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## A Model of the Trade and Government Sectors in Colonial Economies

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ECONOMIC GROWTH CENTER

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Center Discussion Paper No. 130

A MODEL OF THE TRADE AND GOVERNMENT  
SECTORS IN COLONIAL ECONOMIES

by

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and

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A Model of the Trade and Government  
Sectors in Colonial Economies

by

Thomas Birnberg and Stephen Resnick\*

I. Introduction

The aim of this study is to examine historically and quantitatively the process of colonial development for selected economies of Asia, Africa, and Latin America. An econometric model is applied to each country from about the start of the twentieth century until the outbreak of World War II in an attempt to identify those forces which tended to culminate in the establishment of economies dependent on international trade. A principal hypothesis of this research is that a structural model of aggregate behavior can explain empirically the development pattern of several countries in different geographical areas. The sample countries include those experiencing overt colonial control such as Ceylon, India, Jamaica, Nigeria, Philippines, Taiwan, as well as Cuba, Chile, Egypt, and Thailand where foreign influence and control were perhaps more subtle but no less important in determining economic activity. The model focuses on variables external to these countries such as the industrial progress within the developed world and variables internal to these countries

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such as government expenditures directed towards the promotion of an export economy in an endeavor to explain the actual process of development for these selected economies.

Given the vast differences in initial conditions, it is rather remarkable to find how a specific econometric model can be applied to describe the process of change in all the countries. The hypothesis suggested is that common political and economic forces were in operation which tended to transcend historical differences in crops, climate, and cultures and which acted to transform much of the developing world in a similar pattern in a few decades. This is not to deny the fact that historically, important differences among these countries did exist prior to the period examined in this study. The Philippines and Cuba, for example, were effective colonies of Spain for over three hundred years prior to the American period. Jamaica was by no means a new comer to the colonial system having been an important source for trade fortunes generated by English merchants. The economic history of Egypt reveals a long period of European influence and control. Even before the direct control of India by Britain, the British exercised their influence through the East India Company. Nonetheless, there was a quantitative and qualitative change experienced by these countries from the end of the 19th century onwards as economic development took on a new direction. The penetration of Western commodities, organization, and control ushered in the era of the export economy described in the development literature.<sup>1</sup>

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<sup>1</sup>The literature on this subject is vast. One of the best expositions can be found in Myint (34). A good source for further references on trade and development can be found in Meier (30).

Since we wanted our time period to correspond with this emergence of the era of the export economy, we selected countries for which we had reliable and consistent data going roughly as far back as this criterion required. For the time period for the estimates of each country see Table 1.

Although a great deal of qualitative and quantitative evidence has been amassed and several alternative hypotheses have been presented interpreting the international trade system, there have been few systematic attempts to examine empirically the direct and indirect economic linkages between the developed and underdeveloped worlds. The econometric model and analysis presented in this paper provide some quantitative answers as to the time series question of what was the historical process of economic development and suggest several hypotheses to be explored in a cross section over time analysis concerned with the degree of common development experience.<sup>2</sup> The analysis does not intend nor does it show the actual degree or level of exploitation or which groups within which areas benefited or lost from the colonial relationships. If the selected group of countries in this study did start out with rather different initial conditions, but ended up looking rather similar in terms of economic structure, then not only were common political and economic forces operating upon them, but such a historical phenomenon requires the application of a common theory of development and underdevelopment. If, on the other hand, significant differences are discovered among countries, then one must explore the possibility that different economic histories and foreign influence produced non-similar economic structures.

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<sup>2</sup>Only the time series question will be focused upon in this paper. A second paper will provide answers to a series of hypotheses associated with the cross section over time analysis.

The present study provides the necessary framework in which such questions can be explored.

The importance of an historical perspective in studying the question of development is clearly a principal by-product of this study. The historical process of economic development should not be confused with more recent attempts at development through industrialization and import-substitution programs in the 1950's and 1960's. Whereas external trade creation and government expenditures directed towards the development of an export economy marked the international trade system, attempts at internal trade creation import-substitution and government expenditures biased towards industrialization describe much of the development activity during the recent two decades. Yet these two phases of economic change are not independent in the sense that the international forces that acted to transform many countries of the underdeveloped world produced the political and economic environment after World War II within which these countries were to operate. Thus the initial conditions adopted by postwar studies of economic development were determined by historical developments examined in this study.

Following this introduction, the paper is divided into four sections: Section II presents the econometric model; the method of estimation used is discussed in Section III; the empirical results are presented and discussed in Section IV; the reduced forms associated with the structural equations along with their implication for colonial history are discussed in Section V.

## II. The Model

The model formulated is an aggregate annual model of the government and trade sectors estimated by instrumental variables with an adjustment for autocorrelated errors. A basic circular structure underlies an eight equation system describing the growth of the colonial economy. Colonial government expenditures are directed toward promoting the growth of real exports which, in turn, pay for real imports. The expansion of exports and imports generate directly and indirectly revenues for further government expenditures which continue the growth process and complete the circular structure of the model. Changes in real income, prices, and trade policies within the developed world are assumed to affect the colonial structure through the developed world's demand for raw materials and food.

The set of equations reflect, then, two main determinants of economic activity in a colonial country. Government expenditures in the colony and price and income variables in the developed world act upon and transform the colony's trade sector. Estimation of the model provides information on the quantitative importance of these effects which will be called in this paper colonial multipliers.

### The Trade Sector

Four basic equations characterize the colony's trade sector. Supply and demand relationships for real exports along with a market clearing equation act together to determine the economic interrelationship between colony and colonizer. The trade subsystem is completed by a demand for real imports emanating from the colony.

All the equations of the model are specified in double logarithmic form for both theoretical and empirical reasons. First, the double logarithmic form provides a direct linear linkage between the real and nominal variables in the model. Second, the estimated coefficients can be interpreted as elasticities. Third, linear estimates were tried and found to yield inferior estimates with high standard errors and incorrect signs. Fourth, examination of the plots of the residuals from these estimates indicated that the errors were multiplicative rather than additive.

The first equation of the trade subsystem determines the principal commercial activity of the colonial economy which is the supply of real exports. A log linear equation (II.1) is specified where real exports are a function of the export price, import price, accumulated real government expenditures, lagged real exports and appropriate dummy variables.<sup>3</sup>

$$(II.1) \quad \ln X_S^R = a_0 + a_1 \ln P_x + a_2 \ln P_m + a_3 \ln \sum_{i=1}^{\infty} G_{t-i}^R + a_4 \ln X_{S,t-1}^R + a_5 D_{S,t}$$

where:

$X_S^R$  is the supply of total real commodity exports from the colony

$P_x$  is the colony's export price index (1913 = 1) constructed to be a Paasche backward based linked index.<sup>4</sup>

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<sup>3</sup>For ease of exposition, the error terms on all the equations in this section have been omitted.

<sup>4</sup>The Paasche export and import price indices were specially calculated for this study using primary sources of data for each country (see Appendix B). These indices were calculated using the largest bundle of goods for which consistent and reliable quantity and value data were available. We used Paasche indices rather than Laspeyres or Fisher Ideal indices because the composition of the commodity bundles changed more rapidly than did prices. The indices are backward based because exporters respond to current prices relative to past prices, not to future prices. The linkages of the indices were designed to account for the principal changes in the composition of the commodity bundles.



$P_m$  is the colony's Paasche import price index (1913 = 1).

$\sum_{i=1}^{\infty} G_{t-i}^R$  is the lagged value of accumulated real government expenditures in the colony.

$D_S$  is a dummy variable reflecting the impact of exogenous events upon the colony's supply function.

Equation (II.1) postulates an aggregate supply response by assuming that a composite commodity, real exports, depends upon a corresponding unit value export price index. A priori the sign of the export price coefficient is expected to be positive. A different approach would have disaggregated exports by crop and respective price and used a more complicated substitution model to obtain supply response to price. For the questions involved in this paper, however, this method was not deemed appropriate. Because each country exports more than one crop or raw material, the whole colonial system of ten countries inevitably becomes quite large when a disaggregated approach is followed. Furthermore, the determination of an aggregate export function provides the necessary analytical framework in which the behavior of the international colonial system can be studied.

Import prices influence real exports in two ways: the costs of production are assumed to be represented by this index since these economies were dependent on the international market for many of their intermediate goods and almost all of their capital goods;<sup>5</sup> and the cost of incentive or wage goods are assumed to be reflected by this index since their importation often led to the displacement of inferior rural manufactures by superior

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<sup>5</sup>One might assume that domestic labor was available in unlimited supply for export production; not an unreasonable assumption to make in these countries.

foreign commodities.<sup>6</sup> For these two reasons the sign of the import price coefficient is expected to be negative, and the export and import prices taken together should reflect the macro profitability of an export economy.<sup>7</sup>

Accumulated real government expenditures enter as the third argument as the government is assumed to be a crucial provider of the necessary infrastructure and social intermediate products associated with the development of an export economy. The growth of trade experienced by these economies would hardly have been possible without the expenditures on harbors, wharves, culverts, road systems, railroads and other public works as well as the investments in administrative infrastructure, in health facilities such as malaria control, in the establishment of agrarian order such as an organized police and army establishment, and in various directly productive agrarian activities such as irrigation, artesian wells, disease research for crops, and communication facilities. Although various studies attest to the importance of these activities in "opening-up" and sustaining the growth and development of the colonial economy, few, if any, have empirically examined their contribution. A priori the expected sign of the government variable is positive indicating a rightward shift in the supply schedule. And the actual size of the coefficient serves to provide empirical information on the marginal productivity of colonial governments.

To calculate accumulated real government expenditures we first deflated

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<sup>6</sup>See Resnick (39) for such a model of trade behavior.

<sup>7</sup>The hypothesis that the export and import price coefficients were the same in absolute value was tested and rejected. The prices, therefore, appear as separate arguments in (II.1), rather than in ratio form as the terms of trade.

current expenditures,  $G_t$  by the import price index  $Pm_t$  to obtain real government expenditures in a given year

$$G_t^R = G_t / Pm_t$$

The price of imported goods is thus assumed to reflect the cost of government expenditures because government capital goods were usually imported and government employees, particularly colonial officers, were dependent on imports to maintain their standard of living. Lagged accumulated real government expenditures are then calculated using the inventory formula

$$\sum_{i=0}^{\infty} G_{t-i}^R = \sum_{i=1}^{\infty} G_{T_0-i}^R + \sum_{i=T_0}^{t-1} G_i^R$$

where:

$T_0$  is the base year before which we do not use time series values of  $G_t^R$ .

$\sum_{i=1}^{\infty} G_{T_0-i}^R$  is the initial value of accumulated real government expenditure which was estimated by first estimating the regression equation for the growth rate of  $G^R$

$$\ln G_t^R = a_0 + a_1 t \quad t = T_0, T_0 + 1, \dots, \tau$$

where  $\tau$  is selected as the year with the longest consistent pattern of growth of  $G^R$ . Let  $\hat{a}_0$  and  $\hat{a}_1$  be the estimated values of  $a_0$  and  $a_1$ . Then

$$\sum_{i=1}^{\infty} G_{T_0-i}^R = \sum_{i=1}^{\infty} e^{\hat{a}_0} e^{(T_0-i)\hat{a}_1} = e^{\hat{a}_0 + T_0 \hat{a}_1} \sum_{i=1}^{\infty} e^{-\hat{a}_1 i} = \frac{e^{\hat{a}_0 + T_0 \hat{a}_1}}{e^{\hat{a}_1} - 1}$$

is the estimated initial stock of accumulated real government expenditures.

For the base period used in these calculations, see Table 1.

Table 1

Estimation Periods and Growth Rates of Real Government Expenditure Variables

	Equation Estimation Period	Growth Rate over Estimation Period of		Period used to Calculate base	Growth Rate over Base Period of
		$\ln G_t^R$	$\ln \sum_{i=1}^{\infty} G_{t-i}^R$		$\sum_{i=1}^{\infty} G_{t-i}^R$
CEYLON	1899-1918, 1920-1938	4.323	3.980	1891-1904	4.260
CHILE	1892-1938	8.418	6.003	1888-1914	5.174
CUBA	1905-1937	3.728	6.504	1902-1910	11.079
EGYPT	1893-1819, 1921-1937	1.988	2.707	1889-1897	4.035
INDIA	1892-1936	1.599	2.007	1880-1898	2.452
JAMAICA	1888-1938	2.184	3.176	1884-1896	4.820
NIGERIA	1903-1937	2.157	5.540	1900-1914	9.032
PHILIPPINES	1904-1938	5.737	6.626	1902-1915	7.087
TAIWAN	1906-1911, 1915-1919, 1922-1936	4.657	4.786	1900-1914	5.883
THAILAND	1904-1910, 1913-1917, 1921-1936	3.674	6.863	1896-1905	15.329

Government expenditures are not disaggregated by category basically because such a breakdown was only available for a few countries. Even if such a breakdown were available for all in a consistent pattern, there is no theory suggesting what was a development expenditure and what was not. Depending upon the question asked, however, there may be good reason for separating out expenditures on, say, transport systems from those on administrative bureaucracy. For the questions and indeed the theory involved in this study of colonial development, such a breakdown, even where available, was not deemed appropriate. The only compromise taken with this aggregate view of government behavior was to omit rather obvious expenditures such as the royal household expenditures in Thailand, which did not seem connected either directly or indirectly with the development of an export economy.

The model assumes that accumulated government expenditures provided the necessary colonial environment in which producers were able to respond to changing market incentives reflected by export and import prices. It is as if technical progress was embodied within government expenditures thereby providing the favorable "atmosphere" for the historic development of the export economy. In some countries, however, private firms substituted their own capital formation for that of government, and one could further argue that even if this were not the case, government expenditures should depreciate in impact over time thereby allowing private investment to reap the benefits of the original indivisibilities associated with the build-up of social infrastructure. The "big push" would initially be derived from the government, but once the profitable environment was established, private capital would become important. Private investment was omitted from the model because

time series data were not available for the economies selected in this study. If one assumes that historically government expenditures were complements to or that they necessarily preceded private investment, and if the historical constraint on export production was indeed government rather than private expenditures, then the omission of the latter poses no problem.

Although this relationship between private and public capital is an historical question, dependent on concrete examples, we have explored the specific question of the pattern of governmental impact by examining various alternative specifications. We tested whether or not there was a distributive lag process on real government expenditure by postulating alternative lag structures. We estimated the supply equation by three different methods--Almond, Koyck and Pascal--without success. The source of the incorrect results obtained using Almond's method was the high multicollinearity between the different lags of  $G_t^R$ . For Koyck and Pascal methods, non-linear estimation techniques were used and solutions converged either to values which violated the restrictions on the lag parameters or to values which had incorrect signs. In comparison, simply lagged accumulated real government expenditures consistently yielded the best results.

We tested whether lagged accumulated real government expenditures,  $\sum_{i=1}^{\infty} G_{t-i}^R$ , was a time variate in the supply equation. First, we replaced  $\sum_{i=1}^{\infty} G_{t-i}^R$  with time and the results contained incorrect signs and high standard errors. Then, we included both  $\sum_{i=1}^{\infty} G_{t-i}^R$  and time, and the time variate was insignificant while  $\sum_{i=1}^{\infty} G_{t-i}^R$  remained significant. One reason that  $\sum_{i=1}^{\infty} G_{t-i}^R$

is not a proxy for time is because  $\sum_{i=1}^{\infty} G_{t-i}^R$  does not grow linearly. Table 1 shows that there exist many substantial differences between the growth rates of  $G_t^R$  for the model period and for the base period. With the exceptions of Ceylon and Chile, the growth rate of  $G_t^R$  was relatively the highest during the earlier part of the development of these export economies. For these reasons, we rejected time as a variable in our model.

Lagged real exports are introduced into Equation (II.1) in an endeavor to test for the possibility that there was a difference between the short and long run adjustment processes. Initially, distributed lag formulations were introduced first on export prices, then on government expenditures (as noted above), and finally on both variables together. For some countries, the adjustment of real exports to price may not have been instantaneous since it was likely to take more than one crop year to adjust to new market conditions. A distributed lag on government expenditures would provide some answers as to the short and long run impact of the government on the supply of real exports. Finally, the possibility was tested that both variables were subject to distributed lags but that the respective response coefficients were different.

These somewhat complicated formulations which resulted in non-linear estimation procedures did not seem to add enough significant information to justify their continued use. In addition, the procedure frequently yielded solutions which violated the usual restriction on distributed lag parameters or yielded economically unrealistic coefficients on the variables. Therefore, a standard lag formulation was postulated as in (II.1). The final supply equation has been estimated with and without  $X_{t-1}^R$  and we leave this part of

the specification of the equation as an empirical question to be discussed in the next section.

The second equation of the model explains the demand for real exports. A log linear equation (II.2) is specified where the demand for real exports is determined by the level of real economic activity in the developed country, a domestic price index of this country, the colony's export price index measured in the developed country's currency, lagged real export demand, and appropriate dummy variables.

$$(II.2) \ln X_D^R = b_0 + b_1 \ln P_x + b_2 \ln Y^R + b_3 \ln P_d + b_4 \ln X_D^R + b_5 D_t$$

where:

$X_D^R$  is the demand for total real commodity exports emanating from the developed country.

$P_x$  was defined previously; where appropriate, it is multiplied by an exchange rate,  $\pi$ , to put it in the developed country's currency.

$Y^R$  is real GNP in the developed country; for some countries, industrial production,  $Q$ , is used in the corresponding demand equation.

$P_d$  is the domestic price level in the developed country; when  $Y^R$  appears as a variable,  $P_d$  is the implicit GNP price deflator; when  $Q$  is used, a  $P_d$  was appropriately selected to reflect the commodities traded as either an import price index of crude materials, a general import price index, or a price index of raw materials.

$D_t$  is a dummy variable reflecting the effect of exogenous events on the developed country's demand function.

As with the supply equation, various types of distributed lag formulations were introduced into the demand equation. The most appropriate method of estimation turned out to be the use of a standard distributed lag formulation where  $X_D^R$  appears in the equation (II.2).  
t-1



The colony is not assumed to be a price taker; rather the market clearing equation (II.3) is postulated to hold over the sample period.

$$(II.3) \quad \ln X_{S_t}^R = \ln X_{D_t}^R$$

Export prices are then endogenous to the international trade system. This result is in contrast to much of the development literature where export prices are assumed implicitly to be exogenous to the developing world. We empirically tested the hypothesis that the colony was a price taker by estimating equation (II.1) with  $P_x$  as exogenous. The results yielded a negative export supply coefficient for every country. This contradicts the econometric evidence in many development studies of supply responsiveness which have found a positive supply coefficient.<sup>8</sup> Thus the hypothesis that the export price was exogenous was rejected, and the estimation of a demand equation as well as a supply equation using simultaneous equations methods was necessary.

This specification of the trade subsystem assumes that the economy of each colony is like an aggregate industry facing a downward sloping demand schedule so that a shift in the supply schedule will affect the export price. However, if we had disaggregated exports by commodity, then presumably there would be numerous actual and potential suppliers of these commodities. In this disaggregate world, the demand facing any one supplier could be perfectly elastic within the relevant economic range.

The political and economic relationship between the colony and the developed country often led to a fairly high percentage of the former's

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<sup>8</sup> Most of these studies have dealt with a particular crop and/or region of a country. See Bateman (2), Behrman (3), Mangahas, Recto, and Ruttan (28), and Nowshirvani (35).

total commodity trade being carried on with the developed country and its colonies.<sup>9</sup> Exports to these other colonies were either for transshipment (e.g. entrepot trade with Hong Kong and Singapore) or for direct consumption in these colonies. The model assumes that the economic activity of these other colonies are reflected by and can be measured by that of the developed country. Therefore, the specification of equation (II.2) is based upon the empirical observation that colonial trade was bilateral in nature which, in turn, reflected the bilateral political relationship that emerged over time. For these reasons, competitive prices for alternative sources of export supply do not appear in the developed country's aggregate demand schedule. A domestic price level is included to reflect the substitution between domestic and imported goods.

When the export trade pattern did show an obvious change in direction to include another developed country, the model was modified accordingly. In Nigeria, trade with Germany was completely cut off during the first World War; a dummy variable was introduced into the demand function to account for this change. In Jamaica, trade with the United States declined dramatically after the imposition of the Hawley-Smoot tariff of 1930. Correspondingly, a new variable was introduced in the 1930's to account for this decline. In Chile, even though the United States and the United Kingdom were the major trading partners, copper exports were controlled by three U.S. companies. U.S. income and price variables are taken, therefore, as the main determinants of the demand function. In Ceylon, the expansion of rubber exports from about 1905 onwards reflected the relative importance of the United States as a

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<sup>9</sup>See Table 2.

**Table 2**  
**Distribution of Exports for Selected Years**

	Developed Country	Percentage of Trade with Developed Country				Instruments Corresponding to Developed Country
		1900*	1913	1925	1938**	
CEYLON	U.K. + colonies	78.3	58.0	52.2	72.1	$Y_{UK}^R$ , LIMIT
	U.S.	7.0	16.5	29.9	12.6	CARS
CHILE	U.S.	3.9	21.0	39.2	30.0	$Q_{US}$ , $P_{US}^{mm}$ , TARIFF
	U.K.	73.5	39.5	34.6	26.0	
CUBA	U.S.	76.8	79.9	74.6	80.7	$Q_{US}$ , $P_{US}^m$ , QUOTAS
EGYPT	U.K.	54.5	42.6	43.5	30.9	$Y_{UK}^R$ , $P_{UK}$ , FIRST WAR
INDIA	U.K. + colonies	59.1	39.4	34.1	45.7	$Q_{UK}$ , $P_{UK}$
JAMAICA	U.K. + colonies	23.2	24.8	48.6	85.0	$Q_{UK}$ , $P_{UK}$
	U.S.	63.8	57.4	40.7	3.7	RESTRICT
NIGERIA	U.K.	31.4	50.9	54.7	50.0	$Y_{UK}^R$ , $P_{UK}$
	Germany	55.8	41.8	21.3	17.7	FIRST WAR
PHILIPPINES	U.S.	40.0	34.4	73.0	77.0	$Y_{US}^R$ , $P_{US}$ , QUOTAS
TAIWAN	Japan	60.0	75.7	82.0	89.4	$Y_{JP}^R$ , $P_{JP}$ , FIRST WAR
THAILAND	U.K. + colonies	85.5	83.2	74.6	79.0	$Y_{UK}^R$ , $P_{UK}$

\*The initial year used for Cuba is 1903, for Nigeria is 1901, for Philippines is 1904, and for Thailand is 1901.

\*\*The final year used for Chile, Cuba and Egypt is 1937, for India is 1936, and for Taiwan is 1935.

new buyer. Correspondingly, the demand schedule facing Ceylon was changed by introducing a variable measuring the demand for cars in the United States. No relationship, however, was provided in the model between the economic activity in the United States and that in the United Kingdom. In general, then, the model focusses upon the principal trading relationships that emerged historically although adjustments to this approach are made when deemed appropriate. In most cases, however, the incomes and prices of the United Kingdom, United States, and Japan (for the selection of Taiwan) are assumed to be the main driving force or instruments affecting the economic activity of their respective colonies. The specification bias introduced by this assumption of a decomposable trading network is assumed to be negligible given the trading configurations that did emerge.

One hypothesis to be tested is that the growth in real exports had as its dual the growth of real imports. The increased specialization of the colonial economy was reflected by a shift of resources out of traditional activities into commercial ones. Correspondingly, the demand for foreign consumer and intermediate commodities should have expanded. Here, the opposite of an import-substitution policy was being pursued. Colonial policy was clearly biased towards the promotion of exports rather than indigenous manufacturing and the resulting decline of traditional industry associated with the pre-colonial agrarian society was replaced by the expansion of and reliance on imported manufactures.

Equation (II.4) attempts to explain this reflection of real imports on real exports by specifying a log linear demand schedule where the level of real imports are a function of real exports, the price of exports, and

the price of imports.

$$(II.4) \quad \ln M_t^R = c_1 \ln X_t^R + c_2 \ln Pm_t + c_3 \ln Px_t + c_4 D_{M_t}$$

where:  $M_t^R$  is the demand for real commodity imports by the colony.

$D_{M_t}$  is a dummy variable reflecting the impact of exogenous events upon the colony's import function.

The coefficient  $c_1$  measures the reflection ratio of the colony.

If  $c_1 < 1$ , then the colony runs a real trade surplus, while if  $c_1 > 1$ , it runs a real trade deficit. The coefficient  $c_2$  is the import price elasticity of demand by the colony for developed countries' goods. A priori, we expect the sign of  $c_2$  to be negative. The coefficient  $c_3$  measures the shift of the demand schedule for real imports as export prices change. A priori, we expect the sign of  $c_3$  to be positive. With both the import and export prices scaled equal to one in 1913, the coefficients  $c_2$  and  $c_3$  describe how these prices change the real trade balance of the colony relative to that in 1913.

Equation (II.4) can also be expressed in terms of nominal commodity imports  $M_t$  and nominal commodity exports  $X_t$  by employing the definitional equations

$$(II.5) \quad \ln M_t = \ln M_t^R + \ln Pm_t$$

$$(II.6) \quad \ln X_t = \ln X_t^R + \ln Px_t$$

then equation (II.4) becomes

$$(II.4A) \quad \ln M_t = c_1 \ln X_t + (c_2 + 1) \ln Pm_t + (c_3 - c_1) \ln Px_t + c_4 D_{M_t}$$

Note that in comparing (II.4) and (II.4A),  $c_1$  measures the nominal trade balance as well as the real trade balance.

### The Government Sector

The government subsystem is represented by two basic equations, the generation of nominal revenues and the expenditures from that revenue. Equation (II.6) specifies that nominal revenues are a log linear function of real exports, nominal imports, and appropriate dummy variables.

$$(II.7) \quad \ln R_t = d_0 + d_1 \ln X_t^R + d_2 \ln M_t + d_3 D_{R_t}$$

where:  $R$  is total nominal revenues generated in the colony.

$M$  is the colony's total commodity imports.

$D_{R_t}$  is a dummy variable reflecting the impact of exogenous events upon the colony's revenue function.

The expansion of real exports is assumed to generate revenues directly in the case of an export tax or indirectly, given that much of the taxable economic activity in the colony was in one way or another tied to an export structure. Revenues from nominal imports reflect the generation of revenues directly from import duties and indirectly from taxes on commercial import activity.

Government expenditures depend upon revenues generated according to the log linear equation

$$(II.8) \quad G_t = e_1 R_t + e_2 G_{t-1} + e_3 D_{G_t}$$

where:  $G$  is nominal colonial government expenditures.

$D_{G_t}$  is a dummy variable reflecting the impact of exogenous events upon the colony's government expenditure function.

One interpretation of this equation is that it is generated by a revenue expectation model, where government spending in the current period depends

on expected revenue. An alternative interpretation of equation (II.8) is that government expenditures are divided between recurrent expenditures equal to  $e_2 G_{t-1}$  and current expenditures equal to  $e_1^R_{t-1}$ .

Equation (II.8) provides an empirical test of the hypothesis that the colonial government balanced its budget in the long-run. Assuming that  $G_t = G_{t-1}$  in the long-run, then the model provides a test for whether the government was running a surplus, balanced or deficit budget according to whether

$$e_1 + e_2 \begin{matrix} < \\ = \\ > \end{matrix} 1$$

#### The Complete Model

Equations (II.1) through (II.8) constitute for each country a system of eight equations in eight unknowns, namely  $X_S^R$ ,  $X_D^R$ ,  $P_x$ ,  $M^R$ ,  $X$ ,  $M$ ,  $R$ ,  $G$ . This system applies to colonies whose exchange rate was fixed. For countries with a variable exchange rate, the demand price in equation (II.2) is a new variable  $P_x'$  which is defined by an additional equation in the system.

$$(II.9) \quad \ln P_x' = \ln P_x + \ln \pi$$

where:

$\pi$  is exchange rate of the colony's currency relative to that of the developed country to which it was tied.

### III. Estimation Method

The theoretical model described in Section II was estimated by instrumental variables with an adjustment for autocorrelated errors. Initial estimates of the equations using two stage least squares yielded results with many relatively high standard errors and some incorrect coefficient signs. In addition, examination of plots of the residuals indicated well-defined patterns of positive first-order serial correlation in most equations. The average D.W. statistic for the 39 equations indicating such a pattern of correlation was 1.25. When instrumental variable methods with lagged as well as current exogenous variables as instruments were used, the standard errors improved and most sign errors were corrected, but the serial correlation problem remained.

These earlier results suggested that the estimation method needed should be instrumental variables with an adjustment for autocorrelated errors. In addition, the distributive lag specified in the theoretical model required that the econometric model include lagged endogenous variables. In the following two sub-sections, an econometric model for this estimation method is specified, the estimation procedure is outlined, and the key characteristics of the procedure are discussed.

#### A. Econometric Model

Consider a set of K simultaneous equations

$$(III.1) \quad Y\Gamma + Y_{-1}A + X\beta = U$$

where there are K endogenous variables, Y; K lagged endogenous variables,  $Y_{-1}$ ;



and M endogenous variables, X. For T observations, then, Y is a T x K matrix,  $Y_{-1}$  is a T x K matrix and X is a T x M matrix.  $\Gamma$ , A and  $\beta$  are matrices of coefficients to be estimated with dimensions K x K, K x K and M x K respectively.

The error matrix U is assumed to follow a first order autoregressive pattern

$$(III.2) \quad U = U_{-1}R + E$$

where  $U_{-1}$  is the matrix of U lagged, and U,  $U_{-1}$  and E are T x K matrices.

Denoting  $e'_t$  as the column components of the matrix E, the following assumptions are made:

- (i)  $E(e_t) = 0, \quad t = 1, 2, \dots, T$
- (ii)  $E(e_t)(e'_t) = \Sigma \quad t = 1, 2, \dots, T, \Sigma \text{ positive definite}$
- (iii)  $E(e_t)(e'_\tau) = 0 \quad t, \tau = 1, 2, \dots, T, t \neq \tau$
- (iv)  $\text{plim } T^{-1}XE = \text{plim } T^{-1}X_{-1}E = 0$
- (v)  $\text{plim } T^{-1}Q'Q$  exists as a fixed, nonsingular matrix where  $Q = (X, X_{-1})$
- (vi) R is a diagonal matrix with elements  $|r_{ii}| \leq 1, i = 1, 2, \dots, K$
- (vii)  $(\Gamma + A)$  has an inverse.
- (viii) The equations of the model are identified.

Without any loss of generality, let the equation to be estimated be the first equation:

$$(III.3) \quad y_1 = Y_1\gamma_1 + Y_{1-1}\alpha_1 + X_1\beta_1 + u_1$$

where  $y_1$  is a column vector of T observations on the first endogenous

variable;  $Y_1$  is a  $T \times k_1$  matrix of observations on  $k_1$  other included endogenous variables;  $Y_{1-1}$  is a  $T \times j_1$  matrix of observations on  $j_1$  lagged included endogenous variables;  $X_1$  is a  $T \times m_1$  matrix on  $m_1$  included exogenous variables; and  $\beta_1$ ,  $\alpha_1$  and  $\gamma_1$  are vectors of coefficients to be estimated. The  $T$ -component column vectors of error terms,  $u_1$ ,  $u_{1-1}$  and  $e_1$ , satisfy

$$(III.4) \quad u_1 = \rho_1 u_{1-1} + e_1$$

where:

$\rho_1$  is the first diagonal element of  $R$ .

As the only lagged endogenous variables appearing in the theoretical model are lagged left-hand variables, equation (III.3) can be simplified to

$$(III.5) \quad y_1 = Y_1 \gamma_1 + y_{1-1} \alpha_1 + X_1 \beta_1 + u_1$$

From (III.4) and (III.5), the equation to be estimated is

$$(III.6) \quad y_1 - \rho_1 y_{1-1} = (Y_1 - \rho_1 Y_{1-1}) \gamma_1 + (y_{1-1} - \rho_1 y_{1-2}) \alpha_1 + (X_1 - \rho_1 X_{1-1}) \beta_1 + e_1$$

#### B. Outline of Estimation Procedure

The equation (III.6) can be consistently estimated using the following limited information method.

(i) Instrumental Adjustment. Instrumentally adjust  $Y_1$ ,  $Y_{1-1}$ ,  $y_{1-1}$ , and  $y_{1-2}$  using a set of instrumental variables that include  $X_1$  and  $X_{1-1}$  and are asymptotically uncorrelated with  $e_1$ . From the instrumental variable regressions, calculate the predicted values of  $Y_1$ ,  $Y_{1-1}$ ,  $y_{1-1}$  and  $y_{1-2}$  and denote them respectively  $\hat{Y}_1$ ,  $\hat{Y}_{1-1}$ ,  $\hat{y}_{1-1}$  and  $\hat{y}_{1-2}$ .

Calculate the standard error of the equation using

$$(III.10) \quad \hat{S}_1 = \sqrt{(e_1'e_1)/T}$$

The estimated variance-covariance matrix of the estimated coefficients is

$$(III.11) \quad V(\hat{S}_1) = \hat{S}_1^2 (\hat{Z}_1' \hat{Z}_1)^{-1}$$

where:

$$\hat{\delta}_1 = [\hat{\gamma}_1, \hat{\alpha}_1, \hat{\beta}_1]$$

and

$$\hat{Z}_1 = [\hat{Y}_1 - \hat{\rho}_1 \hat{Y}_{1-1}, \hat{y}_{1-1} - \hat{\rho}_1 \hat{y}_{1-2}, X_1 - \hat{\rho}_1 X_{1-1}]$$

and the standard errors of the estimated coefficients are the square roots of the diagonal elements of the variance-covariance matrix.

Consistency of the procedure relies on three facts. First, all the included predetermined variables appearing in equation (III.6), namely  $X_1$  and  $X_{1-1}$ , appear in the list on instruments used in step (i). Second, the equation is assumed to be identified. Third, the set of instrumental variables used are asymptotically uncorrelated with  $e_1$ .

The following sub-sections will discuss the key characteristics of this estimation procedure and its application to our theoretical model.

### C. Lagged Endogenous Variables are Endogenous

The first key characteristic of this estimation procedure is that the lagged endogenous variables appearing in (III.6),  $Y_{1-1}$ ,  $y_{1-1}$ , and  $y_{1-2}$  are endogenous rather than exogenous. Recalling the discussion in Fisher (14), the endogeneity of these lagged variables arises from the fact that they are

correlated with the error term,  $e$ . This argument is particularly applicable here because the lagged left-hand variable appears in the equation because of both a distributed lag process and an autoregressive process. If  $y_{-1}$  and  $Y_{-1}$  are in fact endogenous, then the estimation methods proposed by Fair (13) and Dhrymes (10) will yield inconsistent estimators since they both treat  $y_{-1}$  and  $Y_{-1}$  as exogenous.<sup>9a</sup>

#### D. Instrumental Adjustment

The second important characteristic of the estimation procedure is that  $Y_1, Y_{1-1}, y_{1-1}, y_{1-2}$  can be instrumentally adjusted taking into account the structural ordering of the model using the method described in Fisher (14) and Mitchell and Fisher (32). In our model, structural ordering arises from the need to emphasize lagged exogenous variables rather than current exogenous variables in the instrumental adjustment of lagged endogenous variables, while still satisfying the consistency requirement of using  $X_1$  and  $X_{1-1}$  as instruments. The method of structurally ordered instrumental variables (S.O.I.V.) answers this need by a two stage procedure. First, we regress  $Y_1, Y_{1-1}, y_{1-1}$  and  $y_{1-2}$  on instrument lists of different exogenous variables. Let  $\tilde{Y}_1, \tilde{Y}_{1-1}, \tilde{y}_{1-1}$  and  $\tilde{y}_{1-2}$  be the fitted values of these regressions. In order to insure consistency of the estimators, the second stage requires that we instrumentally adjust  $Y_1, Y_{1-1}, y_{1-1}$  and  $y_{1-2}$  using  $\tilde{Y}_1, \tilde{Y}_{1-1}, \tilde{y}_{1-1}, \tilde{y}_{1-2}, X_1$ , and  $X_{1-1}$ . For this procedure, it should be noted that the theoretical

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<sup>9a</sup>We attempted unsuccessfully to estimate the model using Fair's method, but the method often failed to converge. When convergence did occur, the estimated coefficients often had incorrect signs and the residuals often still exhibited a first-order serial correlation pattern.

model is block triangular, with the export equations forming the highest sector and the lower sectors including the import, revenue and expenditure equations respectively. The four basic exogenous variables of our model, namely  $P_m$ ,  $\sum_{i=1}^{\infty} G_{t-i}^R$ ,  $Y^R$  and  $P_d$  appear in the export sector. In the structural ordering of the instruments for a particular sector, define  $X^*$  as these four exogenous variables plus any dummy variables appearing in that or a higher sector.

In the first stage, instrument lists of various lengths which followed the preference ordering described by Fisher were tried. We estimated each equation for all countries with structurally similarly lengthened instrument lists. The primary purpose for using similar lengths was to assure as much consistency between countries as possible. A secondary benefit was a substantial reduction in the computational burden of the procedure. For this first stage, short instrument lists did not work because the endogenous variables were not instrumentally adjusted enough, and very long instrument lists did not work because the estimates became too close to ordinary least squares results. For almost all the supply and demand equations, instrument lists of intermediate length were used.  $Y_1$  was regressed on  $X^*$  and  $X_{1-1}$ ;  $y_{1-1}$  and  $Y_{1-1}$  were regressed on  $X_{-1}^*$  and  $X_{1-2}$ ; and  $y_{1-2}$  was regressed on  $X_{-2}^*$  and  $X_{1-3}$ . Longer instrument lists were used for most of the import, revenue and expenditure equations.  $Y_1$  was regressed on  $X^*$  and  $X_{-1}^*$ ;  $y_{1-1}$  and  $Y_{1-1}$  were regressed on  $X_{-1}^*$  and  $X_{-2}^*$ ; and  $y_{1-2}$  was regressed on  $X_{-2}^*$  and  $X_{-3}^*$ . In a few cases, supply and demand equations proved to be better estimated using longer instruments lists, and import, revenue and expenditure equations were estimated using intermediate instrument lists.

E. Iteration Method

This iteration method was used for several important reasons. First, the iteration method converged to a value of  $\rho$  that always satisfied the condition that its absolute value did not exceed one. The largest  $\rho$  estimated was .8876 for Ceylon's import equation. Second, the method actually removed the first order serial correlation pattern in the data. While this conclusion is based upon examination of the plots of the estimated residuals,  $\hat{u}_1$  and  $\hat{e}_1$ , of the fifty equations estimated, one indicator of the degree of improvement is given by the Durbin-Watson statistic. The average D.W. statistic was 1.36 before and 1.95 after the autoregressive adjustment. Omitting the nine equations for which no autoregressive adjustment was made, the averages were 1.23 before and 1.93 after the adjustment. Finally, the iterates yielded estimates of the parameters with correct signs and relatively low standard errors.

#### IV. The Results

Tables 1 through 10 of Appendix A report the estimates of the five structural equations for each of the ten countries in our sample. There is no simple way to summarize these results. All the signs of the estimated coefficients are correct, and the standard errors of the coefficients and of the equations are rather low.<sup>10</sup> These tables do, however, conceal a good deal of individual variation among coefficients which will be discussed in this section.

Examining the supply and demand equations, we find lagged real exports  $X_{t-1}^R$  appearing as an explanatory variable indicating the presence of a lagged adjustment process in the supply equations of Cuba, Ceylon, Nigeria, and Taiwan, and in the demand equations of Chile, Nigeria, and the Philippines. For the remaining supply and demand equations, the coefficient of lagged real exports was not significant. For these equations, therefore, lagged real exports was dropped as an explanatory variable.

The estimated export price coefficients of the supply equations indicate inelastic aggregate supply schedules in colonial economies. The estimates vary in magnitude from .117 in Nigeria to .465 in Chile, with an average of .306. They are short-run supply elasticities for all countries, and also long-run supply elasticities for the six countries where there is no distributive lag process. For the four countries in which  $X_{t-1}^R$  appears, the average long run elasticity is .759 ranging from .239 in Nigeria to 1.52 in Ceylon. If Ceylon is excluded on the grounds that its exports were comprised primarily of output from tea and rubber estates, then the estimated

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<sup>10</sup>We have reported the  $R^2$  statistic because it is usually expected. Its explanatory power in a simultaneous equation system such as presented here cannot be relied upon.

aggregate supply elasticity for a colonial economy is inelastic in both the short and long run.<sup>11</sup>

We find that the average elasticity of demand for aggregate real exports is also typically inelastic with the export price coefficient in the demand equation indicating an average price elasticity of  $-0.521$  in the short run for all ten countries. The long run elasticity averages  $-1.15$  for three countries in which an adjustment process is present. If Chile is excluded on the grounds that the demand for the two main exports, copper and nitrate, is elastic, then the average demand elasticity falls to  $-.46$  in the short run and  $-.95$  in the long run (for Nigeria and the Philippines). This finding of relatively inelastic supply and demand schedules for a colonial economy when, as will be seen, both curves are quite shiftable gives rise to rather dramatic changes in the price of exports.

Since it was likely that the main source of income in these countries was derived directly or indirectly from export activity, colonial income and growth were governed by fluctuations in economic forces, some of which the colonies did not control. These economic forces were of two types: the first was real government expenditures in the colony whose determination presumably was in the hands of the colonizer (or if not a formal colony, subject to influence by its main trading partner), and the second was a market influence represented by changes in the developed country's real income and prices. Shifts in the supply schedule are shown by the coefficients

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<sup>11</sup>Of course, within the agrarian sector of these economies, there may be significant shifting of resources out of one crop to another as relative internal crop prices change.



of the import price and accumulated real government expenditures. Shifts in the demand schedule are measured by the coefficients of the domestic price level and real income in the developed country. The average coefficient associated with the government variable is .48 and with the import price, -.34; for the four countries with an adjustment process, the respective long run coefficients are 1.1 and -.7. India has the lowest elasticity associated with government expenditures followed by Egypt and then Thailand. In fact, these three countries seem to be in a relatively low governmental productivity group compared to the other seven countries; the average governmental elasticity being .54 for the latter group and .32 for the former. Almost one half of the Indian budget was devoted on the average to military expenditures for the period and thus a low coefficient is not surprising. Although Egypt and Thailand were not colonies in the legal sense, their respective economies were as much subject to U.K. influence as that of India. Egypt had the slowest growth rate of real exports of all ten countries and her resources seemed to have been increasingly focused more on the required repayment of previous international loans than devoted toward development expenditures.<sup>12</sup> The Thai government was effectively constrained from controlling and utilizing governmental expenditures for productive investments by U.K. financial control.<sup>13</sup>

The average income elasticity of demand for colonial goods is .83 in the short run and 1.41 in the long run for those three countries in which  $X_{t-1}^R$  appears as a variable in the demand schedule. For all ten countries

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<sup>12</sup>See Issawi (22) and Crouchley (6) for further discussion.

<sup>13</sup>See Ingram (20).

the average long run income elasticity is 1.09 which indicates ~~the importance~~ of income growth in the developed countries on export growth in the colonial countries. The average elasticity of substitution between home and colonial commodities in the developed countries is .50 in the short run and, for the latter three countries, 1.34 in the long run. The results of examining these substitution elasticities by colonial blocs suggest that those countries which were under direct or indirect United States influence had the highest substitution effects as compared to the United Kingdom bloc or to Japan (for the case of Taiwan). There was perhaps more internal substitution over the period within the United States (copper for the case of Chile and beet sugar for Cuba and the Philippines) than for either the United Kingdom or Japan. The model would predict, then, that ceteris paribus, a fall in United States prices would shift the demand schedule for colonial goods to the left more than an equivalent shift in the prices of the United Kingdom or Japan. For this reason the world depression of the 1930's had a more dramatic effect on Chile, Cuba, and the Philippines compared to the rest of our sample countries.

The remaining variables to be considered in the supply and demand schedules are the set of country specific dummy variables. Where the economic history of the country suggested the use of an imposed tariff, quota, restriction scheme, or the influence of the First World War, they were introduced into the appropriate trade equation. No simple summary can be given of these different effects except to note that they all have the proper sign and are generally important in magnitude. For example, the imposition of a quota by the United States on Philippine exports beginning in 1934 led to a 17% decline

in Philippine's supply of real exports (sugar fields in the Philippines were burned by producers in response to the imposed quota). Furthermore, the results of the model indicate that similar dummy variables used in different countries need not have the same sign. For example, the effects of World War I benefited the supply of real exports from Taiwan to Japan, whereas Nigerian trade suffered from the effects of the war because trade with Germany, one of its main export markets, was completely cut off and did not resume until 1922. In only two countries, India and Thailand, was there no evidence suggesting the use of appropriate dummy variables reflecting either the impact of World War I or the serious trade restrictions imposed during the 1930's.

Turning now to the import equation, we have empirical evidence on two important colonial questions: the size of the reflection ratio and whether or not real commodity trade was balanced over the period. The Tables reveal that the coefficient associated with  $X^R$  was either less than one or not significantly different from one for all ten countries. The average coefficient was .94 suggesting that, *certeris paribus*, the rate of growth of real imports was slightly less than that of real exports. On the average, then, these countries were running a real surplus on current account. The country with the highest average real surplus over the period was Taiwan. This average coefficient of .94 also indicates a powerful reflection ratio suggesting a robust circular process of development for an export economy. Finally, the results indicate price elasticities of demand less than one for all countries thus once again revealing inelastic demand schedules but this time for imports of the developed countries' goods.

The revenue equation shows a wide range of estimates. The average

contribution of real exports to nominal revenues was slightly higher (.59) than that of nominal imports (.46). However, the marginal contribution of real exports varies from a low of .230 in Thailand to a high of 1.203 in Chile (where imports were not effectively taxed). A similar variation is found on the marginal contribution of nominal imports to revenues--the coefficients ranging from a low of .191 in Cuba to .626 in Jamaica. While on average, the coefficient of  $X^R$  was higher than that of M, the reverse occurs in five countries (India, Jamaica, Philippines, Thailand, and Taiwan). Thus, the averages given above conceal a good deal of variation among the countries.

One interesting feature of the revenue equation is the total tax effort. Adding the coefficients of  $X^R$  and M, we can test for the homogeneity of the function. The average for the ten countries is 1.01 suggesting on average a constant returns to scale revenue function so that an increase in the ratio of real exports to nominal imports will lead to a rise in nominal revenues per unit of nominal imports. However, the revenue equations for Thailand and Taiwan indicate an average sum of tax coefficients of .58. Compared to the other eight countries (where the average, excluding Thailand and Taiwan, is now 1.12) the tax effort for these two countries was not strong enough.

The dummy variables associated with the revenue equation provide additional information on the tax effort. In Chile, Egypt, India, and Thailand, a dummy variable was introduced into the revenue equation reflecting the imposition of an income tax on copper in Chile from 1926 to 1938; the use of a new tariff schedule in Egypt from 1931 to 1938, in India from 1931 to 1937, and in Thailand from 1927 to 1938. The coefficients associated with

these dummy variables indicate that for Chile and India the incremental revenues generated were large compared to those for Egypt and Thailand. Dummies were also introduced into the revenue equations of Ceylon, India, Jamaica, and Taiwan to reflect changes in accounting practices. The use of a dummy variable named NET indicates a shift from including gross revenue (and expenditure) from railroad operations to including only net revenue from railroads. In Jamaica, the RAIL dummy variable reflects the government take-over of railway operations, and in Taiwan the use of a dummy variable from 1921 to 1936 takes into account the change in reporting to include local governmental revenues.

Examining the results of the expenditure equation, all ten colonial governments ran a balanced budget in the long run. The average short run elasticity of current revenue is .67 and the average elasticity associated with lagged expenditures is .33. However, there is significant variation in the distribution between current and recurrent nominal expenditures for the ten countries. Chile, Egypt, India, and Taiwan seem to form one bloc where expenditures are financed almost entirely out of current revenues. For the other six countries, recurrent expenditures are a much more important variable, with the extreme set by Cuba which had the highest elasticity associated with lagged expenditures.

## V. The Reduced Form

Tables 11-20 in Appendix A present for each country the equilibrium reduced form solutions of the estimated structural system. Since a log linear system has been estimated, the Tables show equilibrium multipliers in elasticity form.<sup>14</sup> Reading down a column in these Tables shows that an assumed 1 percent change in an exogenous variable causes a computed percentage change in an endogenous variable. In Ceylon, for example, a 1 percent increase in the real GNP of the United Kingdom caused, ceteris paribus, a .62 percent increase in the real exports of Ceylon, a .39 percent increase in the Ceylonese export price index, a 1.02 percent increase in nominal exports, and so forth for the remaining endogenous variables.

The importance of the government sector in fostering the development of an export economy (e.g., shifting the supply schedule of real exports) was confirmed by the previous econometric results. The lagged accumulated real government expenditures column in the reduced form Tables provides the necessary quantitative information to test the importance of the government sector on all the endogenous variables of the colonial country. One of the most important of these multipliers can be called the reflection ratio,  $\partial G / \partial (\sum_{i=1}^{\infty} G_{t-i}^R)$ , for it measures the equilibrium impact of previous accumulated government expenditures.<sup>15</sup> The sign and magnitude of this multiplier reflects, in a sense, the governmental development effort directed towards the export economy. A positive coefficient suggests the productivity of government activity as it worked its way through the circular process of colonial development. The

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<sup>14</sup> Where appropriate, we have assumed  $X_t^R = X_{t-1}^R$  in the demand or supply equation and  $G_t = G_{t-1}$  in the expenditure equation.

<sup>15</sup> For the theoretical model deriving this concept, see Hymer and Resnick (19).

higher the coefficient the more productive was the government in allocating its own resources to generate real exports and, via the specified feedback of the model, to generate a higher level of expenditures for itself.

The reflection ratios in the Tables reveal clearly two groupings of countries: those in which the multiplier is close to zero (Egypt, India, Jamaica, and Thailand) and those in which the multiplier is positive and significantly different from zero. Of the ten countries, the Philippines stands out as having the highest coefficient. This result is quite consistent with its economic history under American rule where much of the colonial effort was directed towards development expenditures on transport, education, health and so forth.<sup>16</sup> It is also interesting to note that the countries having the highest government reflection ratio were associated with American influence (Chile and Cuba) or direct American control (the Philippines). One might conclude that dependence on America resulted in the relatively efficient development of an export economy.<sup>17</sup> The story for British colonialism is mixed. India, Jamaica, and Egypt had the slowest growth of real exports of the ten countries, and they are also countries with long historical experience of foreign contact and influence.<sup>18</sup> Perhaps historical developments may have

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<sup>16</sup> See, for example, Resnick (39). It is interesting to note that the empirical results of the present model confirm the historical analysis in the Resnick paper which suggested that the Thai government was not as productive as the Philippine government.

<sup>17</sup> It is tempting to argue that the U.S. was a "latecomer" to the colonial process and thus could draw upon the experiences of and could make improvements over the older colonial powers in running a colonial government or in influencing a government.

<sup>18</sup> Cuba and the Philippines were colonies of Spain until the Spanish American War and Chile had gained independence early in the 19th century. One could argue, however, that Spanish colonialism rested on an inferior mode of development as compared with British colonialism with its more favorable history of industrial development.

acted to establish economic and social barriers which were difficult to overcome such as the caste system in India or the emphasis on financial control in Egypt to repay its previous loans. Thailand did have a much higher growth rate of real exports than did these three countries but as indicated previously, the possibility of increased government activity toward development expenditures was constrained by the financial control of the British.<sup>19</sup> Whatever the reasons, the results do suggest that although the processes of export development may have been similar, the effects of colonialism differed among the ten countries in terms of the governmental efforts to promote an export economy. There is no doubt that the government was an important part of the historical process but the degree of its importance differed. Models of export development which have ignored or omitted this variable have therefore been misspecified. This conclusion does not depend on the size of the government reflection ratio, for it is equally important in explaining the low growth of India which had the lowest ratio as in explaining the high growth of the Philippines which had the highest ratio.

The multipliers associated with developed countries' prices, income, and policy variables show the impact of these variables via the international

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<sup>19</sup>One could also argue that if the Thai government had attempted to alter the foreign enforced tax rates or, rather than build up its enormous foreign reserve position, if it had decided to spend its limited revenues on increased expenditures such as irrigation, roads, or power, then the possibility existed that this might have led to a relatively more powerful economic position which, in turn, might have invited a direct confrontation with British colonialism. Thus, to preserve the integrity of Thai institutions, the government was effectively constrained from controlling and utilizing the gains from her export trade.



trade linkages upon the economies of the colonies. As expected, the elements of the column vectors associated with the income and price variables are all positive. An increase in real income in the developed country implies a shift in the effective demand for real exports which increases all the other endogenous variables in the system. An examination of the impact on  $X^R$  of an assumed change in real incomes shows that the strongest link seems to be between Taiwan and Japan, followed by that between Britain and its colonies, and finally, the weakest positive link is found to be between the United States and its colonies. A reverse ordering is discovered if we examine the impact on  $X^R$  indicated by the developed countries' domestic price vector. This suggests, in contrast to the United Kingdom and Japan, that United States prices were more important than its real income in determining real export activity in its trade dependent countries. As discussed previously, this reflects the greater internal substitution within the United States as compared to Japan or the United Kingdom.

The restrictive trade policies pursued by the United States during the 1930's had rather dramatic effects upon Chile, Cuba, the Philippines, and Jamaica. The magnitude of these effects are indicated by the column vectors associated with TARIFF for Chile, QUOTAS for both Cuba and the Philippines, and RESTRICT for Jamaica. Since prices and real income were falling in the United States during the great depression, the imposition of these restrictions on trade, according to our results, should have only compounded the difficulties experienced in these three countries. And the evidence presented here of the differential colonial impact suggests that these countries having substantial trade with America should have suffered more than the countries tied to Britain or Japan. Interestingly enough, however, there

seems to be a difference between the impact upon the Philippines and that upon Chile and Cuba. The trade restrictions put upon the Philippines were not as severe and came somewhat later in the depression years as compared to those for Cuba and Chile. One might argue from this partial evidence, at least for those countries linked to the United States, that legal colonialism as exemplified by the Philippines acted to mitigate the impact of United States policies. Trade dependence may have presented all kinds of economic and political problems for these three countries but if so, then it was better during the 1930's to be a formal colony.

Two other exogenous variables, the import price and the foreign exchange rate, both assumed to be determined in the developed world, have rather interesting effects upon the export sector. *Ceteris paribus*, a rise in  $P_m$  will act to increase  $P_x$  for all ten countries, the average partial elasticity being about .5. Thus, if for any external reasons import prices increased, the results of the model indicate that the terms-of-trade would move against the colonial countries. Another interesting feature of the results is the impact of a change in an exchange rate, assumed to be exogenous to the colony, on real economic activity. In Ceylon, for example, a one percent increase in the rupee pound rate led to a .34 percent rise in Ceylonese real exports, and via the circular flow of the model, to a .33 percent rise in government expenditures. The nominal trade balance slightly improved but the trade balance in real terms slightly deteriorated. Similar sets of results hold for India and Thailand where the exchange rate enters as a variable. The reason for the differential impact upon nominal and real trade balances can be traced to the importance of the trade reflection ratio

in the import equation discussed in the previous section, and the associated export and import price elasticities in this equation.

In Section IV of this paper, we noted the inelasticity of demand and supply schedules and mentioned the effects on the export price of the colony when both curves are shiftable. Thus the export price will rise or fall depending on whether the effects of the rates of growth of real income and prices in the developed country are greater or less than the effects of the rate of growth of accumulated real government expenditures in the developing country. Table 3 presents the solutions of totally differentiating the log linear system for the rates of growth of the endogenous variables in terms of the exogenous ones.<sup>20</sup> The solution for the rate of growth of  $P_x$  is negative for six countries of which five have a negative growth value greater than one percent; Egypt, India, Jamaica, and Taiwan had positive rates of growth of  $P_x$  over the period.

If one assumes that an objective or target of colonial policy was to have a negative rate of growth of export prices so as to pass a portion of the gains-from-trade to the developed country in terms of declining prices for raw materials or food, then with the rates of growth of income and prices in the developed country assumed exogenously given, one can compute the necessary rate of growth of the assumed policy instrument, real accumulated colonial expenditures, to insure such a target. For Egypt, the necessary rate of growth of real government expenditures would have to have exceeded 4.9 percent per year in order to have a negative growth rate of export prices.

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<sup>20</sup>This solution matrix is then calculated as the product of the reduced form coefficients times the vector of actual growth rates of the exogenous variables.

Table 3

## Reduced Form Coefficients Multiplied by Growth Rates

	CEYLON	CHILE	CUBA	EGYPT	INDIA	JAMAICA	NIGERIA	PHILIP- PINES	TAIWAN	THAILAND
$\ln X^R$	4.673	2.455	2.060	0.691	0.777	1.521	4.917	5.710	6.716	2.425
$\ln Px$	-1.532	-1.433	-1.554	1.748	1.134	0.846	-0.334	-1.052	0.166	-1.491
$\ln Px$ ( $\mathcal{L}$ )	-1.118				1.692					-0.224
$\ln K$	3.140	1.022	0.506	2.439	1.911	2.367	4.583	4.658	6.882	0.934
$\ln M^R$	3.889	1.899	1.471	0.570	0.848	1.793	2.131	5.382	5.190	2.107
$\ln M$	3.715	0.686	1.433	2.047	1.675	2.610	4.793	4.531	5.652	1.236
$\ln R$	4.125	6.302	2.155	1.915	1.499	2.495	5.741	4.951	3.675	1.435
$\ln G$	4.128	6.288	2.217	1.909	1.499	2.498	5.793	4.953	3.660	1.416
$\ln X^R - \ln M^R$	0.704	0.556	0.589	0.121	-0.071	-0.271	2.786	0.328	1.527	0.317

For a target of one percent decline in export prices per year, expenditures would have to have been around 6 percent per year. This compares to the actual growth rate of Egypt's accumulated real government expenditures of 2.7 percent per year, and an actual average rate of 6.0 percent per year in government expenditures for the six countries having a negative growth rate for export prices. Thus, if this target is accepted, the Egyptian government did not spend enough on the development of an export economy and British influence should have been directed more to this effort than to the repayment of foreign debt out of government expenditures. A similar story holds for India. To have a negative growth of export prices, accumulated government real expenditures should have grown at a rate higher than 4.7 percent per year compared to an actual growth of about 2 percent per year. A one percent decline in export prices per year would have required a 7 percent growth in government expenditures. British colonialism in India fell far short of this particular target. In Jamaica, the growth rates necessary to insure the respective targets would be for accumulated real government expenditures, higher than 4.6 percent per year and, for a one percent decline in export prices, 6.2 percent per year. This compares to an actual government expenditure rate of 3.2 percent per year. Finally, for Taiwan the necessary rates would have to have been higher than 5.1 percent and 6.8 percent per year. And these rates can be compared to the actual growth rate of government expenditures of 4.8 percent per year. Actually, the Taiwan government only fell slightly short of the first target of a negative growth rate of export prices, and should, therefore, not be placed in the same class as Egypt, India, and Jamaica. We can conclude then that on the basis of this evidence, the development effort

in Egypt, India, and Jamaica was too little in terms of the self-interest of the colonial power.

The above experiment examines only export prices. Presumably, the developed countries would be interested in their terms-of-trade with these particular countries. A similar investigation can be done on the assumption that a movement in the terms-of-trade in favor of the developed countries would be the desired target (recall once again that the terms-of-trade is endogenous in this model. The reduced form solutions for the per year growth rates of the terms-of-trade follow so that they can be compared to the solutions for the growth rates of export prices given in Table 3: Ceylon, -1.48%; Chile, -1.16%; Cuba, -1.54%; Egypt, .38%; India, .76%; Jamaica, .30%; Nigeria, -1.55%; Philippines, -.93%; Taiwan, -.12%; Thailand, -1.00%. The results are similar to the previous ranking of countries. The only developing countries for whom the terms-of-trade moved in their favor would be Egypt, India, and Jamaica, but the governmental effort in these countries required to insure a negative growth rate of the terms-of-trade would be smaller than the previous example indicated though still greater than what was actually expended. Furthermore, Taiwan's terms-of-trade moved over time in favor of Japan because the movement in Japan's export price index to Taiwan overwhelmed the positive growth rate of Taiwan's export prices.

The growth equation associated with real imports (line  $\ln I^R$  in Table 3) provides evidence on the long run benefits received by these countries as a result of their export development. The Philippines shows the highest rate of 5.38% per year while Egypt and India show the lowest average rate of

about .71% per year.<sup>21</sup> The average rate of growth of real imports was 2.5% per year for all ten countries, and excluding Egypt and India, slightly less than 3.0% per year. These are certainly healthy growth rates and serve once again to underline the rather dramatic transformation that took place in these countries over the period being examined.

Given these high growth rates of real imports based on the structure of the model, one wonders what the growth rate of the real trade balance looked like over the period. Table 3 presents the growth rates for  $X^R - M^R$ . The Philippines ran an increasing real export surplus even with a growth rate of real imports of 5.38% per year. Nigeria and Taiwan stand out (2.79% and 1.53% respectively for  $X^R - M^R$ ) given that both had rather healthy growth rates of real exports (see Table 3). In fact, with the exception of India and Jamaica, all countries were running an increasing real export surplus (and India's  $X^R - M^R$  is only slightly less than zero). The underlying reduced form matrix for these two countries suggests that a rather small increase in government expenditures would have turned the growth rate of the real trade balance positive.

For the ten countries in our sample, we have shown the importance of their own government expenditures and the level of income and prices in the developed world in determining their economic development. Our focus has been on the simultaneity of the historical development process as revealed by the interaction between the trade and government sectors, and their dependence

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<sup>21</sup> Interestingly enough the government variable in the Philippines accounts for over 70% of this growth rate which is the highest for all ten countries. For Egypt and India, real income in the U.K. accounts for almost all of the growth of real imports.

on external forces. Such a model works fairly well in explaining the development process for these ten countries. Finally, the results of the model explain the substantial growth that these countries experienced from about 1900 to World War II.



Appendix A

Equation Estimates

and

Reduced Form Coefficients

Definition of Variables

A. Common to All Countries

$G_t$	Government expenditures
$\sum_{i=1}^{\infty} G_{t-i}^R$	Lagged sum of real government expenditures using 1913 prices
$M_t$	Commodity imports
$M_t^R$	Real commodity imports in 1913 prices
$P_{m_t}$	Paasche import price index with 1913 = 1
$P_{x_t}$	Paasche export price index with 1913 = 1
$R_t$	Government revenue
$X_t$	Commodity exports
$X_t^R$	Real commodity exports in 1913 prices

B. Japan

$P_{JP_t}$	GNP price deflator with 1934-36 = 100
$Y_{JP_t}^R$	Real GNP in millions of 1934-36 yen

C. United Kingdom

$P_{UK_t}$	National income price deflator with 1913-14 = 100
$Q_{UK_t}$	Index of industrial production excluding building
$Y_{UK_t}^R$	Real net national income in 1913-14 pounds

D. United States

$CARS_t$	Motor vehicle factory sales
$P_{US_t}$	GNP price deflator with 1929 = 100
$P_{US_t}^m$	Fisher import price index with 1913 = 100
$P_{US_t}^{mm}$	Import price index of crude materials with 1913 = 100
$Q_{US_t}$	Index of manufacturing output with 1929 = 100
$Y_{US_t}^R$	Real GNP in millions of 1929 dollars

E. Dummy Variables

FIXED	Thailand, tariffs fixed by Bowrin's treaty until 1926, and thereafter increasing tariffs, 1926-1937
FIRST WAR	Ceylon, 1915-1918
FIRST WAR	Egypt, 1915-1918
FIRST WAR	Nigeria, effects of first war and aftermath, 1915-1921

FIRST WAR	Taiwan, 1915-1919
INCOME	Chile, income tax on copper producers, 1926-1938
INFRA	Nigeria, completion of infrastructure projects--railroad to Northern Nigeria and port of Lagos--1917-1938
LIMIT	Ceylon, international restriction scheme on rubber exports, 1935-1938
LOCAL	Taiwan, addition of local revenue and expenditures, 1921-1936
NET	Ceylon, change from gross to net railway revenues, 1929-1938
NET	India, change from gross to net railway revenues, 1906-1936
NET	Nigeria, change from gross to net railway revenues, 1927-1938
QUOTAS	Cuba, U.S. import sugar quotas and tariffs, 1930-1937
QUOTAS	Philippines, U.S. import sugar quotas, 1935-1938
RAIL	Jamaica, government takeover of railroads, 1900-1938
RESTRICT	Jamaica, U.S. import tariffs and restrictions, 1932-1938
TARIFF	Chile, new tariff schedule, 1932-1938
TARIFF	Egypt, new tariff schedule, 1931-1938
TARIFF	India, new tariff schedule, 1931-1937
WORKS	Ceylon, expenditure includes public works expenses, 1916-1924

Table 1

CEYLON, Equation Estimates

$$\ln X_S^R = -4.550 + .305 \ln P_x_t - .120 \ln P_m_t + .401 \ln \sum_{i=1}^{\infty} G_{t-i}^R + .811 \ln X_{t-1}^R - .196 \text{LIMIT}_t$$

(1.746) (.084) (.109) (.198) (.151)

(.064)

$R^2 = .9870$   
 $\rho = .0$   
 $D.W. = 1.94$   
 $S.E. = .0698$

$$\ln X_D^R = 9.794 - .431 \ln P_x_t + .794 \ln Y_{UK}^R + .256 \ln \text{CARS}_t - .216 \text{LIMIT}_t$$

(2.105) (.084) (.283) (.017) (.078)

$R^2 = .9851$   
 $\rho = .6147$   
 $D.W. = 1.59$   
 $S.E. = .0747$

$$\ln M_t = .899 \ln X_t^R - .325 \ln P_m_t + .241 \ln P_x_t - .195 \text{FIRST WAR}_t$$

(.021) (.150) (.115) (.066)

$R^2 = .9474$   
 $\rho = .8876$   
 $D.W. = 2.00$   
 $S.E. = .0786$

$$\ln R_t = -.288 + .758 \ln X_t^R + .188 \ln M_t - .036 \text{WORKS}_t - .042 \text{NET}_t$$

(1.247) (.125) (.134) (.060) (.086)

$R^2 = .9730$   
 $\rho = .5100$   
 $D.W. = 2.00$   
 $S.E. = .0880$

$$\ln G_t = .504 \ln R_t + .497 \ln G_{t-1} + .030 \text{WORKS}_t$$

(.107) (.108) (.030)

$R^2 = .9820$   
 $\rho = .0$   
 $D.W. = 1.99$   
 $S.E. = .0744$

Table 2

CHILE, Equation Estimates

$\ln X_{S_t}^R = 8.042 + .465 \ln P_{X_t} - .443 \ln P_{M_t} + .572 \ln \sum_{i=1}^{\infty} G_{t-i}^R - .525 \text{TARIFF}_t$ <p style="margin-left: 40px;"> <span style="margin-right: 100px;">(1.829) (.259)</span> <span style="margin-right: 100px;">(.242)</span> <span style="margin-right: 100px;">(.088)</span> <span style="margin-right: 100px;">i=1</span> <span style="margin-right: 100px;"><math>t-i</math></span> <span style="margin-right: 100px;">(.279)</span> </p>	$R^2 = .7894$ $\rho = .4299$ $D.W. = 1.97$ $S.E. = .1948$
$\ln X_{D_t}^R = 7.509 - 1.011 \ln P_{X_t} + .532 \ln Q_{US_t} + .759 \ln P_{US_t}^{imm} + .333 \ln X_{t-1}^R - .564 \text{TARIFF}_t$ <p style="margin-left: 40px;"> <span style="margin-right: 100px;">(2.832) (.237)</span> <span style="margin-right: 100px;">(.140)</span> <span style="margin-right: 100px;"><math>Q_{US_t}</math></span> <span style="margin-right: 100px;">(.195)</span> <span style="margin-right: 100px;"><math>P_{US_t}^{imm}</math></span> <span style="margin-right: 100px;">(.154)</span> <span style="margin-right: 100px;"><math>\ln X_{t-1}^R</math></span> <span style="margin-right: 100px;">(.206)</span> </p>	$R^2 = .8280$ $\rho = -.1335$ $D.W. = 2.06$ $S.E. = .1760$
$\ln M_t = .979 \ln X_t^R - .411 \ln P_{M_t} + .700 \ln P_{X_t}$ <p style="margin-left: 40px;"> <span style="margin-right: 100px;">(.004)</span> <span style="margin-right: 100px;"><math>\ln X_t^R</math></span> <span style="margin-right: 100px;">(.228)</span> <span style="margin-right: 100px;"><math>\ln P_{M_t}</math></span> <span style="margin-right: 100px;">(.192)</span> <span style="margin-right: 100px;"><math>\ln P_{X_t}</math></span> </p>	$R^2 = .7794$ $\rho = .3021$ $D.W. = 1.93$ $S.E. = .2107$
$\ln R_t = -4.766 + 1.203 \ln X_t^R + 1.310 \text{INCOME}_t$ <p style="margin-left: 40px;"> <span style="margin-right: 100px;">(2.720) (.139)</span> <span style="margin-right: 100px;"><math>\ln X_t^R</math></span> <span style="margin-right: 100px;">(.119)</span> <span style="margin-right: 100px;"><math>\text{INCOME}_t</math></span> </p>	$R^2 = .9642$ $\rho = .4118$ $D.W. = 2.00$ $S.E. = .1886$
$\ln G_t = .951 \ln R_t + .047 \ln G_{t-1}$ <p style="margin-left: 40px;"> <span style="margin-right: 100px;">(.099)</span> <span style="margin-right: 100px;"><math>\ln R_t</math></span> <span style="margin-right: 100px;">(.099)</span> <span style="margin-right: 100px;"><math>\ln G_{t-1}</math></span> </p>	$R^2 = .9816$ $\rho = .4274$ $D.W. = 1.70$ $S.E. = .1407$

Table 3

CUBA, Equation Estimates

$$\ln X_{S_t}^R = 1.764 + .222 \ln P_{X_t} - .342 \ln P_{M_t} + .489 \ln \sum_{i=1}^{\infty} G_{t-i}^R + .373 \ln X_{t-1}^R - .488 \text{QUOTAS}_t$$

(2.190) (.214)      (.292)      (.147)      (.209)      (.165)

R<sup>2</sup> = .8537  
ρ = .0  
D.W. = 2.25  
S.E. = .1229

$$\ln X_{D_t}^R = 10.982 - .784 \ln P_{X_t} + .647 \ln Q_{US_t} + 1.154 \ln P_{US_t}^M - .350 \text{QUOTAS}_t$$

(1.100) (.193)      (.135)      (.287)      (.105)

R<sup>2</sup> = .8829  
ρ = .3514  
D.W. = 1.79  
S.E. = .1122

$$\ln M_t = .985 \ln X_t^R - .171 \ln P_{M_t} + .363 \ln P_{X_t}$$

(.005)      (.332)      (.241)

R<sup>2</sup> = .8012  
ρ = .7448  
D.W. = 1.84  
S.E. = .1399

$$\ln R_t = -3.061 + .913 \ln X_t^R + .191 \ln M_t$$

(4.479) (.274)      (.108)

R<sup>2</sup> = .8395  
ρ = .6123  
D.W. = 1.85  
S.E. = .1555

$$\ln G_t = .282 \ln R_t + .726 \ln G_{t-1}$$

(.067)      (.066)

R<sup>2</sup> = .9604  
ρ = .1740  
D.W. = 1.79  
S.E. = .0875

Table 4

EGYPT, Equation Estimates

$$\ln X_S^R = 4.222 + .206 \ln P_x_t - .400 \ln P_m_t + .341 \ln \sum_{i=1}^{\infty} G_{t-i}^R + .114 \text{ FIRST WAR}_t$$

(1.125) (.179) (.171) (.060)

R<sup>2</sup> = .5890  
 ρ = .0  
 D.W. = 1.91  
 S.E. = .1051

$$\ln X_D^R = 4.352 - .226 \ln P_x_t + .910 \ln Y_{UK}^R + .167 \ln P_{UK_t} - .162 \text{ FIRST WAR}_t$$

(1.056) (.065) (.132) (.078) (.052)

R<sup>2</sup> = .6839  
 ρ = .0  
 D.W. = 2.11  
 S.E. = .0922

$$\ln M_t = .986 \ln X_t^R - .403 \ln P_m_t + .277 \ln P_x_t - .177 \text{ FIRST WAR}_t$$

(.010) (.373) (.341) (.229)

R<sup>2</sup> = .8370  
 ρ = .7266  
 D.W. = 2.30  
 S.E. = .1737

$$\ln R_t = 4.270 + .626 \ln X_t^R + .605 \ln M_t + .033 \text{ TARIFF}_t$$

(2.717) (.236) (.080) (.025)

R<sup>2</sup> = .9456  
 ρ = .6500  
 D.W. = 2.02  
 S.E. = .1154

$$\ln G_t = .921 \ln R_t + .076 \ln G_{t-1}$$

(.135) (.136)

R<sup>2</sup> = .9798  
 ρ = .5101  
 D.W. = 2.29  
 S.E. = .0679



Table 5

INDIA, Equation Estimates

$$\ln X_{S_t}^R = 14.769 + .422 \ln P_{x_t} - .286 \ln P_{m_t} + .267 \ln \sum_{i=1}^{\infty} G_{t-i}^R$$

(3.219) (.190)                      (.149)                      (.127)

R<sup>2</sup> = .7543  
ρ = .5974  
D.W. = 1.60  
S.E. = .0775

$$\ln X_{D_t}^R = 18.045 - .214 \ln P_{x_t} + .604 \ln Q_{UK_t} + .151 \ln P_{UK_t}^R$$

(1.223) (.167)                      (.191)                      (.152)

R<sup>2</sup> = .7162  
ρ = .7516  
D.W. = 1.93  
S.E. = .0833

$$\ln M_t = .979 \ln X_t^R - .450 \ln P_{m_t} + .405 \ln P_{x_t}$$

(.003)                      (.278)                      (.337)

R<sup>2</sup> = .8150  
ρ = .6657  
D.W. = 1.80  
S.E. = .1242

$$\ln R_t = -1.825 + .278 \ln X_t^R + .813 \ln M_t - .332 \text{NET}_t + .564 \text{TARIFF}_t$$

(4.365) (.224)                      (.102)                      (.089)                      (.072)

R<sup>2</sup> = .9204  
ρ = .4428  
D.W. = 1.85  
S.E. = .0905

$$\ln G_t = .871 \ln R_t + .129 \ln G_{t-1}$$

(.099)                      (.099)

R<sup>2</sup> = .9881  
ρ = .5847  
D.W. = 1.66  
S.E. = .0370

Table 6

JAMAICA, Equation Estimates

$\ln X_{S_t}^R = 4.210 + .536 \ln P_{X_t} - .665 \ln P_{M_t} + .606 \ln \sum_{i=1}^{\infty} G_{t-i}^R - .226 \text{RESTRICT}_t$	$R^2 = .7090$
$(1.623) (.337) \quad (.280) \quad (.095) \quad (.151)$	$\rho = .2577$
	$D.W. = 1.97$
	$S.E. = .1478$
$\ln X_{D_t}^R = 10.038 - .451 \ln P_{X_t} + 1.031 \ln Q_{UK_t} + .236 \ln P_{UK_t} - .121 \text{RESTRICT}_t$	$R^2 = .7902$
$(.694) (.200) \quad (.159) \quad (.176) \quad (.084)$	$\rho = .1363$
	$D.W. = 1.94$
	$S.E. = .1255$
$\ln M_t = 1.018 \ln X_t^R - .518 \ln P_{M_t} + .788 \ln P_{X_t}$	$R^2 = .8704$
$(.010) \quad (.301) \quad (.348)$	$\rho = .8500$
	$D.W. = 2.32$
	$S.E. = .1515$
$\ln R_t = -.574 + .353 \ln X_t^R + .627 \ln M_t + .152 \text{RAIL}_t$	$R^2 = .9760$
$(.937) (.080) \quad (.038) \quad (.040)$	$\rho = .2505$
	$D.W. = 2.01$
	$S.E. = .0681$
$\ln G_t = .521 \ln R_t + .479 \ln G_{t-1}$	$R^2 = .9830$
$(.141) \quad (.142)$	$\rho = .0$
	$D.W. = 1.95$
	$S.E. = .0594$

Table 7

NIGERIA, Equation Estimates

$$\ln X_S^R = 1.438 + .118 \ln P_x_t - .213 \ln P_m_t + .347 \ln \sum_{i=1}^{\infty} G_{t-i}^R + .509 \ln X_{t-1}^R + .268 \text{INFRA}_t - .081 \text{FIRST WAR}_t$$

(.740) (.111)
(.107)
(.120)
(.147)
(.095)
(.038)

$R^2 = .9827$   
 $\rho = .0$   
 $D.W. = 2.08$   
 $S.E. = .0681$

$$\ln X_D^R = -.595 - .189 \ln P_x_t + .617 \ln Y_{UK}^R + .366 \ln P_{UK_t} + .735 \ln X_{t-1}^R - .097 \text{FIRST WAR}_t$$

(1.178) (.076)
(.268)
(.132)
(.095)
(.043)

$R^2 = .9785$   
 $\rho = .0$   
 $D.W. = 2.09$   
 $S.E. = .0759$

$$\ln M_t = .994 \ln X_t^R - .941 \ln P_m_t + .750 \ln P_x_t - .259 \text{FIRST WAR}_t$$

(.009)
(.173)
(.206)
(.099)

$R^2 = .8088$   
 $\rho = .7200$   
 $D.W. = 2.02$   
 $S.E. = .1187$

$$\ln R_t = -6.848 + .889 \ln X_t^R + .487 \ln I_t - .262 \text{NET}_t$$

(1.210) (.113)
(.075)
(.086)

$R^2 = .9792$   
 $\rho = .4412$   
 $D.W. = 1.80$   
 $S.E. = .0905$

$$\ln G_t = .413 \ln R_t + .590 \ln G_{t-1}$$

(.092)
(.092)

$R^2 = .9741$   
 $\rho = .3661$   
 $D.W. = 1.94$   
 $S.E. = .0887$

Table 8

PHILIPPINES, Equation Estimates

$\ln X_{S_t}^R = .143 + .268 \ln P_{X_t} - .220 \ln P_{M_t} + .921 \ln \sum_{i=1}^{\infty} G_{t-i}^R - .173 \text{ QUOTAS}_t$ <p style="text-align: center;"> <span style="margin-right: 100px;">(.917)</span> <span style="margin-right: 100px;">(.225)</span> <span style="margin-right: 100px;">(.248)</span> <span style="margin-right: 100px;">(.045)</span> <span style="margin-right: 100px;">(i=1)</span> <span style="margin-right: 100px;">(t-i)</span> <span>(.088)</span> </p>	$R^2 = .9645$ $\rho = .2572$ $D.W. = 1.80$ $S.E. = .1101$
$\ln X_{D_t}^R = 3.137 - .498 \ln P_{X_t} + .424 \ln Y_{US_t}^R + .601 \ln P_{US_t} + .592 \ln X_{t-1}^R - .056 \text{ QUOTAS}_t$ <p style="text-align: center;"> <span style="margin-right: 100px;">(2.027)</span> <span style="margin-right: 100px;">(.212)</span> <span style="margin-right: 100px;">(.240)</span> <span style="margin-right: 100px;">(.267)</span> <span style="margin-right: 100px;">(.179)</span> <span>(.056)</span> </p>	$R^2 = .9762$ $\rho = -.2155$ $D.W. = 2.04$ $S.E. = .0902$
$\ln M_t = .986 \ln X_t^R - .024 \ln P_{M_t} + .256 \ln P_{X_t}$ <p style="text-align: center;"> <span style="margin-right: 100px;">(.003)</span> <span style="margin-right: 100px;">(.242)</span> <span style="margin-right: 100px;">(.201)</span> </p>	$R^2 = .9406$ $\rho = .4207$ $D.W. = 1.86$ $S.E. = .1285$
$\ln R_t = -.433 + .388 \ln X_t^R + .603 \ln M_t$ <p style="text-align: center;"> <span style="margin-right: 100px;">(.925)</span> <span style="margin-right: 100px;">(.074)</span> <span style="margin-right: 100px;">(.082)</span> </p>	$R^2 = .9637$ $\rho = .3125$ $D.W. = 1.94$ $S.E. = .1009$
$\ln G_t = .669 \ln R_t + .331 \ln G_{t-1}$ <p style="text-align: center;"> <span style="margin-right: 100px;">(.083)</span> <span style="margin-right: 100px;">(.083)</span> </p>	$R^2 = .9867$ $\rho = -.1983$ $D.W. = 1.88$ $S.E. = .0633$

Table 9

TAIWAN, Equation Estimates

$\ln X_{S_t}^R = -.287 + .363 \ln P_{X_t} - .482 \ln P_{M_t} + .453 \ln \sum_{i=1}^{\infty} G_{t-i}^R + .626 \ln X_{t-1}^R$ <p style="margin-left: 40px;">                     (2.083) (.222)                      (.228)                      (.328)                      (.205)                 </p> <p style="margin-left: 40px;">                     + .108 FIRST WAR<sub>t</sub>                      (.041)                 </p>	$R^2 = .9822$ $\rho = -.2426$ D.W. = 2.11 S.E. = .0855
$\ln X_{D_t}^R = 6.817 - 1.095 \ln P_{X_t} + 1.650 \ln Y_{JP_t}^R + .287 \ln P_{JP_t}$ <p style="margin-left: 40px;">                     (3.893) (.376)                      (.344)                      (.299)                 </p> <p style="margin-left: 40px;">                     + .171 FIRST WAR<sub>t</sub>                      (.093)                 </p>	$R^2 = .9661$ $\rho = .8024$ D.W. = 2.07 S.E. = .1178
$\ln M_t = .784 \ln X_t^R - .273 \ln P_{M_t} + .305 \ln P_{X_t}$ <p style="margin-left: 40px;">                     (.004)                      (.272)                      (.348)                 </p>	$R^2 = .9682$ $\rho = .7008$ D.W. = 1.57 S.E. = .1107
$\ln R_t = 5.038 + .267 \ln X_t^R + .333 \ln M_t + .415 \text{LOCAL}_t$ <p style="margin-left: 40px;">                     (1.767) (.139)                      (.128)                      (.092)                 </p>	$R^2 = .9721$ $\rho = .3471$ D.W. = 1.97 S.E. = .1005
$\ln G_t = .945 \ln R_t + .052 \ln G_{t-1}$ <p style="margin-left: 40px;">                     (.108)                      (.109)                 </p>	$R^2 = .9834$ $\rho = .4036$ D.W. = 2.04 S.E. = .0825

Table 10

THAILAND, Equation Estimates

$$\ln X_S^R = 2.751 + .158 \ln P x_t - .209 \ln P m_t + .361 \ln \sum_{i=1}^{\infty} G_{t-i}^R$$

(.445) (.217)
(.211)
(.022)

$R^2 = .9178$   
 $\rho = .0$   
 $D.W. = 2.12$   
 $S.E. = .0909$

$$\ln X_D^R = -3.660 - .212 \ln P x_t + 1.093 \ln Y_{UK}^R + .736 \ln P_{UK}^R$$

(1.701) (.109)
(.221)
(.090)

$R^2 = .8990$   
 $\rho = .2507$   
 $D.W. = 1.87$   
 $S.E. = .0875$

$$\ln M_t = .928 \ln X_t^R - .548 \ln P m_t + .416 \ln P x_t$$

(.025)
(.316)
(.270)

$R^2 = .9028$   
 $\rho = .8220$   
 $D.W. = 2.12$   
 $S.E. = .1209$

$$\ln R_t = 1.698 + .230 \ln X_t^R + .325 \ln M_t + .020 \text{FIXED}_t$$

(.865) (.199)
(.080)
(.010)

$R^2 = .9410$   
 $\rho = .6722$   
 $D.W. = 1.67$   
 $S.E. = .0624$

$$\ln G_t = .669 \ln R_t + .322 \ln G_{t-1}$$

(.153)
(.155)

$R^2 = .9528$   
 $\rho = .6686$   
 $D.W. = 2.07$   
 $S.E. = .0631$

Table 11

## CEYLON, Reduced Form Coefficients

	$\ln P_m$	$\ln \sum_{i=1}^{\infty} G_{t-i}^R$	$\ln Y_{UK}^R$	$\ln CARS$	LIMIT	$\pi$	FIRST WAR	WORKS	NET
$\ln X^R$	-0.133	0.447	0.627	0.202	-0.389	0.340	0.	0.	0.
$\ln P_x$	0.310	-1.037	0.389	0.125	0.401	0.211	0.	0.	0.
$\ln P_x$ (₡)	0.310	-1.037	0.389	0.125	0.401	-0.789	0.	0.	0.
$\ln X$	0.176	-0.591	1.015	0.327	0.013	0.551	0.	0.	0.
$\ln M^R$	-0.370	0.151	0.657	0.212	-0.253	0.356	-0.195	0.	0.
$\ln M$	0.630	0.151	0.657	0.212	-0.253	0.356	-0.195	0.	0.
$\ln R$	0.018	0.367	0.599	0.193	-0.342	0.325	-0.037	-0.037	-0.042
$\ln G$	0.018	0.367	0.600	0.193	-0.343	0.325	-0.037	0.023	-0.042

Table 12

## CHILE, Reduced Form Coefficients

	$\ln P_m$	$\ln \sum_{i=1}^{\infty} G_{t-i}^R$	$\ln Q_{US}$	$\ln P_{US}^{imm}$	TARIFF	INCOME
$\ln X^R$	-0.339	0.438	0.187	0.267	-0.600	0.
$\ln P_x$	0.223	-0.289	0.403	0.575	-0.162	0.
$\ln X$	-0.115	0.149	0.590	0.842	-0.763	0.
$\ln M^R$	-0.587	0.226	0.465	0.664	-0.701	0.
$\ln M$	0.413	0.226	0.465	0.664	-0.701	0.
$\ln R$	-0.407	0.527	0.225	0.321	-0.722	1.310
$\ln G$	-0.407	0.525	0.225	0.321	-0.721	1.308

Table 13

## CUBA, Reduced Form Coefficients

	$\ln P_m$	$\ln \sum_{i=1}^{\infty} G_{t-i}^R$	$\ln Q_{US}$	$\ln P_{US}^M$	QUOTAS
$\ln X^R$	-0.376	0.538	0.201	0.359	-0.645
$\ln P_x$	0.479	-0.685	0.568	1.014	0.377
$\ln X$	0.103	-0.148	0.769	1.373	-0.268
$\ln M^R$	-0.367	0.280	0.404	0.722	-0.498
$\ln M$	0.633	0.280	0.404	0.722	-0.498
$\ln K$	-0.222	0.544	0.261	0.466	-0.684
$\ln G$	-0.228	0.560	0.269	0.479	-0.704

Table 14

## EGYPT, Reduced Form Coefficients

	$\ln P_m$	$\ln \sum_{i=1}^{\infty} G_{t-i}^R$	$\ln Y_{UK}^R$	$\ln P_{UK}$	FIRST WAR	TARIFF
$\ln X^R$	-0.210	0.179	0.433	0.079	-0.017	0.
$\ln P_x$	0.927	-0.791	2.111	0.386	-0.640	0.
$\ln X$	0.718	-0.612	2.544	0.466	-0.658	0.
$\ln M^R$	-0.353	-0.042	1.011	0.185	-0.372	0.
$\ln M$	0.647	-0.042	1.011	0.185	-0.372	0.
$\ln R$	0.260	0.086	0.883	0.162	-0.236	0.033
$\ln G$	0.259	0.086	0.880	0.161	-0.235	0.033



Table 15

## INDIA, Reduced Form Coefficients

	$\ln P_m$	$\ln \sum_{i=1}^{\infty} G_{t-i}^R$	$\ln Q_{UK}$	$\ln P_{UK}^R$	$\pi$	TARIFF	NET
$\ln X^R$	-0.096	0.090	0.401	0.100	0.142	0.	0.
$\ln P_x$	0.451	-0.420	0.951	0.238	0.336	0.	0.
$\ln P_x$ ( £ )	0.451	-0.420	0.951	0.238	-0.664	0.	0.
$\ln X$	0.354	-0.330	1.352	0.339	0.478	0.	0.
$\ln M^R$	-0.362	-0.082	0.778	0.195	0.275	0.	0.
$\ln M$	0.638	-0.082	0.778	0.195	0.275	0.	0.
$\ln R$	0.492	-0.042	0.744	0.186	0.263	0.564	-0.332
$\ln G$	0.492	-0.042	0.744	0.186	0.263	0.564	-0.332

Table 16

## JAMAICA, Reduced Form Coefficients

	$\ln P_m$	$\ln \sum_{i=1}^{\infty} G_{t-i}^R$	$\ln Q_{UK}$	$\ln P_{UK}$	RESTRICT	RAIL
$\ln X^R$	-0.304	0.277	0.560	0.128	-0.169	0.
$\ln P_x$	0.673	-0.614	1.045	0.239	0.106	0.
$\ln X$	0.369	-0.337	1.604	0.368	-0.063	0.
$\ln M^R$	-0.297	-0.202	1.393	0.319	-0.088	0.
$\ln M$	0.703	-0.202	1.393	0.319	-0.088	0.
$\ln R$	0.333	-0.028	1.071	0.245	-0.115	0.152
$\ln G$	0.333	-0.028	1.072	0.245	-0.115	0.153

Table 17

## NIGERIA, Reduced Form Coefficients

	$\ln P_m$	$\ln \sum_{i=1}^{\infty} G_{t-i}^R$	$\ln Y_{UK}^R$	$\ln P_{UK}$	INFRA	FIRST WAR	NET
$\ln X^R$	-0.324	0.528	0.585	0.347	0.408	-0.215	0.
$\ln P_x$	0.455	-0.741	2.447	1.450	-0.572	-0.211	0.
$\ln X$	0.131	-0.213	3.032	1.797	-0.164	-0.427	0.
$\ln M^R$	-0.922	-0.031	2.417	1.432	-0.024	-0.631	0.
$\ln M$	0.078	-0.031	2.417	1.432	-0.024	-0.631	0.
$\ln R$	-0.250	0.455	1.698	1.006	0.351	-0.499	-0.262
$\ln G$	-0.252	0.459	1.713	1.015	0.354	-0.504	-0.264

Table 18

## PHILIPPINES, Reduced Form Coefficients

	$\ln P_m$	$\ln \sum_{i=1}^{\infty} G_{t-i}^R$	$\ln Y_{US}^R$	$\ln P_{US}$	QUOTAS
$\ln X^R$	-0.180	0.755	0.187	0.265	-0.166
$\ln P_x$	0.148	-0.618	0.697	0.988	0.023
$\ln X$	-0.033	0.137	0.884	1.254	-0.143
$\ln M^R$	-0.164	0.586	0.363	0.515	-0.158
$\ln M$	0.836	0.586	0.363	0.515	-0.158
$\ln R$	0.434	0.647	0.292	0.414	-0.160
$\ln G$	0.434	0.647	0.292	0.414	-0.160

Table 19

## TAIWAN, Reduced Form Coefficients

	$\ln P_m$	$\ln \sum_{i=1}^{\infty} G_{t-i}^R$	$\ln Y_{JP}^R$	$\ln P_{JP}$	FIRST WAR	LOCAL
$\ln X^R$	-0.683	0.642	0.776	0.135	0.234	0.
$\ln P_x$	0.624	-0.586	0.798	0.139	-0.057	0.
$\ln X$	-0.059	0.056	1.574	0.274	0.176	0.
$\ln M^R$	-0.618	0.324	0.852	0.148	0.166	0.
$\ln M$	0.382	0.324	0.852	0.148	0.166	0.
$\ln R$	-0.055	0.279	0.491	0.085	0.118	0.415
$\ln G$	-0.055	0.278	0.489	0.085	0.117	0.414

Table 20

## THAILAND, Reduced Form Coefficients

	$\ln P_m$	$\ln \sum_{i=1}^{\infty} G_{t-i}^R$	$\ln Y_{UK}^R$	$\ln P_{UK}$	$\pi$	FIXED
$\ln X^R$	-0.120	0.207	0.467	0.314	0.091	0.
$\ln P_x$	0.564	-0.976	2.954	1.988	0.573	0.
$\ln P_x$ ( ¥ )	0.564	-0.976	2.954	1.988	-0.427	0.
$\ln X$	0.444	-0.769	3.421	2.303	0.664	0.
$\ln M^R$	-0.425	-0.214	1.661	1.118	0.322	0.
$\ln M$	0.575	-0.214	1.661	1.118	0.322	0.
$\ln R$	0.159	-0.022	0.647	0.435	0.125	0.020
$\ln G$	0.157	-0.022	0.639	0.430	0.124	0.020

Appendix B

Data Sources by Country

Using the listing in the bibliography, the data sources for each country in the model are given below.

A. Colonial Countries

Ceylon: 12, 15  
Chile: 16, 24, 25, 36  
Cuba: 1, 7, 12, 24, 25, 38  
Egypt: 6, 12, 16, 24, 25  
India: 15  
Jamaica: 12, 15  
Nigeria: 12, 15  
Philippines: 40  
Taiwan: 18  
Thailand: 21, 24, 25, 31

B. Developed Countries

Japan: 23, 37  
United Kingdom: 8, 33  
United States: 5, 26

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