Working Paper Series

Working Paper No. 439

A LATENT VARIABLE REGRESSION MODEL OF NINETEENTH CENTURY ECONOMIC DEVELOPMENT

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BERKELEY

CALIFORNIA AGRICULTURAL EXPERIMENT STATION

University of California

DEPARTMENT OF AGRICULTURAL AND RESOURCE ECONOMICS
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California Agricultural Experiment Station
Giannini Foundation of Agricultural Economics
April, 1987

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Introduction

What insights can the study of the consequences of the Industrial Revolution yield for contemporary development policy in developed and developing countries? In the nineteenth century, the industrialization of Western Europe, especially Great Britain, caused a dramatic expansion in international trade, capital movements, and international migration and severely upset the previous balance of economic and political power. Different countries adapted quite differently to the changed international environment and to the new technological and trade opportunities it provided. Some adapted very successfully, others did not. Some developed, others experienced growth without development, and still others stagnated. The consequences for the working poor also varied very significantly across countries and over time.

Can a model of nineteenth century growth be specified, which will explain this variety of country experiences? In the present paper, we attempt to provide and estimate such a model. The model is based on the data and hypotheses derived from the previous study of Morris and Adelman (in press) of the economic development of 23 countries from 1850 to 1914. It specifies a simultaneous equation regression model and uses latent variables to portray various economic institutions and technological development. The model characterizes the causal chain through which initial conditions, political structures, and economic institutions affected technological and economic development, economic growth, and the diffusion of benefits from growth in the nineteenth and early twentieth centuries. The structure of the model is largely recursive, and the model is estimated using the technique of partial least squares with latent variables first proposed by H. Wold (1975 onward) and the computer program developed by Lohmöller (1981).

The next section summarizes the statistical technique. After a brief section describing the data, we specify our model of nineteenth century growth. We then examine the statistical results of the estimation of the average model for 1850-1914 in the light of historical and development theories, historical case studies, and the previous Morris and Adelman results. We conclude by looking at how the average model varies over time. We fit three, simultaneously estimated, models identical in structure to the average model to 1850-1870, 1870-1890, and 1890-1914 and examine how the individual regression coefficients change over time.

The Method

The general technique of modelling we apply to the historical data is Partial Least Squares (PLS). Linear regression equations are used to model the relations between the variables, which can be observed either directly (manifest variable, MVs) or indirectly (latent variables, LVs) by multiple indicators. The latent variables are estimated as weighted aggregates of their indicators. The weights for the aggregates and the regression coefficients are estimated in an iterative way by the PLS algorithm. The method is described in detail by H. Wold (1975 and onward). The computer program used is PLS 1.8 (Lohmöller 1981). What follows here is a short overview of the statistical model and of the estimation.

Regression: The basic elements of the PLS model are regression equations, which may include only latent, or latent and manifest, variables. We treat all variables as standardized to zero mean and unit variance and leave aside the problem of measurement errors. We write an equation for variables x_j:

$$x_j = \Sigma_i \, b_{ji} x_i + u_j, \qquad (1)$$

where index j stands for the predictand, index i ranges over the predictors of x_j, and there are other, potential, predictors x_h in the model that are not included in the equation for a given x_j. We assume that the conditional expectation of x_j follows the linear expression:

$$E(x_j \mid \text{all } x_i) = \Sigma_i \, b_{ji} x_i. \tag{2}$$

For this specification as well as for the least squares estimates, it is implied that predictors x_i and residual u_j are uncorrelated,

$$\text{cov}(x_i, u_j) = 0 \qquad \text{for all predictors } x_i \text{ in equation } j. \tag{3}$$

The zero-covariance restriction does not necessarily hold for omitted variables, and if the covariance

$$\text{cov}(x_h, u_j) \qquad \text{for any variable } x_h \text{ omitted from equation } j \tag{4}$$

is different from zero, this may give hints for model modification.

Path model: In a path model, a set of variables is connected by a system of regression equations. All variables, which before were called predictands, predictors, and omitted variables [which are available but not included in equation (1)], are collected into one vector $x = [x_j]$. With vector x, vector $u = [u_j]$, and square matrix $B = [b_{ji}]$, we rewrite equation (1) in matrix notation:

$$x = B\,x + u. \tag{5}$$

Some of the regression coefficients b_{ij} are set to zero a priori. In particular, the diagonal elements of B are zero. If B is subdiagonal, the model is recursive. In the ith column of the matrix B, one finds the influences the variable x_i exercises on other variables in the model. The jth row of B gives the coefficients of the regression equation with x_j as a dependent variable and indicates the influences of the other variables on this specific predictand. If the jth row has all zero coefficients, then the corresponding variable x_j is exogenous and the corresponding u_j is not a residual but is identical to x_j. Matrix B is called the path matrix, and the coefficients b_{ji} the path coefficients; under the statistical specification we use in the present analysis, the path coefficients are identical to regresssion coefficients, but in general they need not be. A path diagram (as in Fig. 2) can be used to visualize the connections between the variables.

The pattern of zero and nonzero coefficients is recorded in the path design matrix $D_B = [d_{ji}]$, which contains a zero entry $d_{ji} = 0$ for each path coefficient restricted to zero, and a one, $d_{ji} = 1$, for each path coefficient that is free. Hence, the path matrix follows the restriction

$$b_{ji} = d_{ji} \cdot b_{ji} \qquad \text{or } B = D_B * B, \tag{6}$$

where the star (*) denotes the Hadamard product. The specifiction of the model is done by specifying D_B. The conditional expectation is written as

$$E(x_j \mid \text{all } d_{ji} \cdot x_i) = \Sigma_i \, b_{ij} x_i \qquad \text{for all } x_j. \tag{7}$$

The conditional expectation in (7) implies that the residual variable u_j has mean zero and is uncorrelated with all the predictors which are selected by the expression $d_{ji} \cdot x_i$ but not necessarily with the other variables. Hence, the covariance matrix cov(u,x) has a pattern of zeros that is complementary to the pattern of D_B. Moreover, the conditional expectation (7) implies that least squares estimates are consistent (under mild additional assumptions, see H. Wold 1963); that the system (5) can be estimated by separate multiple regressions for each line; that the residual variance, $var(u_j)$, is minimal for each equation; and that the sum of the residual variances is minimal. However, there is no guarantee that the residuals of different equations are uncorrelated. The covariance matrix

$$Psi = cov(u,u) \tag{8}$$

can be used to identify potential improvements of the predictive power of the model by changing the model specification D_B.

Latent variables: So far, we have taken for granted that the variables x are known, in the sense that either their covariance matrix $S = [s_{ji}] = [cov(x_j,x_i)]$ or their scores $X = [x_{jn}]$, where the index n ranges over the observational units, are known. This is not the case when some x_j are unobservable, and only indicators of the variables x_j are directly observable. In that case, the unobservable variable, known as a latent variable (LV), is established by its relation to its observable, manifest variables (MVs). The relationships between LVs and MVs are described by two equations, see (9) and (10) below. These two equations constitute the outer part of the model (or measurement model), while the path model (5) forms the inner part of the model. The two outer equations give the composition of one set of variables in terms of the other: equation (9) of the MVs in terms of the LVs and equation (10), the composition of the LVs in terms of the MVs.

If we denote the vector of observed variables by $y = [y_k]$ and the matrix of their values (scores) for observation n by $Y = [y_{kn}]$, then:

$$y_{kn} = p_{kj}x_{jn} + e_{kn} \qquad \text{or } Y = PX + E \qquad \text{or } y = Px + e \tag{9}$$

where $P = [p_{kj}]$ is a matrix of regression coefficients, so-called loading coefficients. The residuals $e = [e_k]$ or $E = [_{kn}]$ represent that part of the observation that is not predictable from the LV; in some contexts it is interpreted as measurment error. Notice that (9) does not involve a summation over j, the index of the LVs, because each indicator is attached to only one LV. We treat all variables, MVs and LVs, as standardized, hence the loadings will be correlations, $p_{kj} = cor(y_k, x_j)$. The loading coefficient p_{kj} shows the influence of the latent variable x_k on the manifest variable y_k. A zero loading coefficient indicates that the LV has no explanatory power at all for the MV in question. A high loading coefficient allows for inference about the nature and meaning of the LV.

The loadings in (9) would be easily estimated, were the LV known. But it is not. The LV is estimated by a function specified on the MVs. In PLS the LVs are estimated as linear aggregates of the MVs:

$$x_{jn} = \Sigma_k w_{kj} y_{kn} \qquad \text{or } S = W'Y \qquad \text{or } x = W'y. \tag{10}$$

The pragmatic assumption of linearity, which is in line with the usage of principal components as estimates of common factors, reduces the problem of estimating the latent variables to finding appropriate weights $W = [w_{kj}]$. Once the weights are known, the LVs can be treated as known, and the loadings, path coefficients, and various residual covariances are easily estimated. The assembly of indicators belonging to one LV is called a block of MVs.

There are different ways to think about the tasks an LV must perform in a latent variables path (LVP) or regression model:

- One way is to think of the LV as the best predictor of its indicators in equation (9). Applied to LVP models, this means that one estimates the LVs separately within each block, without reference to the path model. This is, of course, easily done by extracting the principal component of the block of manifest variables.

- Another way is to think along the lines of the canonical correlation model where the only emphasis is on maximizing the correlations between two LVs. With this philosophy, the weights are estimated so as to produce the best predictand in the one block and the "most predictable criterion" (Hotelling, 1936) in the other block of MVs. This concept can be extended to multi-block models, where, depending on its position in the path model, an LV is required to be one of the following: the best predictor, the best mediator, or the best predictand.
- And third, there is a compromise between the two approaches: the LV is supposed to do both--fit well into the path model while being a good predictor for its indicators.

Which view is adopted is up to the researcher. But since each view implies a different error minimization criterion, the choice among these approaches implies different computational procedures and must be specified in advance by the researcher. As indicated above, the first approach requires simply the extraction of the first principal component of the block. The second and third require somewhat more complicated computations. We describe the estimation method that is based on the second approach, the generalization of canonical correlation, first. We then turn to the third, compromise, approach.

PLS algorithm for the second approach: The core of the PLS algorithm is the iterative estimation of the weights w_{kj} and can be characterized in this way: Estimate the latent variable x_j so that it is a good neighbour in its neighbourhood. That is, estimate the LV so that is is well predicted by its predecessors in the path diagram and is a good predictor for its followers in the diagram. Only the variables which have a direct connection to the LV under question are considered to be neighbours in the PLS estimation process. As an estimate of the "ideal" neighbour in this neighbourhood a weighted aggregate of the neighbours is taken:

$$\tilde{x}_{jn} = \Sigma_i \, v_{ji} x_{in}, \tag{11}$$

where $\tilde{x}_j$ is an approximation to the LV (called the inside approximation), and the index i ranges over the neighbours of x_j. In (11) the weights v_{ji} (called the inner weights) are chosen to be

$$v_{ji} = \begin{cases} b_{ji} & \text{if } x_i \text{ is a predictor of } x_j \\ r_{ji} = \operatorname{cor}(x_j, x_i) & \text{if } x_i \text{ is a predictand of } x_j \\ 0 & \text{if } x_i \text{ is not neighbour of } x_j. \end{cases} \tag{12}$$

To make x_{ij}, the LV under question, the best approximation to the "ideal neighbour" $\tilde{x}_j$, one applies multiple regression to the equation:

$$\tilde{x}_j = \Sigma_k \, \tilde{w}_{kj} y_k + \text{residual} \tag{13}$$

to get the weights $\tilde{w}_{kj}$. These weights are, then, rescaled so that the weighted aggregate formed by equation (10) has unit variance

$$w_{kj} = \tilde{w}_{kj} \,/\, \sqrt{\operatorname{var}(\Sigma_k \, \tilde{w}_{kj} y_k)} \;. \tag{14}$$

The x_j that results from the sequence of (12), (11), (13), (14), and (10) will fit better into the path model than the neighbouring variables x_i that go into this algorithm, because the summation in (11) averages out the possible imperfect adjustment of the neighbours to the path model, and because the multiple regression in (13) minimizes the distorting influence of individual MVs, especially if one or more MVs do not belong in the model.

The PLS algorithm estimates the weights for each LV separately, presuming, in each iteration, that the adjacent LVs are known. The weights are estimated so as to make the weighted aggregate fit for its duties in the path model. After each LV is improved in this way, the PLS algorithm starts a new iteration cycle, where each LV is again improved so that it fits better into the path model by reference to its improved neighbours. The iteration is stopped when no weight changes by more than, say, the fifth decimal place. The term Partial Least Squares relates to the fact that the PLS algorithm treats one part of the model, that can directly be estimated by LS methods, at time, then proceeds to the next part, and, in general, treats all parts of the model successively and iteratively, until convergence is judged to have occurred. The algorithm is partial; the result, however, gives a systemwide solution (Bookstein 1982).

Weighting modes: The third approach to LV estimation mentioned above leads to an algorithm with essentially the same steps as described in equations (10) to (14). Only (13) takes a different form, in order to express a different definition of the duties of the LV. Under the third approach, the LV is required to be at the same time a good neighbour in the path model and a good predictor for its own indicators. In this case, the weights are estimated by a simple regression, with the inside approximation as predictor:

$$y_k = \tilde{w}_{kj}\tilde{x}_j + \text{residual}. \tag{15}$$

[This equation does not sum over j, because the MV (y_k) is regressed only on the LV (x_j) of its own block.] The weights according to equation (15) are called Mode A weights whereas the weights of (13) are called Mode B weights. [One can visualize the modes-of-weight computations in a path diagram: Mode A weight estimation is depicted by arrows pointing from the LV "outward" to the MVs, and Mode B weights are drawn as arrows pointing from the MVs "inward" to the LV. This sort of diagram does not show the generating model, but is a sort of PLS command diagram (Bookstein 1982) or visualization of the estimation modes.] The PLS technique allows for the choice of different weighting modes for the different blocks of the LVP model. As a result, two traditional multivariate methods are special cases of the PLS method: A model with two LVs and Mode B weight estimation is identical to the canonical correlation model; a model with one LV, $\tilde{x} = x$, and Mode A weights is identical to the principal components model.

Mode B weights share the fortunate property of multiple regression coefficients that they give best predictions and high R^2 and the unfortunate property that they are less stable across samples and varying model specifications. Another fortunate property that Mode B weights share with multiple regression coefficients is the "Occam's razor" property that helps purge superfluous predictors which turn out to have zero weights. This, then, leads to the following argument regarding the choice of weighting modes: If one is not sure about the meaning of the LV under question, and if one is not sure about the quality of the collection of indicators, then a Mode B weight estimation will pick out those indicators that make their weighted aggregate the best LV in the path model; then, if one of the indicators turns out to have zero weight, the omission of this unnecessary variable will not change the model at all. On the other hand, if one is sure of having the correct sample of indicators for an LV, with no MV missing and no MV superfluous, one should choose Mode A weight estimation, as this will give each variable an equal chance to be represented in the LV. In the model that was estimated with our historical data we have used both weighting modes, depending on our knowledge of our manifest and latent variables.

The interpretation of the LVs utilizes both the weights and the loadings, and they contribute different information about the LVs.

- The weight coefficient w_{kj} is used to construct the estimate of the LV. It indicates the relative necessity of each MV for constructing the LV. If a weight coefficient of an MV is close to zero, then this MV is unnecessary for the rest of the model and could be omitted.
- The loading coefficient p_{kj} shows the influence of the LV x_k on the MV y_k. A zero loading coefficient indicates that the LV has no explanatory power at all for the MV under question. A high loading coefficient allows for inference about the meaning of the LV.
- If the weight coefficient w_{kj} of a given indicator is close to zero and the loading coefficient p_{kj} is of considerable size, then this indicator does not add to the construction of the LV; but it does add to the meaning, interpretation, and validity of this LV and gives additional evidence of the explanatory power of the LV.

If a variable is directly observed, it appears twice in the model, as an MV and as an LV. In this case, the LV is identical to its single indicator; the weight coefficient, without any iteration, is equal to one; and there is no iterative adjustment of this LV to its duties with respect to the neighbourhood in the path model or the indicators. The flow of mutual adjustments between all LVs in the model is then barred by such single-indicator LVs. If there is, in a bigger model, one part that is bordered by single-indicator LVs, then the weights for this part of the model can be estimated separately. The model we present below can be separated in this way into three statistically independent submodels--one for each period. We found that the separate weight estimation for the three submodels gave exactly the same weights as the big longitudinal model--in a tenth of the computing time.

The Data

The data are drawn from the recently completed study of Morris and Adelman (op. cit.) of the development experience of 23 countries between 1850 and 1914. The sample of countries includes all countries that experienced some aggregate growth in the nineteenth century for which at least moderately reliable historical information could be found. Some countries in the sample experienced per capita growth as well; others did not.

The data consist of classificatory variables describing the characteristics of each country in 1850, 1870, and 1890 and rates of change between 1850-1870, 1870-1890, and 1890-1914. In addition to portraying each country's economic structure and dynamics, the data incorporate technological information in both industry and agriculture, socioeconomic and political features of national development, and institutional characteristics relating to the functioning of factor markets, land systems, foreign economic dependence, the government's economic role, and the political power of landed elites. The data form a pooled time-series cross-section set in which each country enters the analysis three times for each variable, once for each facet in each of our three 20-year periods. It is thus suited to the "three mode" statistical analysis presented in the previous section. Short definitions of the included manifest variables are given in Appendix A to the present paper. Full descriptions of the manifest variables are given in Morris and Adelman (op. cit., Appendix) together with the classification and sources on which the classifications are based for each of our 23 countries, 35 indicators, and 3 time periods. The latent variables generated by the PLVs outer model are presented in Table B1 of Appendix B to the present paper and discussed in Appendix B.

The period covered by our study is one of dramatic change. The Industrial Revolution in Great Britain posed new challenges and created new opportunities worldwide. Country responses to these challenges and opportunities varied quite significantly. Some countries responded by industrializing, in an export-led or import-substitution mode; others shifted to specialized high-value agricultural exports or to staple exports; and still others adopted balanced-growth strategies. Success varied as well, both across and within each growth path. A new international order was created, in which some countries became economically dependent, others used free trade and flows of people and capital to engender a complementary development pattern in their colonies, and still others managed to benefit from international trade and factor flows while retaining significant domestic autonomy in setting economic policy.

Partially as a result of their different responses to the challenges of the Industrial Revolution in this period, some of the countries in our sample are currently developed: Australia, Belgium, Canada, Denmark, France, Germany, Great Britain, New Zealand, Norway, Sweden, Switzerland, The Netherlands, and the United States. Others have become developed quite recently: Italy, Japan, and Russia. One, Spain, is in an in-between state. And still others continue to be underdeveloped: Argentina, Brazil, Burma, China, Egypt, and India.

Understanding the diversity of responses to the British Industrial Revolution and the variability in their success in different countries and aspects is the major aim of the present analysis.

The Model

Our model analyzes the role of initial conditions, political forces, and institutional development in explaining differences among countries in economic development during the nineteenth century. It aims both at explaining differences in development patterns across countries and at understanding how differing paths of economic and institutional development affected the spread of benefits to workers in industry and to the working poor in agriculture.

In specifying the model we were guided by the previous empirical analyses of the economic history of the nineteenth century by Morris and Adelman (in press) as well as by the multiplicity of partial causal theories by economists and economic historians about the determinants of economic development. (For an extensive review of these theories, see Morris and Adelman, op. cit., Chapters 1 and 2).

The previous historical work of Morris and Adelman used the method of disjoint principal components developed by Svante Wold (1976) to study patterns of development within groups of countries characterized by similar development processes. The study revealed the existence of significant differences among groups of countries in their within-group development patterns. The different aspects of development studied (market systems, industrialization, agricultural development, international dependence and poverty) evolved differently and interacted in different ways in each group of countries.

Here we do not focus on deriving common models of nineteenth century development <u>witnin</u> groups of countries. Instead, we focus on cross-country analyses of development patterns, and group the observations only by time period but not by similarity of within-group process. We perform both an average analysis for all countries over the period 1850-1914 as a whole, and three simultaneously estimated analyses for each period covered by the Morris and Adelman data: 1850-1870, 1870-1890, and 1890-1914.

The present analysis reflects mostly between-group effects, since within-group differences among countries are relatively small and can be thought of as "replications" of the average process characteristic of each group. By contrast, the previous analysis viewed successive time periods as successive replications of the within-group process.

There is another important philosophical difference between the previously fitted historical models of Morris and Adelman and the present study. The previous study was one of interdependence that did not impose a causal structure on the data. It served to reveal the patterns of interactions among facets of development and to generate hypotheses about the different processes of economic change and institutional interaction during the nineteenth century. Armed with the hypotheses derived from the earlier empirical analyses, we now feel emboldened to take a further step toward "a theory of nineteenth century history." We specify a recursive structural model linking blocks of variables that reflect one or several facets of an institution, condition, or process. The model is only partially specified a priori, however, since the blocks of variables consisting of more than one indicator form latent variables in which the relative importance of each indicator is estimated statistically rather than specified in advance.

The task of formulating a PLS model involves two steps: the selection of variables to be included in the model and the specification of the "path" diagram indicating which variables affect which process. To select the variables for the model, we started by studying the importance of individual variables in accounting for between-group differences in growth patterns in the earlier five disjoint principal components (DPC) analyses of Morris and Adelman. We include in the present model all variables which appeared in at least two DPC analyses in the list of the top ten most important variables accounting for between-group variances.[1] These were: two indicators of initial conditions, population and agricultural resources; two political characteristics, the degree of foreign dependence and the socioeconomic characteristics of political leaderships; a basic indicator of economic structure--the percentage of labor force in agriculture; three institutional characteristics, the level of development of commodity and factor markets, the spread of market systems, and the nature of land tenure;[2] two indices of the development of physical and human infrastructure, inland transport and illiteracy; and three development indicators, the levels of industrial and agricultural technology and of per capita GNP. To these we added several outcome variables which we aim at explaining: the rate of growth of per capita GNP and two indicators of the extent of diffusion of the benefits of growth--the rates of change of industrial and of agricultural wages. We also added one intervening variable about whose effect there is currently a lot of controversy--the extent of direct government participation in economic activity--and three variables stressed by contemporary theories of economic development: the degree of imbalance in technological development between industry and agriculture, the extent of shift in export structure from primary to manufacturing exports, and the rate of growth of exports. Table 1 lists the included variables together with their means and standard deviations.

The formulation of the PLS model requires specifying not only the list of manifest and latent variables but also the design matrix, indicating which variables enter into which equations. In a recursive model, this specification is equivalent to the positing of a causal chain. We do this by drawing on the theoretical literature on economic growth, economic history, and the role of institutional forces in development and on the hypotheses generated from the previous empirical analysis of Morris and Adelman.

The model gives pride of place to politics and institutional development. In this we were guided by the hypotheses and empirical findings stemming from the Morris and Adelman study of nineteenth century economic development. In four out of five of their disjoint principal components models, foreign dependence was the first or second most important variable in explaining between-group variances. And the overall findings of their study accorded

Table 1: Overview of manifest variables for PLS models

Latent Variable	Manifest Variable	Means Ttl	Means '50	Means '70	Means '90	Standard Dev. Ttl	Standard Dev. '50	Standard Dev. '70	Standard Dev. '90	Auto-correlation 1*2	Auto-correlation 2*3	Auto-correlation 1*3	
Populatn	Populatn	44	41	44	46	24	24	24	25	97	98	95	Total population
AgrResou	AgrResou	53	55	53	52	26	25	25	27	97	99	96	Relative abundance of agricultural resources
Immigrat	Immigrat	46	46	44	47	25	22	27	26	85	82	71	Net immigration
Dependcy	Dependcy	48	46	50	49	28	25	29	29	80	98	77	Degree of foreign economic dependence
PolElite	PolElite	40	31	39	51	24	17	23	28	91	89	89	Socioeconomic character of national political leadership
GovtEcon	GovtEcon	43	33	40	54	22	18	21	23	59	73	41	Extent of domestic economic role of government
AgrLabor	AgrLabor	62	71	61	55	21	16	20	23	91	96	85	Percent of labor force in agriculture
LndTenur	LndTenur	64	55	65	71	27	30	27	21	79	93	77	Predominant form of land tenure and holding
	LndConcn	53	51	54	53	23	23	24	23	75	100	76	Concentration of land holdings
	LndTechn	54	52	55	56	24	26	23	21	93	97	90	Favorableness of land institutions to improvements
Market	MktComd	48	34	47	62	24	20	22	21	87	87	75	Level of development of domestic commodity markets
	MktLand	49	36	47	63	24	18	25	20	93	78	65	Level of development of domestic land markets
	MktLabr	55	44	55	66	21	18	22	18	84	89	78	Level of development of domestic labor markets
	MktCptl	35	27	36	46	23	17	22	25	90	87	77	Level of development of domestic capital markets
MarketS	MktComdS	55	42	58	65	21	21	18	16	59	28	01	Rate of spread of domestic commodity markets
	MktLandS	51	51	51	53	24	25	21	25	-20	48	-24	Rate of spread of domestic land markets
	MktLabrS	47	40	46	55	22	25	18	19	67	54	37	Rate of spread of domestic labor markets
	MktCptlS	46	36	47	55	22	18	23	21	67	83	71	Rate of spread of domestic capital markets
Transprt	Transprt	38	22	35	56	30	25	30	25	91	87	79	Level of development of inland transportation
Illiterc	Illiterc	45	52	45	38	30	28	29	30	97	97	90	Extent of adult illiteracy
	Educatn	41	44	37	42	27	32	23	25	48	34	06	Rate of spread of primary education (lagged)
ExportSt	ExportSt	36	30	38	41	26	21	26	29	67	91	55	Rate of growth of real exports
IndTechn	IndTechn	35	24	35	47	21	15	19	21	90	93	87	Level of development of techniques in industry
	IndTechC	52	44	53	58	20	23	17	16	90	58	64	Rate of improvements in techniques in industry
AgrTechn	AgrTechn	49	40	48	59	27	25	27	25	95	94	91	Level of development of techniques in agriculture
	AgrTechC	41	27	37	58	25	16	19	28	83	69	75	Rate of improvements in techniques in agriculture
Imbalanc	Imbalanc	-2	2	4	-13	30	28	23	34	85	61	70	= (IndTec+IndTecC) - (AgrTec+AgrTecC)
GNP	GNP	47	39	49	54	25	20	23	28	90	94	85	Level of per capita income
ExportC	ExportC	54	60	45	58	29	30	26	30	-15	08	-11	Degree of shift in structure of export sector
GNP_C	GNP_C	43	36	37	55	28	25	26	30	27	34	27	Rate of change in per capita income
IndWageC	IndWageC	56	49	58	61	26	27	27	21	13	30	42	Direction of change in average real wages in industry
AgrWageC	AgrWageC	49	46	43	59	27	25	29	23	40	57	32	Direction of change in average real wages in agriculture

Note: The correlation are multiplied by 100 and refer to Period 1 with 2, Period 1 with 3, and Period 2 with 3, respectively institutional influences major importance in determining the path of development and the distribution of benefits from it.

In formulating the model we also tried to: (1) be parsimonious, doing with as few direct influences as we could; (2) give preference to the shortest causal chain, indicating the most direct influences, where a priori theorizing and previous work afforded a choice; and (3) avoid simultaneity, so that ordinary least squares would remain statistically unbiased and efficient.

The overall logical structure of the model (see Figure 1) goes from exogenous initial conditions to political structure. From political structure it goes to institutional development and government investment and trade policies. From institutions and public investment it goes to the indicators of development level--technology and per capita GNP. From here on the logical structure becomes more complex. The next elements in the causal chain describe the economy's dynamism and the diffusion of benefits from growth. These are more deeply embedded in the model, and do not have simple locations in the causal chain. While the rate of growth of GNP is influenced by the indicators of development levels, it is also directly influenced by institutional development and export growth. And the rates of change of exports and the distribution of benefits from growth are influenced directly by political conditions, institutional structure, investment policies, development patterns, and GNP growth.

The path diagram depicted in Figure 2 summarizes our model specification in more detail, as does the structure of zero and nonzero entries in Table 2. We discuss the specification only briefly here, leaving aside the theoretical and historical justification of the specification to the section on estimation

Figure 1: The path model in overview

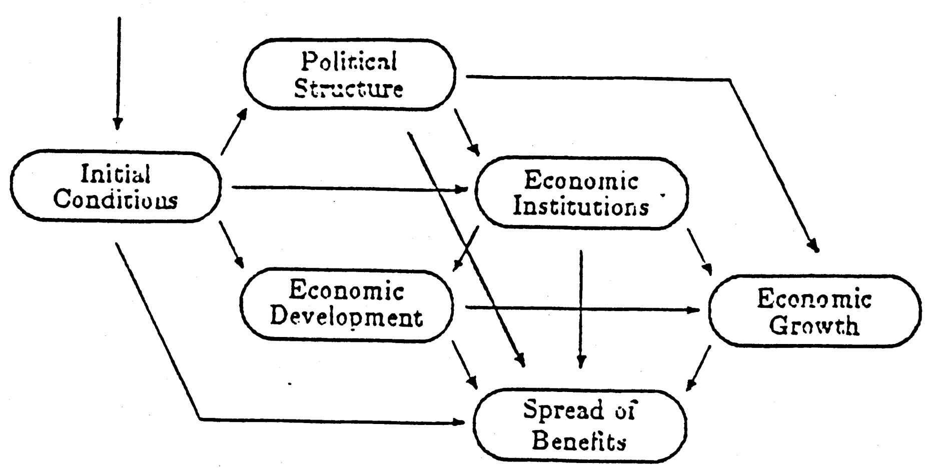

Figure 2: The path model for one period

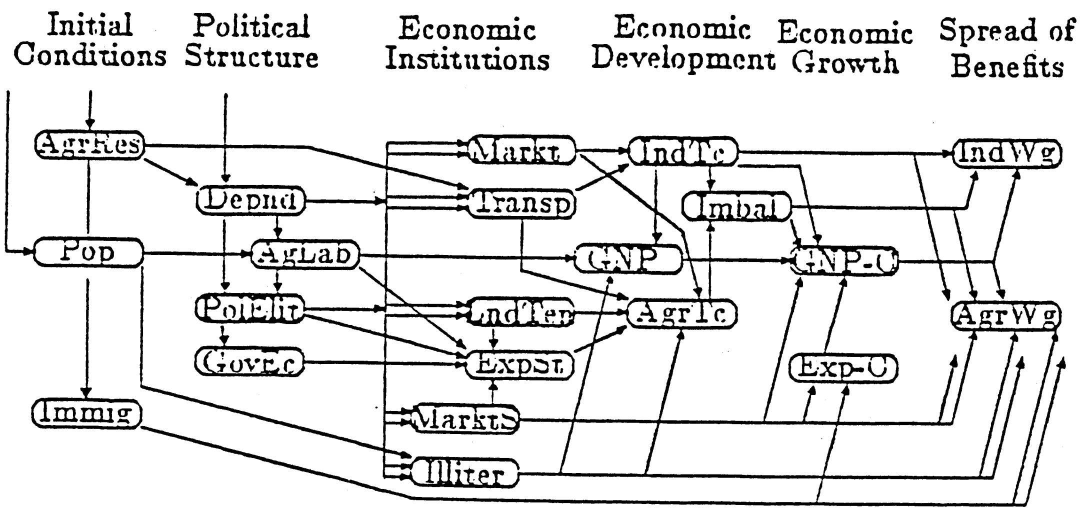

Table 2: Path coefficients for average model

	Populatn	AgrResor	Immigrat	Dependcy	PolLeadr	GovtEcon	AgrLabor	LndTenur	Market	MarketS	Transp	Illitec	ExportSt	IndTech	AgrTech	Imbalanc	GNP	ExportC	GNP_C	IndWageC	AgrWageC	R2
Populatn	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
AgrResou	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Immigrat	.	51	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	26
Dependcy	.	38	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	15
PolElite	.	.	.	-32	.	.	-60	.	.	.	.	.	.	.	.	.	.	.	.	.	.	65
GovtEcon	.	.	.	.	37	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	14
AgrLabor	40	.	.	48	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	37
LndTenur	.	.	.	-48	19	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	37
Market	.	.	.	-38	57	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	72
MarketSp	.	.	.	-29	41	37	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	66
Transport	.	-34	.	-19	55	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	61
Illiterc	33	.	.	36	-46	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	73
ExportSt	.	.	.	-17	.	10	27	30	.	50	.	.	.	.	.	.	.	.	.	.	.	62
IndTech	.	.	.	.	.	.	.	.	78	.	15	.	.	.	.	.	.	.	.	.	.	84
AgrTech	.	15	.	.	.	.	.	15	32	.	28	-26	14	.	.	.	.	.	.	.	.	88
Imbalanc	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
GNP	.	.	.	.	.	.	-44	.	.	.	.	-34	.	22	.	.	.	.	.	.	.	76
ExportC	.	12	29	5	.	7	.	.	.	23	.	.	25	.	.	.	.	.	.	.	.	27
GNP_C	.	.	.	.	.	.	.	.	.	46	.	.	.	29	.	-22	-39	24	.	.	.	50
IndWageC	.	.	-15	-15	.	.	.	.	.	13	.	-28	.	-4	.	-8	.	.	15	.	.	39
AgrWageC	.	.	-31	-4	.	.	-27	11	.	-26	.	-22	.	-17	.	-26	.	.	33	.	.	50

Note: All coefficients are multiplied by 100

results. We do so to avoid repetitiveness. Also, the estimation indicates the directions of association and therefore allows for more pointed references to the literature.

We start from population and agricultural resources that are taken as exogenous initial conditions. The abundance of agricultural resources is assumed to attract immigration into land-abundant countries and cause emigration from land-poor countries. Immigration in turn is assumed to induce a dependent development pattern in the migration-receiving countries.[3]

Without prejudging the issue of whether foreign dependence has positive or negative effects, we posit that the effects of dependency on development are pervasive. Dependence is assumed to affect directly how agricultural the growth pattern is; the predominant land tenure system; how market insitutions function and evolve; the socioeconomic character of political elites; transport and education investment policies; and the rate of growth and structure of exports as well as the rates of growth of industrial and agricultural wages.

Whether the political system reflects primarily the interests of the landed and foreign elites, or whether it reflects also the interests of rising domestic entrepreneurial groups, is assumed in our model to depend both on the extent of foreign dependence and on how agricultural the country is. In turn, the socioeconomic structure of political elites is assumed to influence some of the same institutional features and investment policies as does foreign dependence: land tenure patterns, the development and spread of market institutions, and investment policies in transport and education.

The socioeconomic character of the leadership elite is assumed to also influence the extent of direct government participation in economic activity.

Where governments take a more active economic role, they are presumed to affect how fast market institutions spread and influence changes in the structure and growth of exports.

The politically determined institutional and investment policies described above, in turn, affect industrial and agricultural development and the structure of exports in our model. Industrial technology is assumed to be influenced directly by the spread of market institutions and by reductions in illiteracy. Agricultural technology is assumed to be influenced by land tenure, market development, transport, education, and shifts in export structure as well as by the abundance of agricultural resources. Finally, the level of per capita GNP is assumed to depend directly on the structure of production, industrial technology, and education.

The dynamism of the economy is reflected in our model in the rates of growth of GNP per capita and of exports. The rate of growth of exports is assumed to depend on the structure of exports, the spread of market institutions, government trade policies, foreign dependence, immigration and agricultural resource abundance. Export growth is, in turn, assumed to affect GNP growth. In addition, GNP growth is assumed to depend on industrial and agricultural technology, on the extent of technological imbalance between agriculture and industry, and on the spread of market systems.

Finally, the diffusion of benefits from growth is assumed to be affected directly not only by the rate of growth of overall per capita GNP but also by a host of institutional, political, and technological choices: immigration rates, dependence levels, the spread of markets, education, the level of industrial technology, and the extent of technological dualism between agriculture and industry. In addition, the growth of agricultural wages is also affected by land tenure patterns and by the percentage of the labor force in agriculture.

The Average Model, 1850-1914

The estimation results of the path model are quite good. All the coefficients have signs that accord with a priori expectations and, with only a few exceptions, the R-squares are high.

The estimation results in column 4 of Table 2 lend support to the claim of dependency theorists that the direct results of dependency have mostly negative effects upon development patterns when one looks across countries. We find that, as Baran claimed for currently developing countries, historically, foreign dependence encouraged the domination of politics by expatriates and by the classes with which they were allied--the large primary producers. As a result of the immigration, financial, tariff, and transport policies they supported, countries stayed more agricultural; the development of small-scale family farms was retarded by land alienation and land engrossment policies that promoted the concentration of landholdings; and the development of domestic, as contrasted with export and import-serving markets, was delayed by legal arrangement limiting the operation of factor markets, particulary land and labor. The development of national domestic commodity markets was limited by: transport policies stressing railways linking the interior to ports rather than transport networks promoting internal trade; tariff policies favoring imports over indigenous manufacturing; and financial policies serving exclusively export markets. Finally, our results indicate that dependence fostered slower spread of benefits to industrial workers and small farmers by encouraging and subsidizing immigration even during periods of depression, limiting investment in education and, through tenurial and trade policies, promoting staple exports. The only positive effect of foreign dependence was to encourage faster export growth.

These mostly negative effects of foreign dependence in our present model contrast somewhat with the more mixed results obtained by Morris and Adelman for within-group processes in which only the completely dependent countries got no benefits at all from dependence. In other less dependent countries, the gross effects of dependence were to increase the rates of growth of exports, immigration, and sometimes GNP growth while retarding the development of political institutions giving power to local nonlanded elites, the evolution of tenurial forms favoring medium-sized family farms, and the spread of benefits to workers in urban and rural areas. In part, the contrast between the present and earlier results is due to the difference between cross-section and within-group models. The cross section gives more weight to the extremes and, therefore, stresses the entirely positive effects of colonies on the colony-owning countries and the totally negative effects of extreme dependence on the most dependent colonies. In part, the contrast is due to the fact that the present analysis captures the net effects of dependence and distinguishes the effects of dependence per se from the effects of its important correlates: immigration, the socioeconomic structure of political elites, and resource abundance. By contrast, the former analysis was one of interdependence that did not net out direct from indirect effects.

The current path model results (column 5 of Table 2) indicate that the negative economic effects of foreign dependence can be either partially or wholly counteracted by modernizing local elites to the extent that they are allowed to gain political power. Where indigenous manufacturers, wage earners, or small farmers were politically influential in setting policies, they supported land, tariff, financial, and investment policies more favorable to domestic development. Governments took a more active role in promoting policies fostering the development of local manufactures. The destruction of communal land arrangements and land concentration in export-oriented estates tended to proceed more slowly. Domestic markets for local manufactures, rural banking institutions, and roads for marketing agricultural wage goods tended to develop and spread more rapidly. And the public investments undertaken where nontraditional groups were politically influential stressed the development of feeder roads linking rural communities to cities and rural public education facilities. These beneficial effects of the rise in power of domestic nonlanded elites is entirely consistent with the earlier within-country results of Morris and Adelman. Staple-export theories, that stress how institutional features of linkages limit the spread of benefits from staple export expansion (Hirschman, 1977), point to the obverse of the positive effects captured here.

Economic historians agree on the importance of government economic policies in the 19th Century (column 6 of Table 2). Some of the effects of governments in the 19th Century were already summarized by the two previous political variables: foreign dependence and the socioeconomic character of national elites. In addition, the variables portraying the development of inland transport and the decline in illiteracy also reflect government policy choices. The sixth column of Table 2 focuses on the direct dynamic effects of direct government economic activity. The estimated coefficients indicate that governments promoted the more rapid spread of market institutions and induced shifts out of staple exports into processed and manufactured exports. Historians writing on the period stress the role of legislation and tariff policies in this regard and the varied effects these reforms and policies had in countries with different dependency status and resource endowments. For example, governments promoted legal reforms fostering commercialization of land and the spread of credit institutions. But in colonial settings commercialization of land weakened protection against loss of land, and the spread of credit to rural areas served mainly foreign exporters. Tariff policies affected international trade everywhere, but the effects on agriculture, industry, and export structure varied. In France, for example, high tariffs slowed resource transfer to industry (Golob, 1944). By contrast, Great Britain's failure to protect agriculture accelerated the movement of resources out of agriculture (Orwin and Whetham, 1964) while free trade in the colonies destroyed handicraft industry (Hlaing, 1964, and Chaudhuri, 1968) and the low tariffs in the Netherlands (Brugmans, 1969), Denmark (Jensen, 1937) and Switzerland (Gasser-Stager, 1964) induced a rapid shift from grains to specialized, high value, agricultural exports.

Our results confirm that the shift in export structure out of staple exports in more agricultural countries (row 13 of Table 2) was strongly affected by government tariff policy. It was retarded where tariff and investment policies were dominated by external interests and accelerated where domestic governments reflected the interests of domestic manufacturers and of farmers producing food for the domestic market in setting trade policy. The shift out of staple exports was accelerated where land tenure was conducive to the generation of an agricultural surplus that was widely distributed. It also occurred more rapidly where market institutions spread more quickly. These results are consistent with the earlier work of Morris and Adelman and with the writings of Senghaas and Mentzel (1978) on the historical conditions in which primary export expansion led to successful development.

Our path model provides a very parsimonious model of the development of industrial technology and its spread in the 19th Century. The direct effects (row 14 of Table 2) are only two: the level of development of market institutions and the development of inland transport. Taken by themselves, these two account for over 80 percent of the variance in 19th Century development in industrial technology among countries! The significance of these two variables is consistent with the writings of institutional economic historians. North and Thomas (1970) stress the importance of legal and institutional changes reducing market transactions costs while Polanyi (1944) underlines the drastic social changes that were implicit in the establishment of functioning market systems. Anderson (1967) emphasizes the importance to the industrialization of 19th Century Europe of the revival of Roman law that provided for fixity of contract and for predictable economic transactions between individuals. The earlier work of Morris and Adelman on industrialization in the 19th Century also emphasized the importance of markets and transport. But, in addition, it related industrialization to the major influences on the development of markets and transport as well as to the major consequences flowing from industrialization.

Patterns of agricultural development are more complex than patterns of industrialization and, hence, subject to more influences. This is evident in the specification of influences on agricultural technology adopted in row 15 of Table 2. Our results indicate that agricultural technology was more developed in countries with abundant agricultural resources and that forms of tenure in which medium size, owner-operated farms predominated were more conducive to the use and adoption of high-yield technologies. The transformation of conditional landownership into absolute private property and reductions in the prevalence of sharecropping, parcelized holdings, estate or plantation systems, or communal production were all conducive to agricultural progress. By the same token, neither of the two exremes in land concentration was conducive to technological advance: excessive concentration limited the demand for consumption goods while excessive parcelization limited the agricultural surplus and the ability to save and invest. In addition, the adoption of agricultural improvements was faster where market institutions were more developed and where canals, feeder roads, and railroads linking agricultural producers and consumers with urban and export markets encouraged commerical agricultural production and nonstaple exports. Finally, agricultural productivity was higher where farmers were more literate.

The level of per capita GNP (line 17 of Table 2) varied directly with the structure of production: It was higher where a smaller percentage of the labor force was agricultural, reflecting both demand and supply factors, as stressed in the work of Kuznetz (1968) and Chenery and coauthors (1975 and 1986). It was also higher where technology in industry was more developed and where illiteracy was less.

The dynamism of the economy, reflected in lines 18 and 19 of Table 2, is described by the determinants of export growth and of the growth of GNP per capita. Despite a multiplicity of explanatory variables, we do least well in explaining the rates of growth of exports in the 19th Century. (This is discussed further in the next section.) More agricultural resources, more immigrant expatriates linking domestic development policies to export markets, better trade policies by governments promoting exports, greater shifts in export structure toward manufacturing exports, and more rapid growth of market systems were all conducive to more rapid export growth. But, when all is said and done, we only explain 27 percent of the total variance in export performance. And an examination of the residual correlations for this variable with the omitted variables indicates that there are no other variables in the model that could increase the explanatory power of the export equation.

The estimated equation for the growth of GNP per capita yields a very classical picture of 19th Century economic growth (line 19 of Table 2). It confirms the neoclassical thesis that, in the 19th Century, export-led growth raised the rate of growth of per capita GNP. It emphasizes the dynamic role of the diffusion of the industrial revolution technology in raising rates of economic growth. It also places the changes in economic, social, and legal conditions involved in promoting the effective functioning of commodity and factor markets at the core of an explanation of capitalist development. The technological picture of 19th Century growth is consistent with the writings of Marshall (1920), Landes (1969), and Kuznetz (1968). In their view, the dynamic forces for change in the 19th Century were the revolution in textile and steel technology and the transport revolution embodied in the introduction of the steamship and the railroads. The emphasis on market institutions lends support to the neoclassical institutionalists, North and Thomas (1970) and Hicks (1969) as well as to Polanyi (1944), all of whom view the spread of market systems as the central process for modern economic growth. We also find that balanced industrial-agricultural growth improved the performance of the economy wherever it occurred. Failure to expand agricultural productivity in line with industrial productivity led to bottlenecks in foreign-exchange earnings, domestic savings, and domestic demand as agricultural export earnings became insufficient to pay for the imports of food and intermediates required to support growing immigrant populations and industrialization. These findngs lend support to the balanced-growth theorists, Rosenstein-Rodan (1943) and Nurske (1953), over the long perspective. The estimated equation also indicated that, averaging over the second half of the 19th and earlier 20th Centuries, economies with higher levels of per capital GNP grew, on the average, more slowly.

But, when we come to the diffusion of benefits from growth (lines 20 and 21 of Table 2), the picture is no longer either classical or neoclassical. Over the whole period, there was some, relatively weak, positive effect of change in GNP on industrial wages and a stronger positive effect on agricultural wages. In individual countries and periods, however, the net positive effect of growth on agricultural and industrial wages could be more than counterbalanced by other negative influences. In dependent colonial countries, the encouragement of immigration reduced the rate of increase of both agricultural and industrial wages. And dependency per se worked to depress the growth of wages mostly in industry but also in agriculture. The spread of market systems affected industrial workers differently from the way it affected agricultural labor. It had a strong positive effect on industrial wages and an equally strong negative effect on rural wages. Education, especially reductions in illiteracy, had strong positive effects on wages in both sectors. But increases in industrial technology had a small negative effect on the rate of growth of industrial wages, serving mostly to raise profits, and a more significant negative effect on agricultural wages, serving mostly to increase returns to landowners. The negative effects of industrial growth could be more than counterbalanced, however, by adopting a more balanced growth strategy. Raising agricultural productivity pari pasu with industrial productivity could ameliorate rates of growth of real wages in both sectors. This last effect lends support to those who argue for the adoption of wage goods (de Janvry, 1984) and agricultural (Mellor, 1976; Adelman, 1984; and Singer, 1984) strategies as improving both growth and distribution and indicates a further benefit of balanced growth. The rate of improvement in agricultural wages was also, not surprisingly, affected by some purely agricultural phenomena. There was less improvement in rural wages in economies that remained strongly agrarian and more improvement when tenurial conditions favored family farms of moderate size. The overall picture of influences on agricultural and industrial wages revealed by the analysis is thus complex, leaving room for policy and institutional choices in how growth affects the working class and the poor and in the incidence of the distribution of benefits of growth between urban and agricultural workers. The complexity of the analysis of spread effects from growth is entirely in line with previous analyses of influences on poverty and growth of wages by Adelman and Morris

(1973, 1974), Morris and Adelman (op. cit.), and the policy writings of Adelman (1984-1986).

Differences Over Time

We now turn to a discussion of the "time series" of models. The estimation procedure used allows both for interdependence among periods and for differences in structure and coefficient magnitudes from period to period. We chose to fit the same model specification to all periods in order to allow us to examine how the importance of different processes and interactions changed over time. The only modifications in the models for periods subsequent to the first was to assume that the exogenous variables are linked by a first-order autoregressive process. Below, we comment only on the significant changes over time. A schematic picture of the model structure of the time series model is presented in Figure 3. The PLS estimates of the individual models for the three periods are presented in Tables 3 to 5.

Fitting Procedure: As indicated earlier, if in a bigger model, one part is bordered by single indicator LVs, the weights for this part of the model can be estimated separately. The flow of mutual adjustment between all LVs is then barred and the model becomes statistically separable. Since, in our specification, the exogenous variables (population and abundance of natural resources) are single indicator LVs, the model specified can be separated in this way into three submodels, one for each period. As expected, we found that the separate estimation of the three submodels gave exactly the same weights and coefficients as the big longitudinal model in, literally, one-tenth of the computing time.

Figure 3: The path model in overview

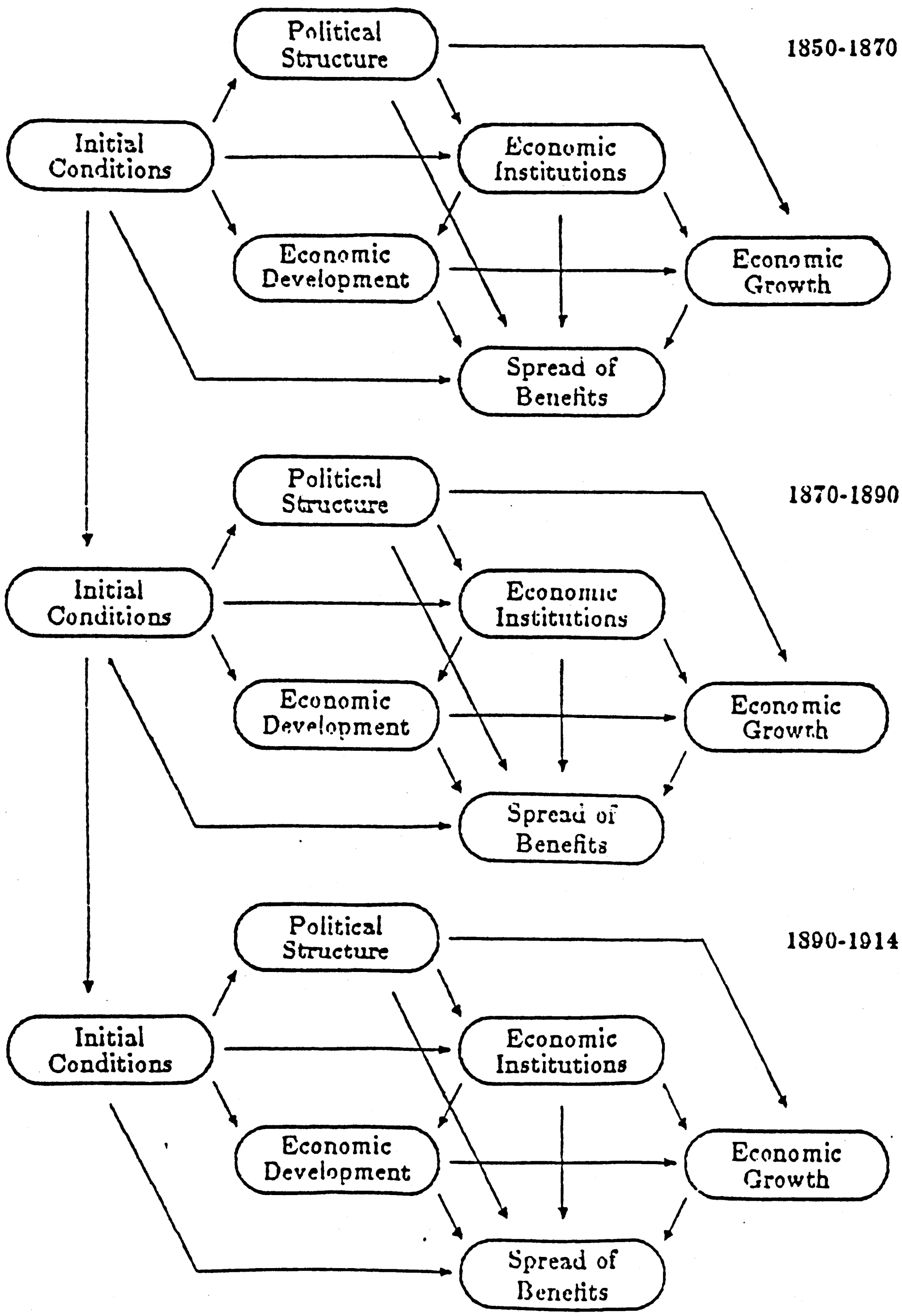

Table 3: Path model for the period 1850 - 1870

	Lag	Popula tn	Agr Res ou	Imm igr at	Dep end cy	Pol Eli te	Gov tEc on	Agr Lab or	Lnd Ten ur	Mar ket	Mar ket Sp	Tra nsp rt	Ill ite rc	Exp ort St	Ind Tec hn	Agr Tec hn	Imb ala nc	GNP	Exp ort C	GNP _C	Ind Wag eC	Agr Wag eC	R2
Populatn	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
AgrResou	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Immigrat	.	.	60	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	36
Dependcy	.	.	41	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	17
PolElite	.	.	.	.	-29	.	.	-56	.	.	.	.	.	.	.	.	.	.	.	.	.	.	50
GovtEcon	.	.	.	.	.	44	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	20
AgrLabor	.	38	.	.	35	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	26
LndTenur	.	.	.	.	-56	21	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	47
Market	.	.	.	.	-51	44	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	65
MarketSp	.	.	.	.	-26	53	19	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	61
Transprt	.	.	-29	.	-32	36	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	51
Illiterc	.	28	.	.	36	-42	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	62
ExportSt	.	.	.	.	-2	.	20	30	35	.	33	.	.	.	.	.	.	.	.	.	.	.	47
IndTechn	.	.	.	.	.	.	.	.	.	68	.	25	.	.	.	.	.	.	.	.	.	.	81
AgrTechn	.	.	5	.	.	.	.	.	32	38	.	15	-37	-9	.	.	.	.	.	.	.	.	90
Imbalanc	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
GNP	.	.	.	.	.	.	.	-37	.	.	.	.	-42	.	13	.	.	.	.	.	.	.	52
ExportC	.	.	43	-42	20	.	37	.	.	.	34	.	.	12	.	.	.	.	.	.	.	.	55
GNP_C	.	.	.	.	.	.	.	.	.	.	84	.	.	.	[illegible]	.	-13	-57	27	.	.	.	69
IndWageC	.	.	.	2	-47	.	.	.	.	.	34	.	-62	.	-73	.	25	.	.	-13	.	.	47
AgrWageC	.	.	.	-13	-8	.	.	-25	-27	.	-58	.	-39	.	13	.	-36	.	.	31	.	.	34

Note: All coefficients are multiplied by 100

Table 4: Path model for the period 1870 - 1890

	Lag	Populatn	AgrResou	Immigrat	Dependcy	PolElite	GovtEcon	AgrLabor	LndTenur	Market	MarketSp	Transprt	Illiterc	ExportSt	IndTechn	AgrTechn	Imbalanc	GNP	ExportC	GNP_C	IndWageC	AgrWageC	R2
Populatn	97	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	94
AgrResou	97	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	94
Immigrat	.	.	47	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	22
Dependcy	75	.	14	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	66
PolElite	.	.	.	.	-48	.	.	-42	.	.	.	.	.	.	.	.	.	.	.	.	.	.	61
GovtEcon	.	.	.	.	.	12	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
AgrLabor	.	42	.	.	54	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	46
LndTenur	.	.	.	.	-49	16	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	37
Market	.	.	.	.	-64	34	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	84
MarketSp	.	.	.	.	-52	28	25	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	63
Transprt	.	.	-30	.	-49	23	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	66
Illiterc	.	44	.	.	48	-27	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	74
ExportSt	.	.	.	.	-23	.	21	31	38	.	30	.	.	.	.	.	.	.	.	.	.	.	65
IndTechn	.	.	.	.	.	.	.	.	.	85	.	11	.	.	.	.	.	.	.	.	.	.	90
AgrTechn	.	.	23	.	.	.	.	.	21	52	.	7	-11	29	.	.	.	.	.	.	.	.	93
Imbalanc	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
GNP	.	.	.	.	.	.	.	-48	.	.	.	.	-25	.	27	.	.	.	.	.	.	.	76
ExportC	.	.	4	54	-30	.	3	.	.	.	-5	.	.	16	.	.	.	.	.	.	.	.	27
GNP_C	.	.	.	.	.	.	.	.	.	.	31	.	.	.	8	.	-43	12	3	.	.	.	53
IndWageC	.	.	.	-39	-2	.	.	.	.	.	3	.	-11	.	24	.	28	.	.	40	.	.	56
AgrWageC	.	.	.	-52	-18	.	.	0	14	.	-33	.	-31	.	-36	.	-3	.	.	53	.	.	82

Note: All coefficients are multiplied by 100

Table 5: Path model for the period 1890 - 1914

	Lag	Pop ula tn	Agr Res ou	Imm igr at	Dep end cy	Pol Eli te	Gov tEc on	Agr Lab or	Lnd Ten ur	Mar ket	Mar ket Sp	Tra nsp rt	Ill ite rc	Exp ort St	Ind Tec hn	Agr Tec hn	Imb ala nc	GNP	Exp ort C	GNP _C	Ind Wag eC	Agr Wag eC	R2
Populatn	98	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
AgrResou	99	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Immigrat	.	.	49	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	24
Dependcy	101	.	32	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10
PolElite	.	.	.	.	-39	.	.	-58	.	.	.	.	.	.	.	.	.	.	.	.	.	.	75
GovtEcon	.	.	.	.	.	32	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	11
AgrLabor	.	53	.	.	62	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	[illegible]
LndTenur	.	.	.	.	-51	10	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	35
Market	.	.	.	.	-68	27	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	82
MarketSp	.	.	.	.	-40	21	46	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	63
Transprt	.	.	-16	.	-57	31	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	75
Illiterc	.	41	.	.	50	-33	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	84
ExportSt	.	.	.	.	-15	.	-14	20	33	.	71	.	.	.	.	.	.	.	.	.	.	.	83
IndTechn	.	.	.	.	.	.	.	.	.	85	.	2	.	.	.	.	.	.	.	.	.	.	76
AgrTechn	.	.	23	.	.	.	.	.	6	20	.	39	-22	19	.	.	.	.	.	.	.	.	86
Imbalanc	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
GNP	.	.	.	.	.	.	.	-40	.	.	.	.	-36	.	31	.	.	.	.	.	.	.	90
ExportC	.	.	-3	51	45	.	-19	.	.	.	62	.	.	21	.	.	.	.	.	.	.	.	32
GNP_C	.	.	.	.	.	.	.	.	.	.	37	.	.	.	39	.	-6	-51	36	.	.	.	51
IndWageC	.	.	.	-28	34	.	.	.	.	.	35	.	-10	.	35	.	-30	.	.	26	.	.	73
AgrWageC	.	.	.	-16	21	.	.	x	31	.	-2	.	-37	.	20	.	-14	.	.	11	.	.	54

Note: All coefficients are multiplied by 100

Selected Trends: Overall, the average model continues to fit well over the whole period. The major differences are in some of the forces governing the economy's dynamics and the diffusion of benefits from growth. The negative effects of foreign dependence and the positive effects of modernizing leaderships remained strong throughout the period. The apparent influence of resource abundance on foreign dependence declined; the main explanation became an autoregressive process. (But, when the autoregressive term is omitted, the impact of resource abundance on foreign dependence continued strong.) The importance and impact of direct government participation in economic activity changed over the period; it was strongly positive in the initiation of structural and institutional change and export growth from 1850-1870, but the positive effects of government on export growth became negligible by 1870 and turned negative on changes in export structure after 1890. The political and economic effects of adopting an agrarian structure of production remained strong throughout. But the retarding influence on rural wages of a large percentage of the labor force remaining agricultural became weak after 1870. The positive influence of family farming on the structure of exports and on agricultural technology remained important, but the effect on agricultural wages changed over time. Family farming at first affected agricultural wages negatively since, initially, family farming reduced demand for wage labor; but, after 1870, family farming on moderate size farms increasingly raised agricultural wages.

The major changes over time were in the dynamics and on the spread effects of growth. The importance of export growth to GNP growth varied over the period: Growth during the middle period was not export led. Also, it was only from 1850-1870 that countries with higher levels of per capita GNP grew more slowly.

The dynamics of export growth also changed significantly over the period: The impact of immigration on the growth of exports was strongly negative from 1850-1870 but became strongly positive after 1870; the influence of agricultural resources on export growth weakened substantially over time and became negligible by 1890 as the structure of exports became less dependent on land-intensive, staple exports; the importance of functioning factor and commodity markets to exports rose over time; and the ability to shift the structure of exports away from primary toward manufacturing exports became more important to export growth over time. Clearly, the poor overall R-square for export growth in the average model was due both to the changes in relationships over time and to the poor explanatory power of the export equation for 1870-1890.

The pattern of influences on wage rate growth also changed significantly over the period. There is some evidence of a U-effect on the rate of growth of industrial wages: In 1850-1970 foreign dependence, improvements in industrial technology, and GNP growth all depressed the rates of increase of industrial wages. By 1870-1890, immigration was the primary force holding down the rate of growth of industrial wages and, between 1890-1914, the negative contribution of immigration to wage growth had declined but the cummulative effects of slower improvements in agricultural technology on the growth of real wages in industry had become significant.

There is also some evidence of a U-effect on agricultural wages. In 1850-1870, education, industrialization, and GNP growth all had positive impacts on the rate of growth of agricultural wages. In 1870-1890, there were countervailing changes: On the one hand, the shift toward family farming started having a positive impact on agricultural wages, and the size of the agricultural sector did not have any retarding effect on rural wage growth; on the other hand, improvements in industrial technology had strong negative effects on the increase of agricultural wages, and the negative impact of immigration on rural wages became very strong. In 1890-1914, the repressive impact of a more agricultural structure on rural wages became negligible, improvements in industrial technology exercised a significant positive effect on rural wages, and a balanced growth pattern could become a positive influence accelerating the increase in rural wages.

Conclusion

Our attempt to model the forces responsible for the variety in development patterns of different countries during the second half of the 19th Century and early 20th Century with the aid of a PLS model has been quite successful. The results of the model explain quite well the varied outcomes of the different development strategies with which different countries responded to the challenges and opportunities provided by the British Industrial Revolution. They also yield interesting insights into variations over time.

The model confirms the previous analysis of Morris and Adelman and is complementary to it. It is also consistent with a great number of historical and development theories and with many country studies. We confirm the following hypotheses:

(1) Political and economic institutions matter a great deal in determining development patterns.

(2) Political and economic institutions play a very significant role in determining the diffusion of benefits of growth to the poorer members of society.

(3) The success of particular institutions and development patterns varies over time.

(4) Our model of economic growth stresses exports, technology, and markets.

(5) Our model of diffusion of benefits from growth stresses land tenure, education, the nature and autonomy of domestic political elites, and the development strategy chosen.

(6) In the long haul, balanced growth, in which improvements in agricultural technology keep pace with industrial innovations, succeeds in increasing both GNP and the diffusion of benefits to the poor.

(7) Governments are more successful in initiating growth than in continuing it.

APPENDIX A:

Short Definition of Variables

All variables are constructed as classifications of 69 observations. The observations are the 23 countries treated as separate observations for each time period. Each variable constitutes a classification and groups the observations into one out of several classes. The classes are rank ordered with category (1) ranking highest. The rank values are transformed into (mostly) equidistant scale values which vary from 0 to 100 with high scores referring to high ranks. Means and standard deviations of these scales are reported in Table 1. Depending on the amount of information available, the classification scheme comprises 4 to 12 classes. For some of the variables, several different measures were assembled and combined into a single classification. Although numeric estimates like census data are available for some variables for some countries, we preferred to use groupings which appeared relatively insensitive to errors in the data.

The following paragraphs on the classification schemes utilized in the analyses are designed to give a general idea of their character. Only leading traits of the schemes are indicated. The classification schemes are presented in detail with the sources on which they are based in Morris and Adelman, Appendix (in press).

Total population: The 69 observations are grouped into seven classes by the size of their total population ranging from (1) more than 100 million to (7) less than one million.

Relative abundance of agricultural resources: Four classes ranging from (1) great abundance of agricultural and pastoral resources relative to the population without major institutional barriers to access to (4) scarcity of agricultural resources with or without major barriers to access.

Net immigration: Five classes ranging from (1) major net immigration probably equivalent to at least one-third of the population increase to (5) major net emigration probably more than one-third of the sum of the population increase plus net emigration.

Degree of foreign economic dependence: Seven dimensions of economic dependence were considered in constructing this variable: Extent of foreign ownership and control of (1) factory industry and (2) foreign trade, export channels and financial services; extent of local dependence on (3) foreign technical and administrative skills, (4) foreign loans, (5) foreign capital inflows, and (6) primary exports for domestic economic growth; and extent of (7) expatriate dominance of national governmental economic initiatives.

Countries were then grouped into seven categories ranging from countries that were (1) heavily dependent of all seven dimensions to (7) advanced countries that had no significant dependent features.

Socioeconomic character of national political leadership: Four principal categories ranging from (1) countries in which rising economic classes, including workers, had direct and controlling share in the political life of the nation to (4) countries where the propertied national or colonial elites were in full control and little influence by indigenous commercial or industrial groups.

Extent of domestic economic role of government: Five categories according to the importance of direct economic actions of government ranging from (1) countries in which the regional and national governments financed the greater part of investment in transportation, as well as in industrial and agricultural expansion, to (4) and (5) countries where the governments' investments were extremely small either in transportation or in the agricultural and industrial expansion.

Percent of labor force in agriculture: Seven categories based on census data of varying quality and other rough estimates having a less-certain basis.

Predominant form of land tenure and holding: Seven categories ranging from (1) countries in which most lands were farmed by cultivators with rights of ownership, with the remaining land farmed by tenants with considerable de facto security of tenure, to the last three categories of countries (5)-(7) with, respectively, "independent" peasants with significant communal controls over types and methods of cultivation; cultivation on large estates by hired laborers or by short-term tenants or sharecroppers; and finally, cultivation on large estates by serfs or other forms of servile labor.

Concentration of landholdings: Six categories ranging from (1) countries with extreme concentration of landholdings with the top 10 percent of landholders probably holding over 75 percent of the cultivated land to (6) countries where small holdings with extreme parcelization and fragmentation prevailed.

Favorableness of land institutions to improvements: This classification scheme is a composite of the predominant form of land tenure and the extent of concentration of landholdings. Countries are grouped into nine categories which are ranked by a priori reasoning about the favorableness of farm size and predominant conditions of tenure to the adoption of agricultural improvements. At the top of the spectrum are independent cultivators with middle-sized or large farms without, however, extreme concentration of landholdings.

Level of development of commodity markets: Seven categories ranging from countries with (1) national markets for most commodities, widespread commercialization, extensive interregional trade, good marketing facilities, and no premodern legal restrictions to (7) overwhelming importance of local self-sufficiency, major transport barriers and premodern legal restrictions (e.g., guilds), and domestic trade limited to luxuries and a few necessities (e.g., salt). Also included in (7) are newly settled countries heavily dependent on imported consumer goods.

Level of development of land markets: Four categories ranging from countries with (1) widely commercialized land markets; individualized landownership; no major premodern restrictions on sale, mortgaging, bestowal and use of land; and some specialized institutions for land transactions to (4) land not widely commercialized and individualized.

Level of development of domestic labor markets: Five categories ranging from countries with (1) widespread wage labor, significant interregional flows and no effective legal barriers to labor mobility, similar wage changes throughout the country, and no persistent regional or sectoral labor surpluses to (5) slave labor, de facto servitude, or widespread compulsory labor.

Level of development of domestic capital markets: Six categories ranging from countries with (1) substantial stock exchanges, significant long-term financing by banks, and no major legal impediments to limited liability enterprises to (6) limited short-term credit through financial institutions, predominance of moneylenders, significant impediments to limited liability, and no securities markets.

Rate of spread of domestic commodity markets: Four categories ranging from countries with (1) major expansion of commodity markets, through either widespread decrease in subsistence or barter, or significant spread of retail and wholesale marketing institutions to (4) very limited spread of relatively insignificant markets including countries in which narrowly based export expansion occurred around a few port cities.

Rate of spread of domestic land markets: Four categories ranging from countries with (1) substantial, rapid commercialization or geographic spread of land markets accompanied by diffusion of institutions favorable to land markets (e.g., building societies or land banks) to (4) little spread of or improvement in conditions for land markets.

Rate of spread of domestic labor markets: Four categories ranging from countries with (1) rapid, widespread increase in the proportion of wage labor accompanied by reduction in split agriculture-industry employment and major increases in sectoral and geographic labor movements to (4) insignificant spread of wage labor.

Rate of spread of domestic capital markets: Four categories ranging from countries with (1) widespread increase in formal institutions and institutional lending for investment financing to (4) very little spread of domestic capital-market institutions, with investment financing either by foreign dominated institutions or by domestic noninstitutional moneylenders.

Level of development of inland transport: Five categories ranging from countries with railways, all weather roads, and waterways suitable for the mass shipment of goods (1) serving towns throughout the country and the agricultural sector well to (5) not serving the overwhelming part of the population, with long distance transport only by natural waterways and dirt tracks.

Extent of adult illiteracy: Ten categories ranging from countries with (1) adult illiteracy exceeding 90 percent to (10) adult illiteracy less than 10 percent.

Rate of spread of primary education (lagged): Five categories ranging from countries where the percent of children aged 6 to 14 increased (1) by at least 15 percent to (5) negligibly, with no legislation extending school attendance.

Rate of growth of real exports: Four categories ranging from countries with rates of growth of real exports (1) exceeding 4 percent from a large base to (4) less than 2 percent from a small base.

Level of development of techniques in industry: Six categories ranging from countries where (1) both the spinning and weaving of cotton were predominantly mechanized, most consumer-goods employment was in factories, and interchangeable parts were quite common in the machinery industry to where (6) there were at most very few factories using low horsepower.

Rate of improvement of techniques in industry: Seven categories ranging from countries with (1) significant across the board industrialization from a substantial base to (7) insignificant growth of industry.

Level of development of techniques in agriculture: Seven categories ranging from countries with (1) most grain production using animal-drawn, cast-iron or steel plows and animal-drawn harvesting machinery, enclosures and stockbreeding for livestock, and improved crop rotation to (7) no significant use of these technologies and poor agricultural resources.

Rate of spread of techniques in agriculture: Six categories ranging from countries with (1) significant improvements in agricultural technology through spread of laborsaving machinery, major increase in fertilizer, or fencing and stockbreeding to (6) countries with moderate improvements in agricultural technology limited to at most one region or crop or very small more widespread improvements.

Level of per capita income: Six categories ranging from countries in which the level of per capita income was (1) over 80 percent to (6) under 20 percent of that of the United Kingdom in 1890.

Degree of shift in export structure: Four categories ranging from countries shifting away from primary exports toward processed primary and manufactured exports (1) very strongly to (4) negligibly.

Rate of change in per capita income: Five categories ranging from countries with the rate of change of per capita income (1) exceeding 2 percent to (5) declining, not necessarily markedly.

Direction of change in average real wages in industry: Five categories ranging from countries in which real wages in industry showed a (1) strong upward movement to (5) a downward movement.

Direction of change in average real wages of the employed agricultural poor: Five categories ranging from countries in which average incomes of the employed agricultural poor showed a (1) strong upward movement to (5) a downward movement. Where the employed agricultural poor consist overwhelmingly of small peasants, including tenants, rather than wage earners, their position rather than just the position of wage earners has been taken into account. Where different groups, such as wage earners and small peasants, experienced different trends, these were weighted according to the relative importance in the population.

APPENDIX B:

The Outer Model

Table B1 presents the weights and loading for the LVs in the four models we estimated, the average model, and the models related to the three periods. Six of the 21 variables of the path models have more than one indicator; five are estimated by PLS.

Technology: For two blocks, Industrial Technology (IndTech) and Agricultural Technology (AgrTech), we chose Mode A weights because we wanted both indicators of each block, the level of development and the rate of improvement, to be represented in each LV. The weights, which range from 0.48 to 0.59, indicate that this intention is supported by the data.

Imbalance between industrial and agricultural technological development: This LV is formed by a priori weights:

Imbalance = (IndusTechn + IndustTechnChng) - (AgricTechn + AgricTechnChng)

Education: For the block of educational variables, Mode B weight estimation was adopted. The two indicators, extent of adult illiteracy and rate of spread of primary education, cut the continuum of education at different levels, and it remains to be seen which cutting point has higher predictive power. The weights in Table B1 indicate that the LV is formed entirely by the illiteracy variable, and the loadings display a perfect correlation between the LV and the MV illiteracy. The loading of the MV education changes with time in exactly the same way the correlations between the two MVs, illiteracy and education, change with time: The correlation drops from 0.89 in 1850 to 0.60 in 1870 down to 0.46 in 1890.

Table B1: The outer model

Variables		Weights				Loadings			
Latent	Manifest	Total	'50	'70	'90	Total	'50	'70	'90
LndTenur	LndTenur	43	47	39	40	93	97	92	88
	LndConcn	-20	-17	-27	-19	-55	-46	-67	-59
	LndTechn	55	51	53	59	90	91	87	90
Market	MktComd	47	64	46	44	96	95	97	95
	MktLand	7	12	24	2	86	84	90	75
	MktLabr	12	20	11	6	87	76	85	88
	MktCptl	41	16	25	53	96	90	96	97
MarketSp	MktComdS	4	-10	24	-5	72	85	74	51
	MktLandS	-9	34	-32	7	26	85	8	2
	MktLabrS	32	34	17	51	84	88	67	91
	MktCptlS	75	52	82	60	97	94	91	93
Illiterc	Illiterc	109	109	101	105	99	100	100	100
	EducatCL	14	10	2	10	-59	-89	-60	-46
IndTech	IndTech	56	48	55	59	95	97	96	94
	IndTechC	50	54	50	49	94	98	95	91
AgrTech	AgrTech	55	51	57	57	94	97	93	94
	AgrTechC	51	52	51	51	93	97	92	92

Note: All coefficients are multiplied by 100

Markets: Two latent variables are created to capture the level and the spread of markets. Both have four indicators each, related to the markets of commodities, land, labor, and capital. Because the land market was very thin, we considered omitting the level and spread of land markets from the analysis. Instead, we chose Mode B weight estimation which leaves this decision to the predictands and predictors of market LVs in the model. The loadings show that the power of the land market variable changes over time. In the first period both MVs, level and spread of land market, have high loadings (0.84, 0.85), which implies that variations in these variables have an impact on development. In the second and third period, the loadings of the spread of the land market (0.08, 0.02) is actually zero, which implies that the spread of the land market has reached such a level that variations around this level have no further impact.

Land tenure: This LV is a composite of three indicators which portray the characteristics of landownership that are relevant for development. The three indicators are: the predominant form of land tenure and holding; the concentration of landholdings; and the favorableness of land institutions to improvements. The sign of the weight of the concentration variable is negative for all time points, meaning that this variable enters the linear aggregate not as concentration but as spread. The loadings of the MV concentration are lower, in absolute terms, than the loadings of the other two indicators, indicating that concentration is not the strongest indicator of the land tenure LV which fits best into the path diagram.

Footnotes

[1]Colonialism, which appeared in the top ten list in three analyses, was excluded because the correlation matrix among the full list of potentially available manifest variables indicated that colonialism is dominated everywhere by the broader measure of extent of foreign dependence. A latent variable formed including colonialism would either have given colonialism negligible weight under Mode B weights or lowered the correlation of the latent variable with other variables under Mode A weights. In neither case would its inclusion have added to the analysis.

[2]The land tenure indicators appeared in the top ten list only once, in the study of agricultural development. We, nevertheless, included this indicator because it was pervasively important in the analysis of agricultural growth.

[3]For a discussion of the importance of immigration in the evolution of mutally integrated patterns of Commonwealth development in the 19th Century, see Thomas (1973). A less sanguine view of the effects of dependency on development is provided by Baran (1957), and the dependency school. The varying effects of dependency on within-group growth are studied empirically by Morris and Adelman (op. cit.) in chapter 6.

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