1.43X_{ij} - 2.24\log I_j - 3.38\log G(-1)_j \quad (5.13)$$

The R^2 value of 0.987 tells us that the regression equation explains 98.7% of the total variation, that is, that variations in S, X, logI and logG(-1) explain 98.7% of the variation in the demand for treatment services. There is the need to know the levels of precision and confidence that are associated with the values for the independent variables inserted to ensure that the forecast of the demand for malaria services will be as accurate as this regression equation allows. The same approach should be applied to increase the accuracy of the demand forecast when equation (5.13) is used. The F test value of 270.13 shows that the entire equation is significant. All the t ratios are statistically significant, which indicates that the term and each of the regression coefficients is significantly different from 0. Examinations of the residual plots show that the residuals are about constant. They are neither larger nor smaller in the beginning or at the end. The value of the D-W test of 1.867 falls within the allowable range of 1.72 to 2.28 and finally the normality of the residual distribution is assumed acceptable as the number of observations is quite large enough.

Once the regression equation is found (1) whose regression coefficients are statistically significant, (2) that gives a sufficiently high value of R^2 and (3) that meets the assumptions inherent in regression the equation can be used for forecasting purposes (Makridakis et al, 1989). In doing so we should consider the confidence interval for individual forecasts at the malaria clinics and the accuracy of the values of the independent variables.

The same consideration can be applied to the equation (5.12) as above. The equation is reproduced here for discussion, that is,

$$S_{ij} = 317.66 + 0.57S(-1)_{ij} - 23.27\log I(-1)_j - 59.34\log G(-1)_j \quad (5.14)$$

The equation does represent a linear relationship, the t tests of significance are satisfied, the R^2 is good, and it appears that the regression equation is a good representation of this situation. The residuals are constant, D-W test of 1.980 is also good. The F test is significant and it appears the forecasting equation for annual blood slide examination is good for forecasting purposes in each of the malaria clinics. As with equation (5.13), the confidence interval of individual malaria clinic forecasts and accuracy of the values for the independent variables should be considered. However, the constant value 317.66 is large and suggests that there may be additional independent variable(s) that might explain more of the dependent variables. Identifying such variable(s) also may increase the value of R^2 which indicates that 23.7% (100-76.3) of the total variation in annual blood examination is still unexplained.

Therefore, based on the above statistic analyses, we can conclude that the two equations (5.13 and 5.14) are reliable and can be used by managers for forecasting purposes.

6.2 Economic Implications

There is a great deal of useful information that can be derived from the two equations (5.13 and 5.14) above. However, in order to interpret the results we convert the normal logarithms of I and G(-1) into their natural logarithms in equations 5.13 and 5.14 , thus;

Equation 5.13 becomes

$$Q_{ij} = 13.17 + 0.33S_{ij} - 1.43X_{ij} - 0.97\log_e I_j - 1.45\log_e G(-1)_j \quad (5.15)$$

and equation 5.14 also becomes

$$S_{ij} = 317.66 + 0.57S(-1)_{ij} - 10.11\log_e I(-1)_j - 25.77\log_e G(-1)_j \quad (5.16)$$

In equation (5.15) the total annual blood slides examined variable S, (which is a measure of total annual attendance of patients in each sector malaria clinic irrespective of whether or not they are diagnosed positive for malaria parasites), has a significant positive coefficient. This indicates (all other factors constant) an increase in incidence of malaria cases whenever there is an increase in demand for malaria services. As shown, for every 100 suspected patients microscopically examined for malaria parasites 33 of them are likely to be tested positive for malaria parasites. These are the patients considered as the actual malaria patients who are then given full malaria drug treatment. The remaining 67 patients receive no such treatment though they may be suffering from other diseases.

Any sudden rise of the attendance of patients in the sector malaria clinics may give a signal of a possible epidemic outbreak which may be promptly investigated.

According to Russel (1952) in the genesis of malaria epidemics the following major points should be considered: (1) increased susceptibility of the human population of non immunes into an endemic area; (2) increased infective reservoir in the population; (3) increased contact between man and the Anopheles vector; (4) greater effectiveness of local Anopheles in transmitting the malaria parasites.

Beside the attendance rate, the equation also shows a significant inverse relationships between the output treatment variable Q, and the other independent variables X, for mean travel distance, I, the household income, and G(-1), the lagged per capita government expenditure on malaria control activities.

The result shows that travel distances to malaria service points are very significant in determining the demand for the services. Malaria patients are likely to opt for other service outlets for treatment if they should travel long distances in order to seek services at the malaria clinics. Usually, the most easily available means is self-treatment (Hongvivatana et al, 1985), a situation which has contributed in no small way to the malaria drug resistance menace in many endemic countries. The study also confirms findings made by other researchers (Kaewsonthi and Harding, 1984; Ettling et al, 1989) that long distances travelled to the malaria clinics limit utilisation of malaria services in the endemic areas of Thailand. As shown, a decrease of the existing mean traveling distances to malaria clinics by 1 km will increase demand for services (blood slides examinations) by 433 on the average and treatment of malaria cases of about 143 (positive cases) average annually in each malaria clinic, all other factors constant.

It is however interesting to note that the mean travel distances to malaria clinics appear to have improved considerably over the years as for instance, the maximum travel distance of 68 km to Phop phra malaria clinic in 1989 (Ettling et al, 1989) is found to have reduced to 24 km in the present study.

The introduction of mobile malaria clinics have also helped to reduce the travel distances and hence travel costs to malaria clinics in most endemic areas in Tak province (informal discussion with senior malaria staff)

Also, equation (5.15) reveals that an increase of annual household income by 1000 Bahts will decrease the number of patients diagnosed and treated by 97 on the average in each malaria clinic annually, an equivalent to about 294 annual attendance (total blood slides examination) in each clinic. This means that households with lower income are more prone to malaria infection and disease and their demand for malaria services are higher than the higher income groups.

As postulated in the theoretical framework, a fall in income means that the number of feasible combinations of health input and consumption activities open to the individual are diminished. As a result his health stock is reduced because he has less to spend on health inputs such as house screening, mosquito nets, mosquito repellents etc and so he becomes a helpless victim to the factors that make him more vulnerable to malaria infection and disease hence their demand for more services. In fact it is expected that households in lower income groups derive more utility from antimalarial activities, given the higher relative value of their health at subsistence levels (Banguero,1984).

Furthermore, the most significant effect on demand for services at malaria clinics is by the lagged government expenditure on malaria control activities variable, G(-1). Other things being constant, an increase in annual per capita government expenditure by 1.00 Baht reduces incidence of malaria cases in malaria clinics in a district by 1,450 cases and demand for the services by 4,394 attendances at the clinics in the subsequent year, and vice versa. This is an important information for example in planning for government budget allocation for malaria control activities in the endemic districts. The lagged government expenditure judiciously spent on malaria control activities reduces incidence of malaria cases in control areas drastically as the study shows.

The incidence of malaria depend on the vectorial capacity (a measure of the `receptivity' to malaria in a defined area) of Anopheles population and malaria parasite reservoir in the community, giving a certain level of community immunity. Malaria control activities such as environmental modification and manipulation, chemical and biological larvicides, and residual insecticide spraying, are designed to reduce vector breeding habitats, vector densities and the longevity of vector population and therefore reduce the vectorial capacity. Others such as clinical treatment of acute cases of malaria antiplasmodial measures are also designed to reduce the parasite reservoir in the community. A reduction of the vectorial capacity and the parasite reservoir decreases the incidence of malaria in the community and therefore leads to a decrease in demand for malaria services at the malaria clinics.

The integrated approach of malaria control adopted by the Malaria Division seems to reduce the vulnerability of the control areas to malaria transmission and hence its spilled-over effect on demand for malaria services in the subsequent years. However, this approach of control requires a regular budget to support and maintain it as any reduction of government expenditure allocated to malaria control activities in the districts will give rise to increase in the vectorial capacity of the Anopheles population and the parasite reservoir in the communities and shoot up the incidence of malaria infection and disease. Consequently, the demand for malaria services at malaria clinics will also increase.

As the study shows. households of lower income group suffer most from malaria disease and therefore they will be the most worse of socially and economically if there should be any policy to cut down government spending on malaria control activities in the endemic areas. Moreover, if the government policy of providing free services to patients at the malaria clinics still stands as it is now, then any such policy to reduce government spending on malaria control will not reduce cost to the government in the long run. This is because the incidence of malaria will shoot up again which will lead to a rising demand for services at the Malaria clinics and therefore a high cost services to patients at the clinics. As a result, any cut-down policy on government expenditure for malaria control activities will not be a cost saving but rather it will lead to a more spending on the part of the government in the long run in order to cater for the high demand for services at the Malaria clinics.

Lastly, the equation (5.16) provides a useful information for short and medium term planning. Having data on lagged values of annual blood slides examined, per capita government expenditure and average household income for a district, the annual malaria clinics' attendance can be forecast and in substituting this forecast attendance value in equation (5.15), malaria cases for the year can also be forecast with some level of precision and accurate confidence interval, assuming constant for other factors. Therefore the number of annual positive cases and blood slides examination can be predicted and drugs and other provisions made during annual budget, equipment and personnel allocations to the districts concerned.

Three findings of this study quantitatively proved are of particular interest in regards to the factors that influence demand for malaria services at the malaria clinics. First is the household income. The lower income groups suffer from malaria disease more and demand for malaria services more. Second is the travel distance to the service points and the degree to which access is limited by social and economic factors among low income groups. The third is the importance of government budget on malaria control activities including the running of the malaria clinics on incidence of malaria cases and infection. Demand for malaria services in a poor community rises with cut-down on government expenditure on malaria control activities as a result of increase in incidence of malaria cases and infection in the community. The tailoring of malaria clinic services to provide diagnosis and treatment for vulnerable populations must take these factors into consideration, more especially with the use of government and other non government funding to reduce access to service points, vectorial capacity of Anopheles population and the gametocyte output in the communities.

In spite of the caution that must be exercised in interpreting and using these results, the analyses of the regression functions developed in this study can be used in a wide range of situations for understanding some of the factors influencing malaria services and also forecasting demand for services including treatment of positive cases in the sector malaria clinics.