Globalization, Trade and Real Wages in the Pre-World War II Tropics

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This paper uses GMM estimation and the example of rubber in Southeast Asia to analyze competing trade-migration effects on tropical real wages during late nineteenth- and early twentieth-century globalization. Throughout this period unskilled real wages in the tropics, W A Lewis famously argued, remained constant because of a perfectly elastic supply of immigrants from India and China, and migrants from the traditional sectors of tropical dual economies, willing to work for a shilling a day. We test a recent Dowrick-DeLong conjecture that an analysis of tropical 'wage increase-less' growth as equally valid as Lewis's is that the global economy's industrial core generated too little demand for exports from the tropics to raise wages there. Using the example of Malaya cited by Dowrick and DeLong, we ask what level of exports would have been needed to move Malaya away from real-wage constancy. Our conclusion is pessimistic as to the possibility that trade could have acted as the engine of growth to create a pre-World War II international economic order significantly different from the historically realized sharp divergence in living standards between the tropics and core industrial countries.

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Real wage divergence beginning in the late nineteenth century between the tropics and a global industrial core was associated with sharply contrasting patterns of trade and industrialization. The world economy divided into a small group of high-wage industrial economies and a much larger number of low-wage countries specialized as exporters of primary commodities. The United States, United Kingdom, Germany and France comprised the industrial core; its primary-producing periphery included virtually all of Asia and Africa.

Malaya, under British colonial rule from the 1870s onwards, exemplified the low-wage 'have-nots' in this new international economic order. The British, as Steve Dowrick and Bradford DeLong (2003, pp. 198-99) point out, brought rubber seeds to Malaya, while immigrant workers came from India and South China 'to produce the rubber to satisfy demand back in the world economy's core'. In Malaya, however, large exports of rubber — and, elsewhere in the tropical periphery, of other primary commodities — gave rise only to a 'peculiar wage increase-less' form of growth. Globalization yielded this outcome in Malaya because, it can be argued, for unskilled workers — the great mass of the country's population — the stimulus of swift trade expansion to raise wages was 'overwhelmed by the elastic supply of potential migrant labor from China and India'.

But did it have to be this way? Just as valid an approach, Dowrick and DeLong go on to suggest, is 'not that migrant labour supply from India and China was remarkably large, but that the amount of increased trade between the tropical periphery and industrial core was relatively small'. In other words, late nineteenth-century globalization could have served as an engine of growth and convergence through generating enough trade to exhaust unlimited labour in the pre-World War II tropics. But how realistic is it to view the problem as a quantity one of simply too little trade?

Trade and migration can be complements, as shown theoretically by Markusen (1983) and demonstrated historically by O'Rourke and Williamson (2000) and Findlay and O'Rourke (2007). Clearly, complementarity operated in Malaya. There and in Indonesia, the pre-World War II world's other main rubber producer, the vent that trade provided for surplus land had as its complement large inflows of migrant workers from the surrounding countryside and immigrant labour from abroad (Findlay and Lundahl, 1994, 2001; Drake, 2004).

A long-standing theoretical literature explores the other possibility: that trade can substitute for migration and possibly equalize factor prices (Samuelson, 1949; Lerner, 1952; Mundell, 1957). Substitution would have had to provide the route through which late-nineteenth century globalization engineered real wage convergence between Malaya and the United States, the world wage leader and easily the chief consumer of rubber. As between Malaya, India and China, the almost entirely unrestricted movement of workers led to the creation of a large, integrated Asian labour market. Asian integration through unhindered factor flows could not, however, extend to encompass the global industrial core. Mass immigration of Asians on a scale comparable to that within pre-war Asia was politically unacceptable to electorates in the West. Accordingly, there would have needed to be a sufficiently large volume of exported rubber — and so demand for workers to grow and process the commodity — to raise Asian real wages towards United States levels. Only then would trade in the form of primary commodity exports have truly functioned as an engine of growth.

One argument is that exports of primary commodities failed as growth's engine because this would have necessitated industrialization and its attainment was prejudiced by trade specialization like that in the late nineteenth-century tropical periphery (Krugman, 1981; Williamson, 2006). However, the component of the trade and growth literature relevant to this article focuses specifically on the growth-inducing properties that stem from primary commodity exports. An empirical strand of this literature observes that primary exports led on to successful growth and increasing real wages in the early development of Canada, Australia and the northern United States (Watkins, 1963; Crafts, 1973; Engerman and Sokoloff, 1997 and Sokoloff and Engerman, 2000). A counter-argument, and rather different literature — the one that Dowrick and DeLong question — is associated with W. A. Lewis (1978a, 1978b), Ronald Findlay (1980, 1981) and Angus Deaton (1999; Deaton and Miller, 1995; Deaton and Laroque, 2003). In this view, wages in the poor periphery were (and some proponents might argue still are) set by the marginal product of labour in subsistence agriculture. Wages in the tropical periphery could not increase so long as the opportunity cost of migrant labour within poor countries and immigrant workers attracted from other, even poorer, countries remained at the subsistence agricultural wage plus some mark-up to cover transport costs and offer an incentive to migrate.

Deaton (1999) and Deaton and Miller (1995) point out that the price of primary commodity exports from sub-Saharan Africa, although subject to booms and slumps, reverts to an essentially trendless mean. It does so because in the long-term price equals the marginal cost of production and this, in turn, is determined by the subsistence wage of an as yet unexhausted supply of unskilled African workers. Similarly, the wages of rubber growers in Malaya and Indonesia stagnated because, Lewis (1978a, p. 188) contended, there existed 'an unlimited supply of Indians and Chinese willing to travel to the ends of the earth to work on plantations for a shilling a day'.

This study focuses on Malaya and Southeast Asia — the example of Dowrick and DeLong — and attempts to tests their conjecture on trade, wages and growth in late-nineteenth-century globalization. Given the structure of the pre-World War II world economy with its small industrial core and large periphery, could trade have realistically dominated both international immigration and internal migration from traditional sectors of dual economies such as to create a different international economic order? What level of industrial core demand would, in practice, have been needed for the labour supply curve to turn decisively upwards and deliver sustained unskilled real wage increases in the tropics and so also a measure of global wage convergence?

We proceed as follows. The next section places in historical context the surge in world demand for rubber, Malayan and Indonesian supply response, and the mass immigration from India and China fundamental to this. Section 2 develops a model which will be used to analyze the triangular relationship between world rubber demand, wages in Malaya and the supply of labour to produce rubber. In Section 3 we describe our data sets, present empirical results for Malaya and extend these to include Indonesia. The concluding section summarizes what can be learned from empirical analysis of globalization's first great phase and what insights a case study of Malaya and Southeast Asia provides on trade as an engine of growth in the tropical periphery.

1. Rubber Production in Malaya and Indonesia

Rubber stands out as the world's greatest agricultural commodity boom: "No other branch of agriculture has ever developed so rapidly" (Bauer, 1948, p. 25). In 1937 rubber ranked, by some margin, as the most important tropical agricultural export. It far exceeded rice, tea, coffee and cocoa; sugar alone came close to rubber in export value (table 1, panel a).

The industrial core required rubber almost wholly to make tyres for motorized transport, and from the early 1900s onwards, as this great wave of Schumpetarian innovation began to take hold, the demand for rubber followed suit. In 1925-29, the United States, United Kingdom, Germany and France consumed 84% of all rubber. The United States accounted for over three quarters of this consumption. Of major United States imports of primary commodities rubber grew to rank at, or near, the top. Panel b in table 1 summarizes the position for 1937-1941. Except for 1938 when rubber prices were severely depressed, rubber was easily the largest of the principal United States commodity imports.

HERE INSERT TABLE 1

1.1 Cultivated rubber and labour supply

Rubber supply was no less localized than demand. Malaya contributed 45% and Indonesia for 34% of world rubber shipments in 1925-29; by 1932 this total of 79% for the two countries had risen to 87%. At the end of the 1930s, however, the proportion fell to 74%, because the 1934 formation of a rubber-producers cartel raised prices, which led to more output from other non-cartel Southeast Asian producers, notably Thailand and Indochina (McFadyean, 1944, pp. 226-35). We now trace the tropical rubber supply response to industrial core demand and draw attention to extreme economic specialization in Southeast Asia and to how it was effected through the utilization of surplus land and mass migration of workers.

As late as 1910 most of the world's rubber was wild, rather than cultivated as in Southeast Asia, and came from the Brazilian Amazon. Brazil could not, however, successfully expand production to accommodate the explosion of world demand, because of attempts at rubber valorization and labour shortages in the sparsely populated Amazonian jungle (Barker, 1940, pp. 22-23; Wallace, 1952, p. 329). Like Brazil, Malaya, in the 1860s largely empty and hardly explored, had (and still had in the 1950s) vast quantities of land well suited to rubber. Moreover, Malaya had easy access to workers needed for the labour-intensive process of rubber production, because of its situation halfway between — and only few days sailing distance from — the large labour-surplus areas of the Madras Presidency in India and Kwangtung

(Guangdong) and Fukien (Fujian) in Southeastern China. As a British colonial official observed early in the century: ‘the two great Provinces of Southern China, called Kuang Tung and Fu Chien, are greatly over-populated and their surplus population flocks to the Straits and Federated Malay States every year’. We need have ‘no real fear that the sources of this supply will ever run dry’ (Federated Malay States, 1901, p. 50). Nor did they. In 1931 a Singapore resident could write that we are near ‘two unlimited sources of supply for cheap labour, namely India and China’(Rotary Club, 1931, p. 2).

Indentured labour was never important in the Malayan rubber industry and even before the formal abolition of indenture in 1910 had all but disappeared. Mass migration to Malaya from India and China was a market response driven by the incentive of considerably higher wages than obtainable at home. Large numbers of Indians and Chinese came to Malaya and after working three to five years generally left. Between 1881 and 1939 Malaya averaged immigrant inflows per decade of 826 persons per 1,000 resident population, almost five times the immigration rate to Argentina, which had higher rates than any New World country. In 1931, Malaya’s population of 4.4 million was 45% Malay, 39% Chinese and 14% Indian. Most Indians worked in the rubber industry as did many Chinese. Although the Malay population was referred to as indigenous, a sizeable proportion of it consisted of migrants from Indonesia who were attracted by the rubber industry. The 1931 census found that rubber cultivation alone employed fully a third of the Malayan workforce (Malaya, 1932, p. 99).

1.2 Rubber and Malaya’s economy

Rubber production, as Peter Bauer (1948) calculated and subsequent work confirms, dominated Malayan GDP. Growth was strongly export-led. By the 1920s Malaya had the highest per capita exports recorded for any pre-war tropical or New World country. In 1925-27 these averaged (in 1990 US dollars) some $1,319 annually for each of Malaya’s inhabitants (Huff, 2007).

The rubber industry brought fundamental change to Malaya. A bigger population and an increasing share of it in the labour force (due to migration being chiefly working age males) contributed to substantial increases in Malayan GDP. Per capita GDP also rose and some people became wealthy through the capture of natural resource rents from rubber. But, as Dowrick and DeLong stress, for unskilled workers in the rubber industry, Malaya's was a strange wage increase-less sort of growth. Between 1910 and 1939 long-term, unskilled real wages remained constant, and, interestingly, if expressed in sterling, equaled Lewis's shilling (US$0.24) a day. When Malayan wages deviated much from this level, typically due to core demand shocks, more immigrants came to (or departed from) Malaya. The Malayan labour market operated with a Swiss-style flexibility (Huff and Caggiano, 2007a).

Rubber supply in Southeast Asia was more complicated, and in reality much greater, than only the spread of rubber plantations, most of which were owned by Europeans and relied on Indian and Chinese immigrant labour. Capital requirements to grow rubber could be minimal and the technology was traditional. Ease of entry allowed smallholders — defined as those cultivating under 100 acres but often families working two to five and no more than 15 acres — to grow a high proportion of Malayan and Indonesian rubber. Land was abundant and, so long as families were willing to give up some leisure time, labour could be mobilized at no money outlay. In 1932 in Malaya, smallholders accounted for two fifths of production and, because more of their trees than those on plantations had yet to mature, over two fifths of Malaya's total of 3.1million acres under rubber (Malaya, 1933).

1.3 Indonesian supply

The potential that Indonesia — with its vast reservoirs of labour and uncultivated land — possessed to respond to any increase in demand by growing more rubber is striking. Indonesia divides into Java and Madura and all the country's other islands, the so called Outer Provinces. By 1910 Java was among the world's most thickly settled areas and already overpopulated. In

Java, responsible in 1930 for some 27% of Indonesian production, plantation owners had 'access to virtually unlimited supplies of labour from the native villages of this densely populated island' (Bauer, 1948, p. 48). While land in Java was scarce, it was in effect unlimited in the Outer Provinces. Throughout the twentieth century, migrants left Java for the Outer Islands, partly in response to the demand for labour to work on rubber plantations. But in the race to absorb surplus Javanese labour, natural increase remained far ahead. At the close of the 1930s no one could hope for inter-island Indonesian migration of more than 60,000 people annually but at that time the Javanese population was increasing by 600,000 every year (Pelzer, 1945, pp. 210, 228-29).

The scope that indigenous Indonesian smallholders in the Outer Islands had to expand rubber output was particularly impressive. As in all sections of the rubber industry, short-term responsiveness was limited to more tapping of existing trees, since rubber trees take six to seven years to mature and yield latex. But long-term production elasticity was considerable. Able to draw on the great abundance of land, a large, if uncertain, proportion of Indonesian smallholders had a cost of cultivating additional rubber that was 'negligible in terms of cash or effort' (Bauer, 1948, p. 67). Smallholder expansion of rubber production involved little more than clearing jungle growth though burning, planting rubber seedlings, and waiting for them to grow while continuing with subsistence cultivation on the same (if rubber trees were interplanted with another crop), or on adjoining land. Outer Island smallholders increased production from 4,464 tons in 1919 to 80,800 tons in 1930 and 210,143 tons by 1939. This last figure approached half of Indonesian output. Even more telling, however, was that by 1939 Outer Island smallholders owned well over half of the Indonesia's 3.3 million acres planted in rubber (Mansvelt, 1975, pp. 93-94). Many rubber smallholders were the indigenous Malay.

Over the 30 years 1910 to 1939, world rubber absorption rose nearly tenfold from 99,400 tons to 937,700 tons. And yet during this period rubber supply regularly outstripped demand. Through the pre-war decades the trend in rubber prices was downwards.

2. The Model

In an export economy like Malaya's, subject to mass immigration, wages are the outcome of two opposing forces. Increased rubber absorption in the industrial core shifts the labour demand curve upwards, or to the right, while bigger immigrant inflows cause labour supply to shift downwards, or to the left. Emigration to Malaya from Madras and Southeastern China decreases the number of workers available in these areas and raises wages so long as labour supply is not perfectly elastic. If net migration from emigrant areas exceeds the rate of domestic labour force growth, the wage gap with Malaya (roughly around 2.5: 1) would narrow and the incentive to emigrate lessen.

To establish at what point trade would decisively raise Malayan real wages, a model of rubber industry demand and supply is needed. Our model has four regions. The industrial core (United States and Europe) demands rubber used by automobiles and other motor vehicles. Malaya produces the raw material, rubber, and employs workers for this. The two regions of Madras and Southeastern China export workers according to individuals' decisions to stay at home or migrate for work in rubber production. Migration links the Asian labour markets of Malaya, Madras and Southeastern China. The demand for rubber exports, determined in the world's industrial core, is exogenous.

2.1 Rubber demand

Industrial core demand for rubber came overwhelmingly from the manufacture of tyres. These were needed both for new motor vehicles (cars and commercial trucks and buses) and for an existing stock of vehicles. At first, tyre production relied almost entirely on new, imported rubber but by the interwar years rubber reclaimed domestically gained importance. Substitutability was far from perfect but when import prices rose manufacturers used appreciably more reclaimed rubber (Knorr, 1945). Export demand for rubber can be written as a linear function of new vehicle production, the existing stock of vehicles, and rubber's world price

$$XD_t = \alpha_0 + \alpha_1 IP_t + \alpha_2 S_{t-1} + \alpha_3 p_t + \varepsilon_t, \qquad (1)$$

where XD_t is world demand of rubber, IP_t new vehicle production, S_{t-1} the stock of existing vehicles, and p_t the world price of rubber. This last captures the potential for substituting reclaimed for imported rubber. The error term u_{1t} is an exogenous shock assumed to be normally and independently distributed. We expect α_1>0, α_2>0, and α_3<0.

2.2 Malaya labour market

Labour demand in Malaya depended on the production of rubber, and this, in turn, on export demand. Workers were employed in the rubber industry to weed and maintain existing acreage, to tap latex from the trees, and to clear the jungle and plant more rubber. Labour requirements were a function of the cost of production (real wages), export demand and expected profits, approximated by the expected price of rubber:

$$L_{it}^t = \beta_0^d + \beta_1^d w_{it} + \beta_2^d XD_t + \beta_3^d p_t^e + \varepsilon_{it}^d,$$

where w_{it} is real wages in Malaya (denoted by I) at time t, p_t^e the expected normal price of rubber, and ε_{it}^d a labour demand shock. Labour supply is given by the sum of the domestic labour force and migration:

$$L_{it}^s = N_{it} + m_{it},$$

where N_{it} represents domestic labour force changes and $m_{it} = m_{jit} + m_{hit}$ immigration from Madras and Southeastern China, denoted by j and h respectively. Labour supply consists of two components: an inelastic component, the domestic labour force, which is determined exogenously by the rate of growth of domestic population, and a wage-elastic component, due to immigration, explicitly modeled later in this section. Immigration depended on the wage gap between the receiving country and sending regions and on employment opportunities, given by the dynamics of export demand (Huff and Caggiano 2007a, eq. 4). Equating changes in labour demand and supply gives:

$$w_{it} = \beta_0 + \beta_1 XD_t + \beta_2 p_t^e + \beta_3 m_{jit} + \beta_4 m_{hit} + \beta_5 N_{it} + u_{1t}. \qquad (2)$$

We expect $\beta_1>0$, $\beta_2>0$, $\beta_3<0$ and $\beta_4<0$. In specifying the formation of expectations, we follow Hartley et al. (1987) and adopt a simple adaptive expectations model:

$$p_t^e - p_{t-1}^e = \lambda\left[p_{t-1} - p_{t-1}^e\right].$$

Solving backwards yields

$$p_t^e = (1-\lambda)\sum_{n=1}^{\infty} \lambda^n p_{t-n}.$$

We fit the distributed lag model given by (eq.10) and use the fitted series to measure expected price. The Schwarz Information Criterion indicates a specification with one lag only.

2.3 Madras labour market

Labour demand in Madras depends on the cost of production (real wages) and on aggregate demand which can be proxied by total population:

$$L_{jt}^d = \chi_0^d + \chi_1^d w_{jt} + \chi_2^d N_{jt} + \eta_{jt}^d,$$

where N_{jt} is total population at time t. Labour supply depends on domestic real wages and on the dynamics of relative real wages:

$$L_{jt}^s = \chi_{1t}^s + \chi_{2t}^s w_{jt} + \chi_{3t}^s \left(w_{it-1} - \lambda_j w_{jt-1}\right) + \eta_{jt}^s.$$

Solving for w_{jt} and rearranging gives the labour market equilibrium condition:

$$w_{jt} = \chi_0 + \chi_1 N_{jt} + \chi_2 \left(w_{it-1} - \lambda_j w_{jt-1}\right) + u_{2t}. \qquad (3)$$

2.4 Southeastern China labour market

As for Madras, labour demand is:

$$L_{ht}^{d} = \delta_0^d + \delta_1^d w_{ht} + \delta_2^d N_{ht} + \eta_{ht}^d ,$$

and labour supply:

$$L_{ht}^{s} = \delta_{1t}^s + \delta_{2t}^s w_{ht} + \delta_{3t}^s \left(w_{it-1} - \lambda_h w_{ht-1}\right) + \eta_{ht}^s .$$

The labour market equilibrium condition is:

$$w_{ht} = \delta_0 + \delta_1 N_{ht} + \delta_2 \left(w_{it-1} - \lambda_h w_{ht-1}\right) + u_{3t} . \quad (4)$$

2.5 Migration equations

Migration depends on the relative conditions of the labour markets in the receiving and the sending countries, given by the relative level of real wages, and on the dynamics of aggregate demand in the receiving country. This latter is approximated by rubber demand from the industrial core (for a more elaborate description and estimation of migration in pre-war Southeast Asia, see Huff and Caggiano, 2007a). The implied Madras migration equation is:

$$m_{jit} = \gamma_0 + \gamma_1 \left(w_{it-1} + \phi_j w_{jt-1}\right) + \gamma_2 XD_t + \gamma_3 \Delta XD_t + \gamma_4 m_{jit-1} + u_{4t} , \quad (5)$$

where w_{it} and w_{jt} are real wages in Malaya and Madras respectively, m_{jit-1} captures a "friends-and-relatives" effect through which past migration leads to more migrants from the same ethnic or linguistic group, and ΔXD_t represents changes in demand of rubber. Similarly, the Chinese migration equation is:

$$m_{hit} = \theta_0 + \theta_1 \left(w_{it-1} + \phi_h w_{ht-1}\right) + \theta_2 XD_t + \theta_3 \Delta XD_t + \theta_4 m_{hit-1} + u_{5t} , \quad (6)$$

where w_{it} and w_{ht} are real wages in Malaya and Southeastern China respectively.

2.5 Stock of potential migrants

Although in its early stages Indian emigration to Malaya was nearly all male, increasingly Indian women emigrated along with their men folk to work on rubber estates. The number of females per 1,000 males in the total Indian population of Malaya was 308 in 1911, 406 in

1921 and 482 by 1931 (Sandhu, 1969, pp. 185-86). To reflect this female component of the Malayan workforce, we estimate the Madras working age population with a potential to migrate as 40% of females aged 15 to 45 living in the Presidency along with all males in that age range. Chinese emigration was, however, predominantly male and the working age population in Southeastern China is taken to be its male population between the ages of 15 and 45. Potential migrants are:

$$M_t^* = M_{jt}^* + M_{ht}^* = N_{jt-1}^* + n_{jt} - m_{jit} + N_{ht-1}^* + n_{ht} - m_{hit}$$

where N_{jt-1}^* is working-age population at time t-1, n_{it} the change in domestic labour force, and m_{jit} the number of those of working age who migrate.

To summarize, the model for estimation comprises labour market equilibrium equations for Malaya, Madras and Southeastern China, (eqs. 2, 3 and 4) together with the two Indian and Chinese migration equations (eqs. 5 and 6). Rubber demand (eq. 1) is estimated separately because of its exogenity to Asia's labour market.

In the next section, we briefly indicate data sources and explain econometric methodology before estimating the model. Estimation gives the elasticity of (a) rubber demand to industrial production (α_1) and to rubber price (α_3); (b) Malaya real wages to export demand (δ_3); (c) Madras real wage responsiveness to changes in Malaya labour market conditions (θ_2); (d) Chinese real wage responsiveness to changes in Malaya labour market conditions (φ_2); and (e) and the reaction of migration to relative wages (γ_1) and (σ_1).

3. Empirical analysis

3.1 Data sources

Our data, described in an appendix, covers the four decades 1900-1939. Data for Asia comes primarily from censuses, government wage surveys and annual immigration returns compiled by port or customs officials. Pre-war data for Asia, especially agrarian wage data, is always subject to qualification and a certain amount of caution. While for the British colonial areas of Madras and Malaya and the Dutch colony of Indonesia data compilation was thorough and systematic, statistics are less complete for Southeastern China where Treaty Port administrations are the main institutional statistical source.

Wages are real wages deflated by multi-commodity price indexes constructed by the authors. The indexes are different for each of Madras, Southeastern China and Malaya and real wages are exchange-rate-adjusted to the common currency of US dollars. Emigrants to Malaya were almost all unskilled, mostly men and largely from agricultural areas. To reflect this, our wage series, with the partial exception of China, are unskilled, male agrarian wages. In Malaya, job overlaps, including the many Chinese working on rubber estates, and considerable labour mobility, allow one to speak, if not of a common Malayan wage, of wage movements fluctuating around the level obtaining for unskilled Indian estate workers. These served as a benchmark for all of Malaya's workers (Malaya, 1939, p. 39).

Price series for rubber are the yearly average for standard quality on the London exchange. Statistics for industrial core rubber absorption which, as distinct from imports, literally means rubber disappearing each year from international commerce, derive from official statistics for the four core countries (Barker, 1938, p. 12). Industrial core data can be regarded as reliable.

3.2 Econometric methodology

Estimation of the system of equations involves significant econometric problems. One is that not all regressors can be considered as strictly exogenous. Second, most of the variables included in the relationships have some form of non-stationarity and often not I(1). Econometric approaches to these two issues have generally treated them separately. Nonstationarity is typically addressed within a cointegration framework such as the

Johansen Maximum Likelihood approach. The usual approach to endogeneity is GMM estimation.[1]

As a first step, we pre-test all variables in the model for the presence of a unit root. The Augmented Dickey-Fuller, the GLS-ADF, and the KPSS tests point in the majority of cases to nonstationarity different from a unit root (see for example Abadir and Taylor, 1999; Abadir et al. 2008). The most nonstationary of the series appears to be United States net imports of rubber, industrial production and stock of motor vehicles. By contrast, the hypothesis of a unit root can be decisively rejected for all wage and migration series. Problems of mixed, possibly fractional, orders of integration can be handled within the Kitamura and Phillips (1997) framework. However, as a first approximation and to simplify analysis we assume that no variables contain a unit root and estimate the model of the Southeast Asian labour markets by standard GMM.

3.3 Rubber demand

We begin by estimating the United States rubber demand equation to determine the responsiveness of rubber absorption to changes in motor vehicle production, the number of vehicles in use, and rubber prices. Rubber demand is

$$XD_t = \alpha_0 + \alpha_1 IP_t + \alpha_2 S_{t-1} + \alpha_3 p_t + \varepsilon_t,$$

where XD_t is world demand of rubber, IP_t new vehicle production, S_{t-1} the stock of existing vehicles, and p_t the world price of rubber. Writing all variables in logs allows estimated coefficients to be interpreted as elasticities. In dealing with issues of potential nonstationarity and endogeneity, we begin with the latter. Here rubber prices are a prime suspect, because the price of rubber, p_t,, and rubber demand may be determined simultaneously. To test for endogeneity we use the two-step Hausman test proposed by

[1] The best approach would be to address both issues simultaneously. To do so we need to depart from standard GMM, which holds for stationary or trend-stationary series (see Hall, 2005 for a discussion), and employ instead the

Davidson and MacKinnon (1989, 1993). We first estimate an auxiliary regression by regressing the potential endogenous variable and all exogenous variables and retrieve the residuals. The second stage is re-estimation of the rubber demand equation including the residuals from the first regression and $\hat{u}_t$ as an additional regressor:

$$XD_t = \alpha_0 + \alpha_1 IP_t + \alpha_2 S_{t-1} + \alpha_3 p_t + \alpha_4 \hat{u}_t + \varepsilon_{1t}.$$

Since the coefficient on the first stage residuals is not statistically significant the price of rubber, p_t, can be treated as exogenous.

Tests for unit roots, already carried out above, indicated possible nonstationarity in the rubber demand equation. Accordingly, we adopt the Engle-Granger cointegration procedure. Results are summarized in Table 2.

HERE INSERT TABLE 2

As expected, rubber demand is positively related to the existing stock of motor vehicles and negatively related to the price of rubber. Surprisingly, new motor vehicle production does not enter the regression significantly. The relationship between rubber demand and the independent variables is, however, clearly unstable (see the rolling estimates of the coefficients in figure 1).

HERE INSERT Figure 1: Recursive Coefficient Estimates

Stability tests (the Chow breakpoint test, the CUSUM test, the one-step forecast test) point to 1915 as the likely break date. Hence, we re-estimate rubber demand using the subsample 1915-1939. Results are shown Table 3.

HERE INSERT TABLE 3

Around 1915 rubber demand became price inelastic as automotive transport emerged as overwhelmingly the largest consumer of rubber due to the rise of mass vehicle

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fully modified GMM estimation procedure proposed by Kitamura and Phillips (1997). It allows for potentially non-stationary regressors and instruments. Extension to the Kitamura and Phillips (1997) is on our agenda.

production, a growing stock of vehicles, and large increase in their use. Motor vehicles and tyres are a classic example of complementary goods: neither has any utility without the other. Because tyres are a minor element in the overall cost of automobiles, trucks and buses, the influence of the price of rubber on the demand for imported, crude rubber became negligible. Reclaimed rubber, although a partial substitute for crude rubber, differed from it in fundamental respects and could be used only to a limited extent in tyre manufacture. In the late inter-war years a good quality automobile tyre, weighing 22 pounds, contained 11 pounds of crude rubber and a pound of reclaim. The rest consisted of fabric, compounding ingredients and bead wire (Knorr, 1945).

3.3 Results for Malaya

By how much would Malaya's rubber exports have had to expand for unskilled real Malayan wages permanently to increase? To answer this question, we first estimate Malayan wage responsiveness to export demand and migration. Since responsiveness depended not just on change in Malaya but also in other components of what was an integrated Asian labour market, we estimate jointly the elasticity of real wages in Malaya to export demand from the industrial core and to immigration from Madras and Southeastern China. The system of equations to be estimated by GMM comprises labour market equilibrium conditions in these three Asian areas and, furthermore, the two migration equations linking Madras to Malaya and Southeastern China to Malaya.

HERE INSERT TABLE 4

The coefficients attached to trade, β_1, and migration, β_3 and β_4, all have the expected sign and all are highly significant (table 4). A 1% increase in export demand raised real wages in Malaya by 0.54%. But, set against this, a simultaneous 1% increase in total migration from Madras and Southeastern China pushed down wages by 0.69%. Like the trade and migration coefficients, expected profits, β_2, are highly significant. However, the responsiveness of real wages in Madras, χ_2, to changes in Malayan wages is null. Responsiveness for Southeastern China, δ_2, although significant and positive, is slight. For Madras the responsiveness of migration to a joint change in export demand and lagged relative wages is negligible, but for Southeastern China a 1% increase in trade and relative wages implies a 0.47% increase in migration.

We now quantify the effects of a larger volume of industrial core rubber demand on Malayan real wages and pose the counterfactual. At what level of increased United States rubber absorption would there have been a permanent upwards trend in Malayan wages? To make the question concrete: suppose that at time t export demand for rubber increased 1%. That would raise real wages in Malaya by 0.55%. At time t+1, potential migrants in Madras (the male population aged 15-45 and 40% of females in that age range) and in Southeastern China (men between 15 and 45) would decide whether to migrate to Malaya in light of export demand at time t+1 and relative wages at time t. Since the impact on migration of a joint 1% increase in exports and relative wages is 0.03% in Madras and 0.47% in Southeastern China, the stock of potential migrant at time t+2 must be recalculated to allow for the earlier shift in export demand. A lower stock of potential migrants reduces the incentive to migrate through pushing up real wages in migrant-sending areas. But a reduction in migrant-sending area populations decreases aggregate demand in these areas and shifts leftwards the demand curve for labour.

Two simplifying assumptions should be made explicit. One is that an increase in Malayan real wages is assumed equal to an increase in relative (to the sending countries) real wages. The assumption is justified by our estimation results that the dynamics of wages in Madras are totally insensitive to changes in real wages in Malaya and that wages Southeastern China responded only slightly (0.11%) to a 1% change in Malaya. Second, it is assumed that the net effect of a reduction in the stock of potential migrants in the two sending regions is zero: the rightwards shift in the labour supply schedule is cancelled out by the demand schedule's leftwards shift.

HERE INSERT FIGURE 2

Results from simulations are shown in figure 2. It plots five wage series: actual Malayan real wages and four simulated series. The simulated series are generated under four different scenarios: levels of rubber absorption of two, three, five and ten times bigger than observed for Malaya. A marked increase of Malayan wages, starting from the mid 1910s, would have required a five-to-ten times higher level of rubber exports.[2] The Lewisian unlimited supply of labour from Madras and Southeast China, although overcome by a much larger volume of exports, would have still played a role in keeping wages down: drainage of the stock of potential migrants in the two sending regions would have required a hundredfold increase in United States rubber absorption.

To help put these numbers in perspective, in 1939 the United States had 31 million motor vehicles. Four decades later, in 1980, this had risen to 156 million. At that time the world stock of motor vehicles was some 300 million, or roughly the tenfold increase needed in 1939 to absorb enough Indian and Chinese immigrant labour appreciably to raise unskilled real wages in Malaya.

In supposing this tenfold increase in rubber exports — and so Malaya's escape from wage increase-less growth — two assumptions require emphasis. One is that a rise in the price of rubber would not have caused the development of a synthetic substitute for crude rubber. Helpful in this assumption would be the avoidance of World War II, since it was a principal stimulus to synthetic rubber development. The other assumption is that Malaya — even admitting that its peninsula had sufficient land to accommodate a

[2] A statistical test for equality of deterministic time trends, as in Vogelsang and Franses (2005), could be done but the main message of the counterfactual would be unchanged: a much larger level of rubber absorption would have necessary to make Malayan wages trending upwards.

several-fold increase in rubber trees — was the only country in the world that was growing rubber.

3.4 Indonesian rubber supply

Although our econometric analysis has implicitly assumed that Malaya alone supplied rubber this, as indicated in section 1.3, was not so. By the 1930s Indonesia had a share of rubber supply not far short of Malaya's. The results of the counterfactual analysis are valid only under the assumption that rubber from Indonesia was not a substitute of Malayan rubber. Why? Suppose wages did begin to increase in Malaya. Would a response of greater supply form Indonesia have put a stop to this? In other words, the market for primary commodities is global and one needs to consider the totality of labour supply to grow rubber. Comprehensive analysis of global rubber supply needs an extended model. In it, the rubber market is made up of the two large suppliers — Malaya and Indonesia — and the costs of production (real wages) differ: in one region (Malaya), real wages are determined by demand and supply; in the other region (Indonesia), real wages are determined by the subsistence agricultural wage.[3] Analysis of a global market of rubber, with an extended, and considerably refined, version of the model considered in this article is on our agenda.

4. Conclusion

As part of the world's late nineteenth- and early twentieth-century 'great specialization', Malaya, like many other Asian and African economies, came to rely on exports of primary commodities that went almost wholly to the global industrial core and were not produced there. That trade pattern limited growth in the periphery to a rate no higher than in the industrial core. For Malaya the opportunity that trade afforded to combine elastic supplies of land and migrant labour served as an engine of growth. Malaya had never had significant manufacturing and, contrary to the de-industrialization hypothesis, booming trade promoted net gains in industry. Trade was, however, no more than a partial growth engine. Against the countervailing force of migrant labour inflows, trade proved unable to raise unskilled real Malayan wages. Between 1910 and 1939 United States rubber absorption rose nearly 12-fold and Malayan rubber exports by a factor of 57, but over the three decades wages in Malaya remained virtually unchanged. Factor prices, rather than equalizing, continuously diverged. In 1910 the ratio of United States to Malayan unskilled agricultural wages was approximately 8:1 but by 1939 stood at 14:1.

Malaya has a unique place in world economic history as the centre of the world's greatest agricultural commodity boom. The expansion of Southeast Asian rubber production stands out as 'one of the most remarkable developments in the history of economic plants' (McHale, 1964, p. 34). Exceptional rapidity of development along with its large scale may help to explain why Dowrick and DeLong (2003) single out rubber as their example of stellar trade increase but wage increase-less growth. Through modeling rubber export from, and migration to, Malaya and analyzing these flows econometrically, this paper has emphasized the limitations of trade as an engine of growth in the pre-World War II tropical periphery. Trade may well be a near-essential accompaniment to growth. But on Malayan evidence the tropical periphery would have had to look to much greater export expansion than possible in the world's pre-war economy for a long-term growth engine and real wage convergence towards the industrial core.

During the late nineteenth- and early twentieth-centuries, with so little of the world industrialized and so much of its non-industrial-core population confined to subsistence agriculture, it is hard to imagine that ready supplies of cheap periphery labour would not have continuously overwhelmed the beneficial effects of trade expansion on real wages in

[3] We abstract from rapid and substantial 1930s increases in rubber production in some other Southeast Asian

the tropics. That finding supports the arguments of Lewis, Findlay and Deaton. Few tropical countries had such massive inflows of Indian and Chinese labour as Malaya. But the export sectors in pre-war Asian and African economies were typically embedded in — and usually much the smaller component of — dual economies. Their traditional sectors served as reservoirs of subsistence-wage labour. Even supposing that industrial core demand for primary commodities exported by periphery countries could have expanded many-fold and temporarily raised wages, it seems likely — as suggested by our extension of the rubber export-labour supply-real wage relationship to include Indonesia — that more labour would have flowed from traditional subsistence sectors to once again push down wages.

Appendix: Data Sources

- United States rubber absorption is from Barker (1938), pp. 14-15 and McFadyean (1944), pp. 232-35.
- New vehicle production is measured by US total motor vehicle output and the stock of existing vehicles is measured by US total registered vehicles Carter et al., (2006), pp. 4-830-31.
- Price of rubber is the London Average Standard Quality price. For 1896 - 1902 prices are for Brazilian para, for 1903 - 6 for cultivated para, for 1907 - 10 for first grade plantation crepe, and thereafter for London average standard quality. For 1907 onwards the series is for closely comparable quality rubber. Data for 1896 – 1909 from Drabble (1973), p. 213 and for 1910 – 1939 from McFadyean (1944), p. 239. London prices were checked against and are closely correlated with the New York yearly average price of rubber from Commodity Research Bureau (1939), p. 375.
- Real wages for Malayan Indians, Malayan Chinese, Madras and Southeastern China are unskilled wages and, with few exceptions, are agricultural wages. Data were compiled from a number of original reports and sources supplemented by

countries, notably Siam (Thailand) and Indochina, and also in Ceylon.

contemporary survey data as discussed in Appendix C to Huff and Caggiano (2007b). Malayan real wages are the average of Indian and Chinese wages.

- Migration is measured by Indian immigrants to Malaya and Chinese immigrants to Malaya as compiled by Malayan port and immigration officials, government departments including the and Malaya's Protector of Chinese. The data is compiled in Appendix A in Huff and Caggiano (2007b).
- Madras population and age and sex data are from the Madras volume of the three Indian censuses for 1911, 1921 and 1931: India (1912), India (1922) and India (1932). Data for the population of Southeastern China is from Perkins (1969). In calculating the stock of potential migrants the age structure of population is assumed to be the same as in Madras.

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Table 1
Principal Tropical Exports and United States Commodity Imports 1937-1941

				US$ million			
(a) Tropical exports, 1937							
	Rubber	530		Coffee	333		
	Rice	294		Cocoa	112		
	Tea	208		Sugar	432		
(b) United States imports							
		1937	1938	1939	1940	1941	
	Rubber	248	130	178	318	417	
	Wool	96	23	50	85	205	
	Coffee	151	138	140	127	177	
	Sugar	166	130	125	113	153	
	Tin	104	45	71	128	150	

Table 2
U.S. rubber demand, 1900 – 1939: estimation results

	Estimate	Standard Error
α_0	9.57***	0.50
α_1	0.08	0.14
α_2	0.32**	0.13
α_3	-0.22**	0.10

Table 3
U.S. rubber demand, 1915 – 1939: estimation results

	Estimate	Standard Error
α_0	6.61***	0.43
α_1	0.29***	0.09
α_2	0.41***	0.07
α_3	-0.06	0.06

Table 4
Malaya labour market, 1900 – 1937: estimation results

	Estimate	Standard Error
β_1	0.54***	0.02
β_2	0.50***	0.03
β_3	-0.37***	0.02
β_4	-0.32***	0.02
χ_2	0	0.01
δ_2	0.11	0.01
$\gamma_1 + \gamma_2$	0.03	0.03
$\theta_1 + \theta_2$	0.47***	0.05

Figure 1
Recursive coefficient estimates

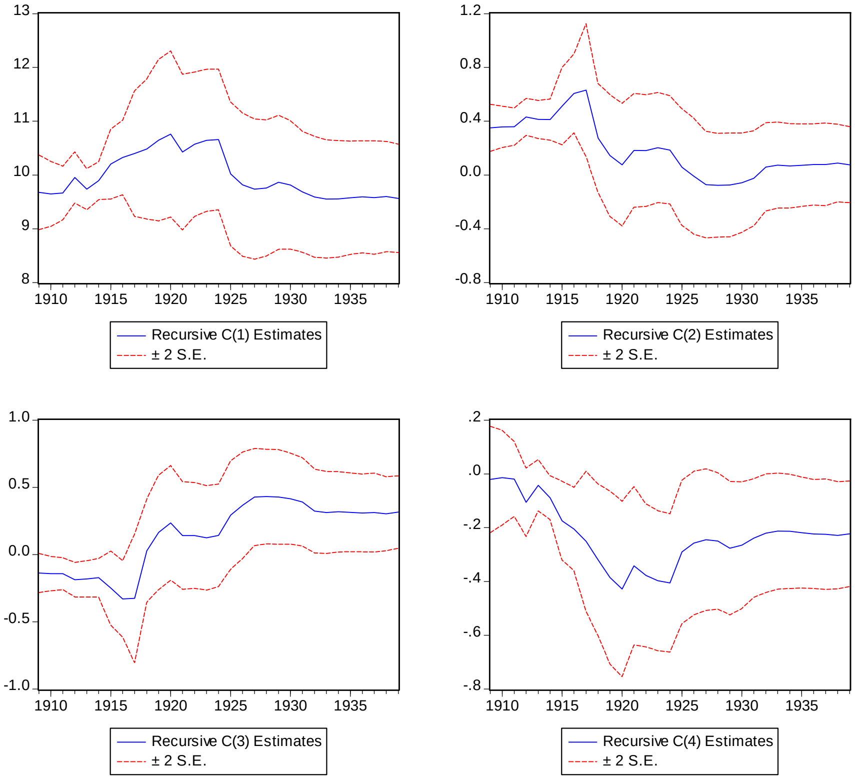

Figure 2

Malaya simulated real wages