

# Kenya's Development Path and Factor Prices 1964-2000\*

by

Arne Bigsten and Dick Durevall

Department of Economics  
School of Economics and Commercial Law  
Göteborg University

Box 640  
SE 405 30 Göteborg  
Sweden

[Arne.Bigsten@economics.gu.se](mailto:Arne.Bigsten@economics.gu.se)  
[Dick.Durevall@economics.gu.se](mailto:Dick.Durevall@economics.gu.se)

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## Abstract

This study analyses how changes in factor abundance and trade policy have affected factor prices in Kenya since 1964. First there was a period of capital deepening, but this was reversed from 1982. As a result, there has been a shift of production towards the labour-intensive informal sector. The econometric analysis shows that in the long run factor proportions determined relative factor returns; for instance, an increase in the capital-labour ratio raised the wage-capital rental ratio. We did not find any significant impact of changes in goods prices, due to among other things changes in trade policy, on factor returns.

**JEL Classification:** D13, F13, O55.

**Keywords:** Factor abundance, trade policy, globalisation, factor prices, Kenya.

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## 1. Introduction

After independence Kenya first pursued import-substitution policies and then structural adjustment policies. In this paper we investigate the distributional implications of these policies. The impact of growth and policy on income distribution is a controversial and important issue, but due to lack of data there have been few attempts to look at changes over long periods of time for Third World Countries, in particular in Africa.<sup>1</sup> We use a Heckscher-Ohlin type of model developed by Leamer (1987) as a starting point for our analysis of how changes in the factor endowments and openness have affected factor prices in Kenya over the period 1964-2000. There have been very few attempts to apply Leamer's model empirically apart from Leamer et al. (2000).

We find that there was a period of capital deepening 1964-1982, but that it was reversed 1982-2000. This resulted in a shift of production towards the labour-intensive informal sector in the latter period. The econometric analysis shows that the wage-capital rental was determined by the capita-labour ratio in the long run; increases in the capital-labour ratio raised the wage-capital rental ratio. We also find that factor proportions drove the ratio between land and capital rentals. Changes in relative goods prices seem to have played a minor role in the determination of factor returns. Hence, the influence of the international economy on factor prices has not increased significantly in spite of the steps taken to open up of the economy.

In Section 2 we present a three-factor model due to Leamer (1987). The model provides the analytical framework for the analysis of development paths, that is, an analysis of the impact of the accumulation of factors and changes in trade policy on factor returns. Section 3

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<sup>1</sup> See for example the review by Bigsten and Levin (2004).

presents our data on changes in Kenya's factor endowments, while Section 4 discusses changes in Kenyan factor markets and presents our factor price estimates. Section 5 looks at changes in Kenya's trade policy, and introduces our relative goods price proxy. Section 6 provides an econometric analysis of the links between changes in factor abundance and openness on the one hand and changes in factor prices on the other. Section 7 concludes and summarizes the paper.

## **2. Paths of Development in a 3-Factor n-Goods Model of a Small Open Economy**

For the analysis of the evolution of factor prices in Kenya we want a model that is sufficiently rich to be able represent major traits of the Kenyan economy, at the same time as it is simple enough to make it possible to get an intuitive grasp of major economic linkages. In the standard Heckscher-Ohlin model with the same number of goods and factors, capital accumulation does not have any dramatic effect on the returns to factors since in a competitive equilibrium without specialisation factor prices are independent of factor supplies. An extension of this model is the 2-factor n-goods model (Jones, 1974), where countries in different diversification cones have different factor prices. In this setting capital accumulation leads to an increasingly capital intensive mix of outputs and increasing wages. This approach is somewhat restrictive, though, since it only generates one path of development. All capital-poor countries start from the same specialisation and low wages, and over time change their pattern of specialisation in the same way. Therefore, Leamer (1987) proposed a three-factor model, which allows for a richer menu of development paths. If the three factors are labour (L), capital (K), and land (T), the impact of capital accumulation on factor rewards will also depend on the land abundance of the country.

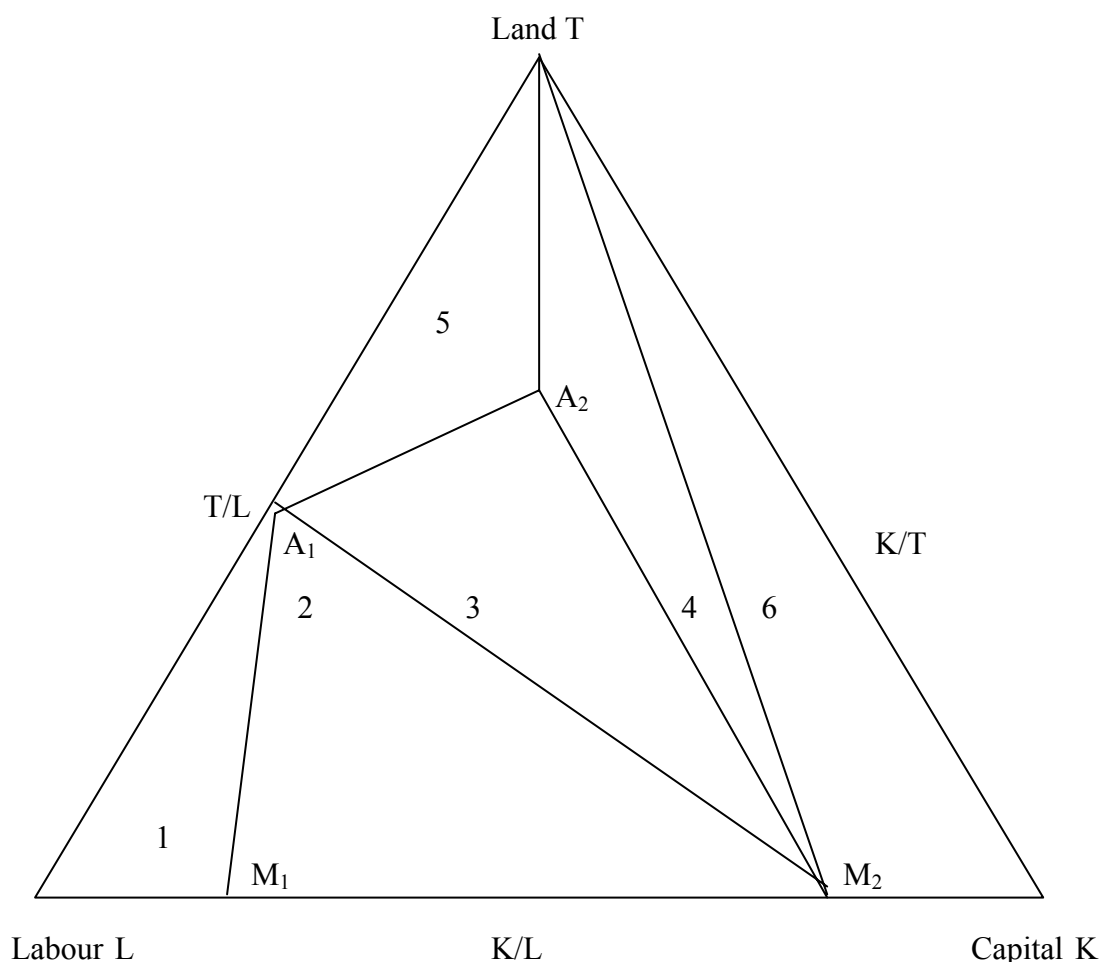
Leamer presents the 3-dimensional factor space in a two-dimensional endowment triangle. In this the ratios between the availability of two factors ( $K/L$ ,  $T/L$ , and  $K/T$ ) are measured along the three sides (see Figure 1). A certain factor endowment can be illustrated by one point within the endowment triangle, and the three factor proportions can then be read off where a ray from the opposite corner meets the sideline. If we assume that the input vectors of the different goods are fixed, we can insert points in the endowment triangle for the input vectors of the goods that may be produced in the economy. This makes it possible to identify regions of diversification. The positions of those depend on production technology used for the various goods. The assumption of fixed production technologies is strong, but the relaxation of it does not undermine the basic insights about the character of the development paths.

For the case of Kenya we may divide the economy into four sectors. In the non-agricultural part of the economy (call it manufacturing), where we assume that only capital and labour are used, we have a less capital-intensive or informal sector  $M_1$  and a more capital-intensive or formal sector  $M_2$ . Then we distinguish between two agricultural sectors, a smallholder sector  $A_1$  using only land and labour, and a modern agricultural sector  $A_2$  using all three factors. Hypothetical positions of the four input vectors are shown as in Figure 1. By linking these points we get cones of diversification. How this linking is done depends on the prices of the goods. The higher the price of a good, the more points it will tend to be connected to, and the more likely it is that it will be part of the pattern of specialisation. For example, if the price of capital-intensive manufactures is increased by a tariff, this good is more likely than before to be produced.

The pattern of production that actually materialises will be determined by the position of the Kenyan endowments vector. When endowments change, the vector position will change. As long as the endowment vector moves within one triangle, factor prices will be unchanged,

although the proportion of the outputs produced will change. When the vector reaches a triangle border, the pattern of specialisation will change as will the factor price structure.

**Figure 1: Endowment Triangle with Alternative Triangles of Specialisation**



The model outlined here allows for the production of a maximum of three goods, the mix of which will depend on the factor endowments of the economy. The simplifying assumptions made by Leamer to make it possible to draw his neat diagram means that the results tend to become too sharp. In reality there are substitution possibilities in production, which mean that the pattern of adjustment will be more complex, and the pattern of specialisation less extreme. Moreover, the number of goods or sectors is larger than four, which means that the endowment vector will cross borders leading to changes in factor prices more often than what our figure suggests. Still, the model illustrates that both production structures and the pattern

of factor prices will change in a systematic fashion as the endowment vector and the goods price structure change. When capital is accumulated the endowment point moves towards the K-corner, and capital-intensive goods will increase their share in production. An increase in labour supply drives the economy towards the L-corner and a more labour-intensive product mix. The amount of arable land (which is going to be our land variable) has changed very little in Kenya, which means that the endowment vector shifts downwards in the diagram as labour and capital increase. The main question with regard to factor proportions is then whether labour or capital will have the fastest growth. When capital grows faster than labour the vector will drift towards the K-corner, while we will approach the L-corner when labour grows faster than capital.

There are four major determinants of factor prices. First, changes in factor endowments may affect factor returns. We have already noted that when the economy moves from one triangle of specialisation to another the factor returns change. If, for example, we move across triangles from left to right towards the K-corner in the bottom part of the diagram, we will tend to move towards higher wages and lower capital rentals, although the details of factor intensities and goods prices need to be known to determine the factor price changes with certainty. Returns to land would tend to be low in the upper part of the overall endowment triangle, while a downward drift of a country's endowment point would tend to lead to increased land rents.

Secondly, changes in the character of the relationship with the world market may affect factor rewards. The structure of factor prices could be affected by the integration of the domestic factor markets with the international factor markets. This could possibly be the case for the capital market. Wood (1994) argues that global capital markets throughout the world are so integrated that capital abundance is no longer a basis for comparative advantage. We do not

think that this is the case for the period we study, although there certainly has been some movement towards closer integration in the latter part of the period. We assume that the impacts from the international economy come via the goods prices.

Goods prices can change autonomously or the government can intervene with trade policies to change the domestic price structure. The way the implied price changes on the goods affects factor returns may be referred to as Stolper-Samuelson effects. The impact of changes in the prices of goods on factor returns is vastly more complex in the  $3 \times n$  world than in the  $2 \times 2$  world. Still, some regularities persist. In our case returns to capital cannot fall when prices increase in capital-intensive agriculture or capital intensive manufacturing, or when prices on labour intensive agricultural goods fall. The impact of a price increase in labour intensive manufactures is ambiguous and will depend on the zone of diversification. When we are in a zone where the capital intensive manufactured goods is also produced, there will be a negative effect on capital returns. With regard to land the picture is more straightforward. Landowners will benefit from higher prices on agricultural goods and lose from higher prices of manufactured goods. In our set-up the effects of a tariff depends on zone of diversification. If we were in sector 2, for example, a tariff on the capital intensive manufacturing good would reduce wages, while a price increase or a tariff on the labour intensive manufacturing good  $M_1$  would lead to higher wages.

Thirdly, factor rewards may be affected by technical progress. The effects depend on the character of the technical progress, that is, the extent to which it saves or uses labour, land, and capital.

Fourthly, Leamer's model as outlined here does not allow for factor market distortions, which also could influence factor prices. We discuss distortions in some detail in Section 4.

We may thus distinguish four different types of influences on factor rewards. First, there is the effect on factor returns due to changes in the factor endowment of the economy. Second, there are the effects that come from changes in goods prices that are either due to changes in trade policy, exogenous price changes in the world market for goods, or domestic shocks such as droughts. Thirdly, we may have effects from technical progress, and finally distortions.

### **3. Factor Endowments**

Our model predicts that factor abundance is a crucial determinant of the pattern of specialisation and factor prices, although market distortions may make factor prices diverge from the equilibrium values. The Kenyan economy started out in pre-colonial times at the left-side edge of the triangle producing only labour-intensive agricultural goods without any capital input plus some simple handicraft or manufactured goods. The settlers then introduced capital-intensive agriculture. As the economy accumulated more capital and labour supply increased, the endowment point moved down and in the direction of the capital corner, and the economy began to produce the capital intensive manufacturing good. This would have happened without policy interventions, as long as the changes of the factor composition move the endowment point of economy.

We have factor estimates for the period from 1964 onwards.<sup>2</sup> Our capital stock estimates are taken from Ryan (2002), while labour and land data are from World Development Indicators (2002). Using these data we have computed the endowment ratios shown in Figure 2. The

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<sup>2</sup> Estimates by Nehru and Dhareshwar (1993) go further back and show that there was an increase in the K/L ratio throughout the 1950s, followed by a drop during the transfer to independence in the first half of the 1960s.



K/L ratio is very important for the pattern of specialisation and the factor price outcomes. We see that the ratio increased until 1982, but that the trend then was reversed. Figure 3 shows the evolution the factor proportions in the triangle. There was a drift towards the K-corner of the triangle up to 1982 followed by a slight turn towards the L-corner for the rest of the period. As expected the capital-land ratio grows and the land-labour ratio declines continuously.

The pattern of factor growth up to 1982 should according to our model have led to increasing land rents, and tended to increase wages and reduce capital rentals. The post 1982-pattern should have generated higher capital rentals and lower wages, while land rents should have continued to increase provided there was a move between triangles. Leamer discusses how countries climb the ladder of development, and by this he basically means an increase in capital relative to labour (and land). For an economy that starts from a labour-abundant point this would generally lead to higher wages and lower capital rentals and a shift in the pattern of specialisation towards a more capital-intensive mix of goods. In the Kenyan case there has not been a continuous climb up on the ladder. Moreover, if the economy remains within the same “triangle of diversification” (and goods prices and technology remain unchanged) the change in factor endowments would not change factor prices; there would only be a rebalancing of the sectors of production. The rapid expansion of the informal sector in Kenya is certainly consistent with such a story. The development path with an increasing capital-labour ratio that was the essence of Leamer’s analysis was reversed. This is a serious indication of the failure of Kenya to move towards sustainable growth.

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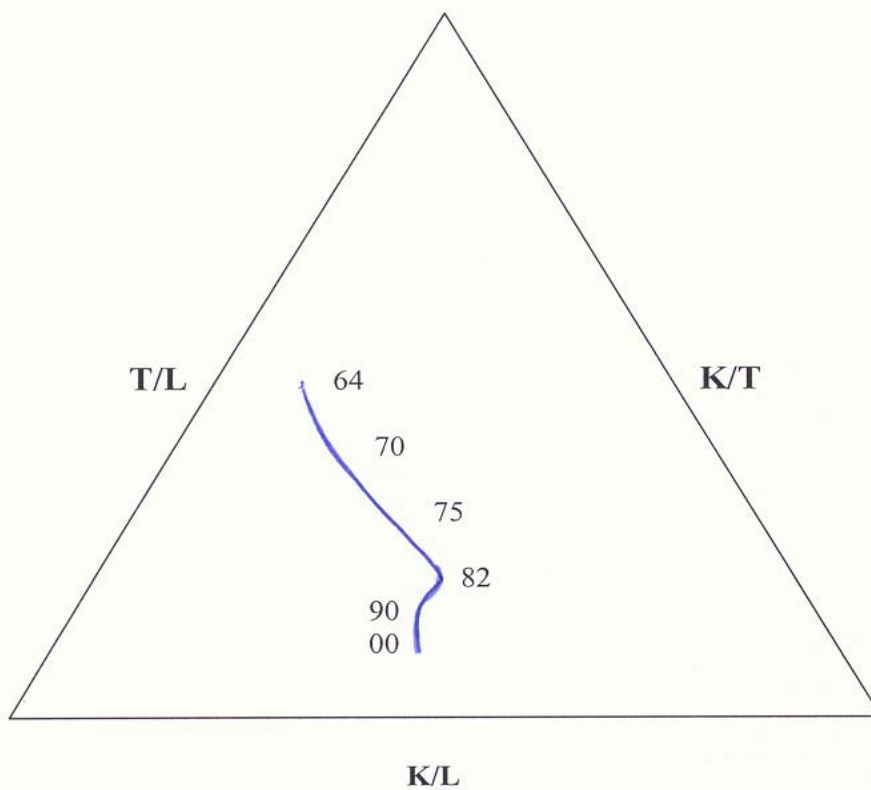
The capital-labour ratio using capital stock estimates from in Ryan (2002) peaks in 1982, while the one using capital-stock estimates from Nehru and Dhareshwar (1993) peaks in 1980.

**Figure 2: Relative Factor Endowments in Kenya 1950 – 2000.**



Note:  $K/L = \text{---}$ ,  $T/L = \text{- - -}$ ,  $K/T = \text{.....}$ . The variables have been mean and variance adjusted to increase the readability of the graph.

**Figure 3: Changes in Factor Abundance in Kenya 1950-2000**



## 4. Factor Markets

During the colonial period the settlers chose to protect their privileges by administrative means. The best land was reserved for them, and pass laws meant that Africans could only work as contract or resident labour in the White Highlands (Bigsten, 1984). By restricting the scope of activities allowed on the African farms and through hut and poll taxes the supply price of African labour was kept down. These interventions had profound impacts on income distribution (Bigsten, 1986).

The urban-rural gap started to increase rapidly in the mid-1950s, largely driven by substantial increases in minimum wages,<sup>3</sup> and this process continued for a period after Independence in 1963.<sup>4</sup> There was at the same time a very high rate of population growth, which resulted in a rapid increase in the labour force. Most of this was initially absorbed by the smallholder sector. During the 1970s private real wages fell again as labour supply growth continued to outstrip formal sector job creation, and the use of minimum wages to push up real formal sector wages became increasingly ineffective. Collier and Lal (1986) characterise the period from 1968 onwards as one of competition as far as the labour market is concerned.

The most dramatic shift in the pattern of labour use in the last decades has been the rapid expansion of employment in the informal sector outside agriculture. Unfortunately there is a paucity of adequate historical data on employment but according to the labour force survey from 1998/99 smallholder agriculture still dominates with 51.6 % of the employed labour followed by the informal sector with 31.9 % and the formal sector with 16.5% (Economic Survey 2003, Ch. 16). Table 1 shows employment outside traditional smallholder agriculture

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<sup>3</sup> According to Collier and Lal (1986, p.64) half of the urban-rural wage gap was due to differences in skill composition.

<sup>4</sup> This (temporary) pattern of development in Kenya provided the inspiration for Harris and Todaro (1970), to formulate their famous model of migration.

in modern and informal non-agricultural establishments. Modern sector employment has hardly grown at all in recent years, which means that its share has been shrinking rapidly.

**Table 1: The formal-informal structure of employment outside smallholder agriculture 1998 and 2002 ('000)**

	1998	2002	Annual growth rate (%)
Modern establishments*	1743.2	1763.2	0.5
Urban informal sector	1146.6	1739.1	11.0
Rural informal sector	2206.9	3347.3	11.0
Total employment outside smallholder agriculture	5097.6	6851.6	7.7

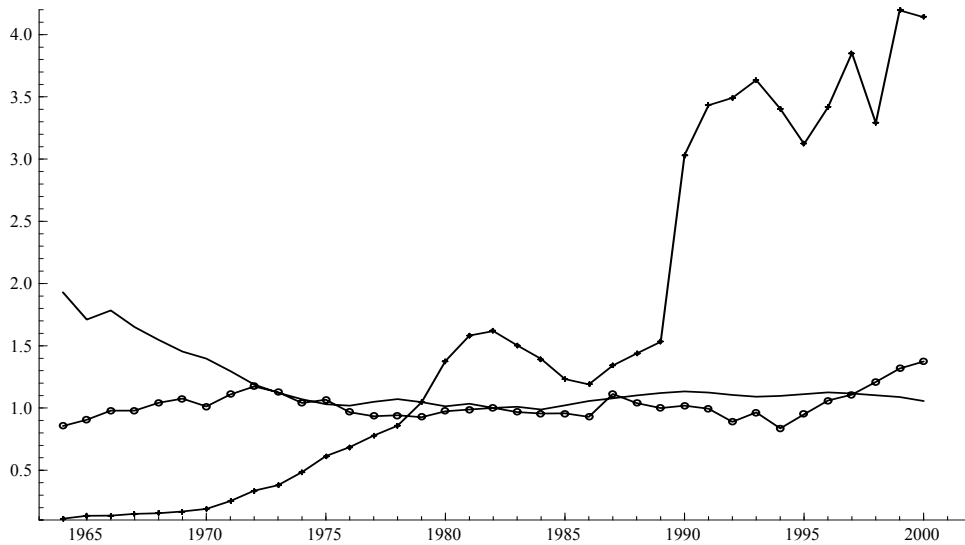
\*Wage employment including self-employed and unpaid family members.

Source: Economic Survey 2003, p. 57.

The evolution of real wages is depicted in Figure 4. It is measured as earnings, including allowances, of employees in manufacturing divided by the GDP deflator. Earnings in commercial farming should constitute a better measure, since one would assume that they have been less affected by changes in the skill composition of the labour force. However, agricultural wages may have been more affected by minimum wages. The development of manufacturing wages closely follows the development of wages in the whole of the private sector net of agriculture.

As shown in Figure 4, real returns to labour increased by about 25 percent from the mid-1960 until the beginning of the 1970. This was followed by a slow decline until 1995 when real wages started to increase rapidly, a process that continued for the rest of the decade; the growth in real earnings between 1994 and 2000 was 65 percent. Real earnings in commercial farming (not reported) increased even faster, although from a lower level. They also started their surge ten years earlier than earnings in manufacturing.

**Figure 4. Real Returns to Factors in Kenya 1964 – 2000.**



Note: Real return to capital = —, real return to labour = -●-●-, real return to land = -+--+-. The GDP deflator was used to calculate the real values of earnings and land prices. The base year is 1982 = 1. The series for land prices is the moving average of the actual series.

The land market interventions in favour of the settler community were eliminated at independence in 1963. Still the land market in Kenya has been fairly inflexible, and it has remained difficult for farmers to buy and sell land in some areas. However, the land that is actually traded has been sold at freely negotiated prices. So even if those are not full equilibrium prices, development over time should give a reasonable reflection of how the scarcity value of land has changed. We have collected prices from agricultural land sales in two districts and constructed indexes that we use as our price series for land rentals.<sup>5</sup> Land prices are not an ideal proxy for the land rent, but they would reflect the return on land in a perfect market. Land prices have been used by, for instance, Williamson (2002) and Williamson and O'Rourke (2002) as proxies for return to land.

Figure 4 shows a smoothed version of real land prices in Kiambu. It is evident that real land prices, and return to land, have risen sharply during the last 35 years. The other series we

collected was for Kakamega (not reported). It shows a similar growth pattern, although from a much lower level. Over the whole period real land prices increased fifteen fold.

The third factor return depicted in Figure 4 is the real return to capital. During most of the period covered in our subsequent analysis there were extensive interventions in the capital market with controlled interest rates and administrative interventions in credit allocation (Bevan et al, 1990; Isaksson and Wihlborg, 2001). Financial liberalisation was part of the structural adjustment efforts started in the early 1980s, but the process was gradual, and it is only recently that interest rates have approached equilibrium rates. Therefore we have not tried to use interest rates to measure capital rentals. Instead we use a measure of return to capital based on the approach developed by Sarel (1997) and described in Appendix 2. We used the Kenyan national accounts for the calculations but the technical capital shares for the individual sectors (at the one-digit GDP level) are based on averages from a number of countries. An advantage of this approach, compared to using factor incomes from the Kenyan national accounts, is that we correct for the classification of incomes of self employed as capital income, something that cannot be done with Kenyan data alone. We obtain capital shares that vary between 0.245 and 0.280 over the period 1964 and 2000. Our values are in line with the international averages and, for instance, close to those obtained for the Ivory Coast, where data on compensation for self-employment are available (see Gollin, 2002).

As Figure 4 shows, return to capital declined continuously from 1964 to the mid 1970s; in total a reduction of 50%. After 1975 there were only mild fluctuations in the return to capital, with an increase from 1985 to 1990, a period of stability, and a small decline from 1996.

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<sup>5</sup> See Appendix 2 for a description of the data on land prices.

Our model predicts that for the period when capital grew faster than labour we would see higher wages and lower capital rentals. For the recent period, when labour grew faster than capital, we would expect lower wages and higher capital rentals. Returns to land would tend to be low in the upper part of the triangle, but since we see a downward drift of Kenya's endowment point we would expect land rents to increase. In Section 6 we will undertake an econometric analysis to investigate the extent to which these predictions are borne out.

## **5. Trade Policy and Goods Markets**

From independence in 1963 until the early 1980s Kenya pursued import substitution policy, which implied increasing levels of protection. By 1980 the macroeconomic imbalances had become so severe, that the country had to embark on a structural adjustment programme, which implied a gradual liberalisation of international trade. Since independence we can thus distinguish between a period of closing up during the 1960s and 1970s, and a period of a gradual opening up of the economy during the 1980s and 1990s.

The policy of import-substitution did push up the relative price of formal manufacturing goods  $M_2$ , which made it more likely that it was part of the pattern of specialisation, and it also had an impact on factor rewards separate from the factor endowment effect. The theory predicts that Kenyan trade policy interventions in the 1960s and 1970s tended to increase capital rentals and reduce wages, while we would expect the reverse effects in the recent period. Changes in world market prices would also have an effect. One of the major external events during the period was the coffee boom in the 1970s, which temporarily pushed up the returns to labour and land.

In general changes of prices of goods in the domestic market may either be due to changes in the international goods market or to changes in domestic policies or to exogenous shocks. What we observe is the aggregate outcome of all the influences, while it is hard to separate out the effects of the various influences.

To give a good description of changes in the level of protection in Kenya we would need consistent time series on tariffs and detailed information about quantitative restrictions.<sup>6</sup>

What is available for part of the period are estimates of tariffs collected as shares of imports. These estimates were 13-14 % in the mid-70s, peaking at close to 23 % in 1982, before declining to the 13-14 % range again in the late 1990s (World Development Indicators, 2003). However, the actual tariff rates on the books were considerably higher than what this measure shows, but some importers were able to get their import taxes waived. There were also extensive quantitative restrictions on imports, which had a large effect on domestic prices. We have no means to quantify these effects.

Sachs and Warner (1995) constructed an openness indicator based on five variables, namely tariff level, extent of non-tariff barriers, black market premium, presence of state monopolies in exports of major crops, and whether countries had a socialist economic system. By this approach they concluded that Kenya was opened up in 1993. A recent paper by Wacziarg and Welch (2003) update their data set and redo the exercise, and also they conclude that Kenya opened up in 1993. It is of course not straightforward to say when a gradual liberalization process has reached the point where one can say that the country changes from closed to open, but it is clearly fair to say that trade interventions remained extensive into the 1990s.

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<sup>6</sup> Export taxes have not been very important in the case of Kenya.

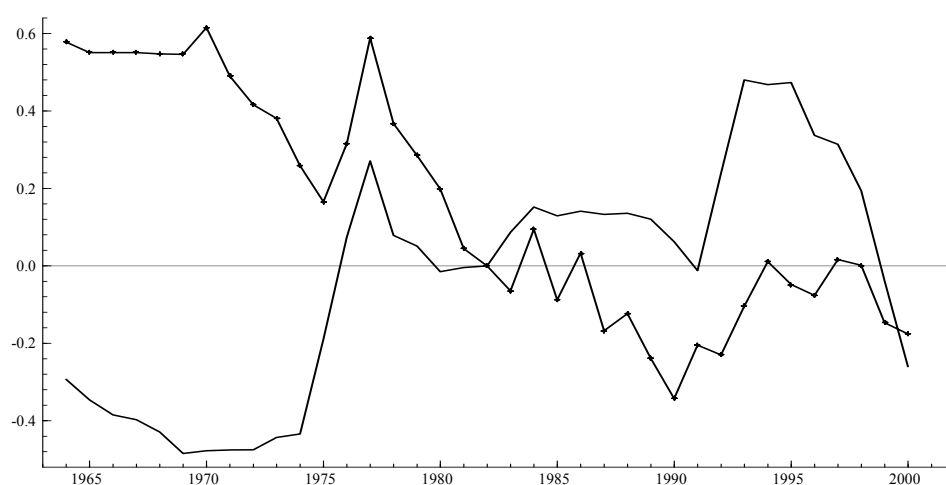


Given the above complications we do not attempt to use the collection ratio or the Sachs-Warner dummy as a proxy variable for the degree of protection. Instead we use the ratio between prices of agricultural and manufacturing goods (the sectoral deflators) measured in logs, denoted *PAPM*, as our indicator of trade policy. In the Kenyan context, an increase in *PAPM* may, *ceteris paribus*, be interpreted as an indication of increased integration in the world economy, and vice versa. This is based on the fact that import substitution policies, which have been a dominant obstacle to international integration, aimed at increasing prices of manufactured goods relative to agricultural goods.

Figure 5 shows the evolution of *PAPM* and the log of terms of trade (*TOT*). Until the early 1970s there is a declining trend in *PAPM*, which is what one would expect when protection is increased. The small increase 1973-74 was largely due to the drought in 1973/74 that pushed up agricultural prices. Then in 1975-77 we have the large effect of the coffee-boom pushing up agricultural prices dramatically, followed by a correction. During the 1980s *PAPM* changes little, in spite of a strong drop in terms of trade. This could indicate that its negative effect on *PAPM* was counteracted by liberalisation measures in a series of structural adjustment programmes pushing up relative agricultural prices. The pattern of the 1980s may also have been affected by the introduction of purchasing-power-parity based pricing of agricultural goods in 1980s (Mwega and Ndung'u, 2002). In the early 1990s there was again a drought increasing *PAPM*, followed by a correction. The later part of the 1990s is a period of falling *PAPM*. There were several exogenous shocks affecting this development during this period such as falling coffee prices, and a decline in terms of trade fell by 16% between 1998 and 2000 (Economic Survey 2003, p. 108). Liberalisation measures were not enough to compensate for this price effect.

The recent behaviour of *PAPM* seems to contradict the claim that Kenya is an open economy from about 1993; it declines during the latter half of the 1990s and in 2000 the *PAPM* is at the same level as in the mid-1970s.<sup>7</sup> As this brief review indicates, the Kenyan relative goods prices have been strongly affected by non-policy factors. Still, changes in good prices should in any case have an effect on factor prices. We therefore include our relative price variable in the econometric analysis of the determinants of factor prices in the next section.

**Figure 5: Log of relative goods prices (*PAPM*) and Terms of Trade (*TOT*) 1964-2000**



Note: *PAPM* = —, *TOT* = —+—+—

## 6. Regression Analysis

In this section we look at the determinants of relative factor and goods prices in Kenya. Since we are interested in their long-run determinants, and several of the variables are non-stationary, we first tested for cointegration. Then we estimated error correction models (ECMs) to evaluate the adjustment process towards the long-run equilibrium, and as a further

<sup>7</sup> Another indicator of openness or, more correctly, deviation from comparative advantage, has been proposed by Lin (2003) and Lin and Liu (2004). There are two versions: the ratios between 1) the capital-labour ratio in manufacturing and the capital-labour ratio of the entire economy, and 2) the ratio between the share of manufacturing value added in GDP and the ratio between labour in manufacturing and the labour force. We calculated various versions of the indicators, using different measures of labour and capital. Most of them indicated an increase in openness during the end of the 1970s and the beginning of the 1980s, little change until the beginning or mid-90s, and then a reduction in openness. The indicators of Lin are broadly consistent with our measure of openness, *PAPM*.

check on the cointegration results. All through the analysis an emphasis is put on obtaining models with reasonably stable parameters, and testing for structural breaks.

The specification of the long-run model is,

$$f_j = c_j + \beta_{1j}PAPM + \beta_{j2}KLAN + \beta_{j3}KL \quad (1)$$

where  $f_j$  is the log of the wage-capital rental ratio (*WR*) or land-capital rental ratio (*LRR*)<sup>8</sup> *PAPM* is the log of the price ratio of agricultural goods and manufactured goods, *KL*, and *KLAN* are the log of capital-labour and capital-land ratios.<sup>9</sup> In principle, the tests for long-run relations should be done in a system, but all variables do not matter for each relative factor price, and we have few observations. Hence, we estimated single-equation models.

The ECM is specified as,

$$\Delta f_{j,t} = c_j + \Phi_j D_{j,t} + \sum_{i=1}^n \pi_{j1,i} \Delta f_{t-i} + \sum_{i=0}^n \pi_{j2,i} \Delta x_{t-i} + \alpha_j [f_j + \beta_j x]_{t-1} \quad (2)$$

where  $\Delta$  is the first difference operator,  $c_j$  is the constant,  $D_j$  is a vector of deterministic (dummy) variables, and  $x$  is a vector of exogenous variables.

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<sup>8</sup> We did not analyze the wage-land rental ratio since it is a linear combination of the other two ratios.

<sup>9</sup> Since changes in productivity may affect factor prices we also calculated total factor productivity (TFP) growth in Kenya, using two different approaches. There was hardly any TFP growth over the period 1964 – 2000. Our results are thus consistent with the detailed study by Gerdin (1997), who found that there was no TFP growth over the period 1964-1994. Although factor-specific productivity growth is likely to have a stronger effect on factor price ratios than TFP growth, our findings indicate that productivity growth has been of second order importance; we could not find that TFP growth had any explanatory power in the regression analysis (results not reported). To measure TFP growth, we first estimated a log-linear production function with capital and labour. Tests for cointegration based on both OLS and Fully Modified OLS indicated that there was no growth in TFP during the period 1964 – 2000. Moreover, they supported the assumption of constant returns to scale. The estimate of the elasticity for capital ranged from 0.23 to 0.37, depending on the specification. Then, based on the assumption of constant returns to scale Cobb-Douglas production technology, TFP was calculated using the elasticities (0.5, 0.5), (0.3,0.6) (0.2, 0.8) for capital and labour. In no case was the growth rate more than 1 percent over the period 1964 – 2000.

## 6.1 Data Description

In this subsection we plot the data to obtain information about potential long-run relations and the stochastic properties of the variables. Figure 6 depicts the log of the wage-capital rental ratio ( $WR$ ) and the capital-labour ratio ( $KL$ ). The wage series was deflated with the GDP deflator.  $WR$  and  $KL$  evolve in a similar way until the mid-1990s, when  $WR$  starts to increase while  $KL$  stays flat. As noted above, Kenya has been classified as an open economy from about 1993. In addition, there seems to be a change in relationship in the middle of the 1970s, when there is a decline in  $WR$  and an increase in  $KL$ . Figure 6 also shows that it is not straightforward to describe  $WR$  and  $KL$  as first order difference stationary series, that is, integrated of order one (denoted  $I(1)$ ). The stochastic properties seem to change over the sample, maybe being  $I(2)$  during the first 10 to 15 years, and then  $I(1)$  or stationary during the rest of the period. Nevertheless, both series appear to have the same stochastic properties.

The land-capital rental ( $LRR$ ) and capital-land ( $KLAN$ ) ratios are plotted in Figure 7. They follow each other closely, although  $LRR$  is much more volatile than  $KLAN$ . It seems obvious that they are cointegrated and thus follow a common stochastic trend.

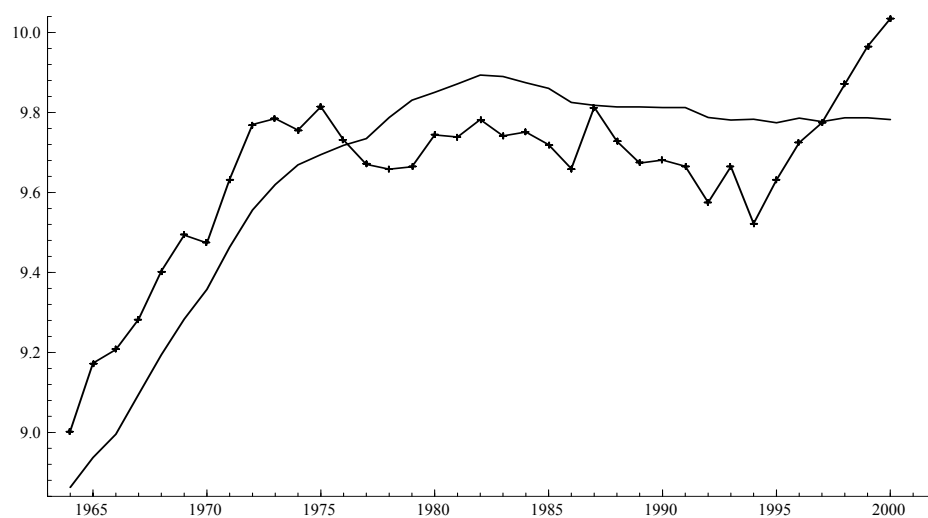
Finally we have the relative price between agricultural and manufacturing prices ( $PAPM$ ) and terms of trade ( $TOT$ ), plotted in Figure 5 in Section 5 above. With free trade, one would expect a positive relation between the log-levels of two series, but as the figure shows, if there is any relation, it is negative.

## 6.2 Data Analysis

We first used the Fully Modified OLS (FMOLS) estimator developed by Phillips (1988) and Phillips and Hansen (1990) to test for cointegration. Compared to the commonly used Engle and Granger cointegration test, FMOLS has the advantage of not requiring the regressors to

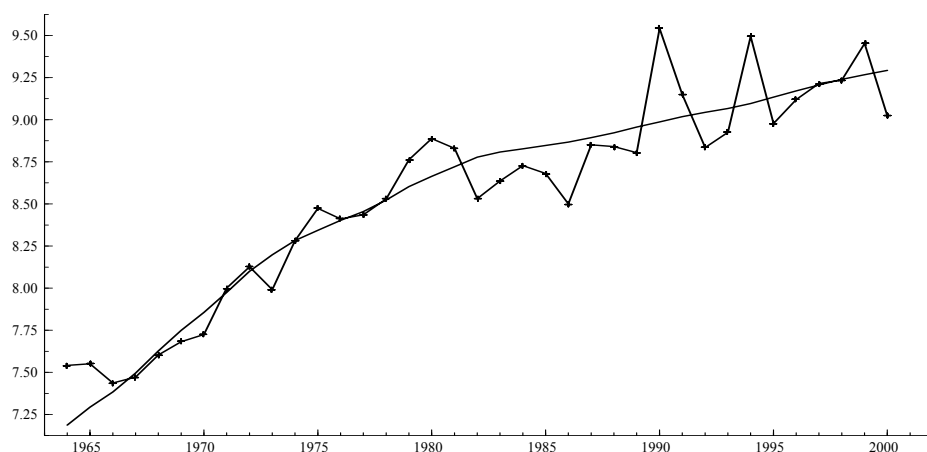
be weakly exogenous, and compared to the Johansen (1988) approach, it has the advantage, for our limited set of data, that it does not require a well-specified full system. To implement the FMOLS, a RATS procedure was used that automatically selects the bandwidth. Based on the results from the cointegration analysis we estimated single-equation error correction models. By estimating separate ECMs we could easily evaluate the stability of each parameter and gain insight into the role of individual variables. The ECMs were also used to test for cointegration using an alternative approach, denoted the ECM procedure (see Ericsson and Mackinnon, 2002). The ECM procedure requires weak exogeneity, which is not the case for FMOLS, but it is robust to various assumptions of the dynamics, which FMOLS is not. We used a program supplied by Ericsson and Mackinnon (2002) to simulate  $p$ -values for the ECM procedure.

**Figure 6: Log of capital-labour ratio and wage-capital rental ratio 1964-2000**



Note:  $KL = \text{—}$ ,  $WR = \text{—}+\text{—}+\text{—}$   $WR$  has been mean and variance adjusted to increase the readability of the graph.

**Figure 7: Log of capital-land (*KLAN*) ratio and land-capital rental (*LRR*) 1964-2000**



Note: *KLAN* = —, *LRR* = —+—+—. *LRR* has been mean and variance adjusted to increase the readability of the graph.

Table 2 reports the FMOLS cointegration tests statistics for the wage-capital rental ratio. We started by regressing *WR* on *KL* and a constant. Column 1 shows that the t-statistic is insignificant, 1.55. Although the distribution of the t-statistic may be non-standard because of the stochastic properties of *WR* and *KL*, the lack of cointegration could also be due to the structural breaks described in sub-section 6.1. To check for this, recursive estimation was used to calculate three Chow tests, 1-Step break-point and forecast Chow tests. Figure 8a summarizes the results obtained by showing the 1-Step Chow tests, scaled by their 5% significance level. Although the asymptotic critical values for Chow tests with unknown breakdate are larger than for standard Chow tests with known breakdate (see Hansen, 2001), we used the standard 5% level as a rough guide since we have few observations. As indicated by Figure 8a, there are two periods when the relation breaks down, during the later half of the 1970s and in the middle of the 1990s.

**Table 2: Cointegration Tests – Wage/Capital Rental Ratio:  
Fully Modified OLS, 1964-2000**

	1	2	3
Dependent Var.	<i>WR</i>	<i>WR</i>	<i>WR</i>
<i>KL</i>	0.44 (1.55)	1.27 (2.06)	0.92 (11.68)
<i>PAPM</i>		-1.09 (2.03)	
<i>DUMS77</i>			-0.23 (5.18)
<i>DUMT94</i>			0.04 (4.67)
<i>Constant</i>	-4.35 (1.60)	-12.46 (2.08)	-8.91 (12.03)

Note: All ratios are in logs. *DUMT94* is trend a dummy for the period 1994 - 2000 and *DUMS77* is a step dummy for 1977-200. Absolute values of t-statistics in parenthesis.

In column 2 the relative price between agricultural and manufactured goods (*PAPM*) is added to the model. It improves the regression so both *KL* and *PAPM* are significant, although the t-values are only 2. The coefficient for *KL* is positive, as expected, while the one for *PAPM* is negative, which is not expected. Nevertheless, the structural breaks in the model are still present, as evident from the Chow tests reported in Figure 8b.

Next we introduced dummy variables for the two structural breaks. Inspection of Figure 6 with *WR* and *KL* indicates that there is a shift in the intercept during the latter half of the 1970s, and an upward trend during the 1990s. The former is likely to be related to structural or policy changes that took place during the end of the 1970s as a result of the coffee boom and the oil price shocks (see Bevan et al, 1990; Mwega and Ndung'u 2002) and the latter one is probably due to market liberalization, which led to rapid wage increases (see IMF, 2003). The dummy for the shift in the intercept is denoted *DUMS77*. It has zeros up until 1976 and then ones. The trend dummy is denoted *DUMT95*, and has zeros until 1994 and then 1, 2, 3, and so on. Column 3 shows that both dummy variables are highly significant and that their inclusion raises the t-value of *KL* to 11.7, and Figure 8c show that they remove the breaks. As shown by the negative value of the step dummy (-0.23), there is a downward shift around 1977 in the *WR – KL* relation. This can be interpreted as a relative improvement for capital

owners relative to wage earners. The second shift in the relation between  $WR$  and  $KL$  is when wages start to grow 4% faster than the return to capital. To conclude, the FMOLS analysis found two cointegrating vectors, one made up of  $WR$  and  $KL$  and the dummy variables and one made up of  $WR$ ,  $KL$ , and  $PAPM$ , though the latter appear to suffer from structural breaks. The two vectors are plotted in Figure 9 under the names  $EC_{WR}$  and  $EC_{PAPM}$ .

Table 3 reports the results from the analysis of the land–capital rental ratio. First we ran a regression with  $KLAN$  and a constant; the t-value for  $KLAN$  was 15, indicating cointegration (see column 1). Then we looked at the stability. The 1-step Chow tests, reported in Figure 10a, are significant in two cases. As evident from Figure 7, these are likely to be outliers, not structural breaks. The outliers would be due to exceptionally high land prices in 1990 and 1994, which possibly are measurement errors because they are not present in the other price series we collected. Including impulse dummies for 1990 and 1994 gives the result reported in column 2; they only have a minor effect on the coefficient and t-value of  $KLAN$ , but make the Chow test statistics insignificant (see Figure 10b). Finally, we included  $PAPM$  but it was insignificant. We conclude that there is one cointegrating vector formed by  $LRR$  and  $KLAN$ . It is graphed in Figure 9, called  $EC_{LRR}$ .

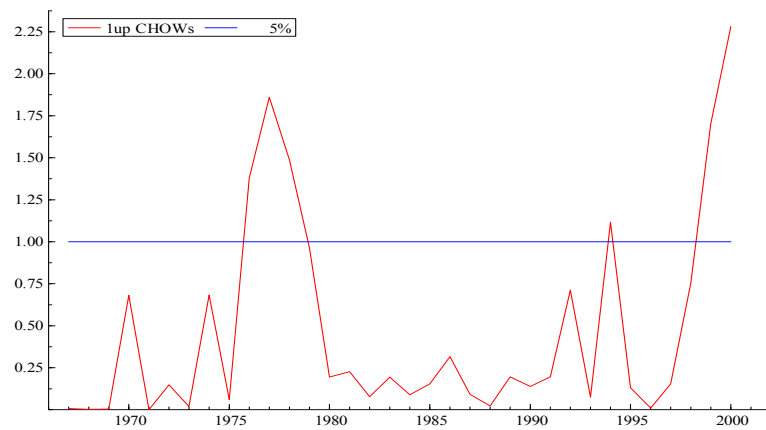
**Table 3: Cointegration Tests for Land-Capital Rental Ratio:  
Fully Modified OLS, 1964-2000**

	1	2	3
<i>Dependent Var.</i>	<i>LRR</i>	<i>LRR</i>	<i>LRR</i>
<i>KLAN</i>	1.82 (14.70)	1.74 (15.75)	1.67 (8.88)
<i>PAPM</i>			0.37 (1.03)
<i>DUMI90</i>		1.03 (2.74)	
<i>DUMI94</i>		0.83 (2.19)	
<i>Constant</i>	-15.59 (14.59)	-14.94 (15.73)	-14.31 (8.77)

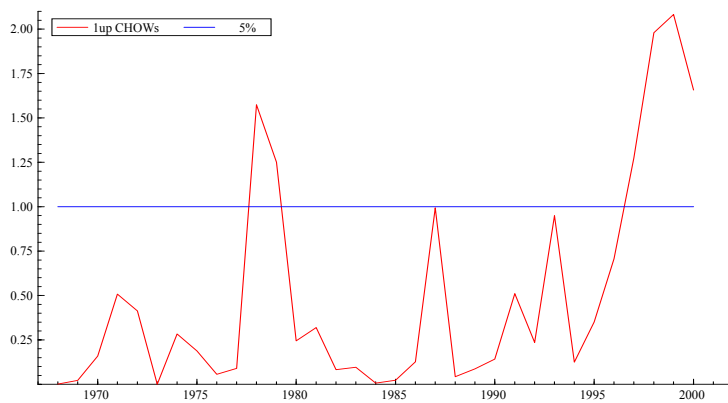
Note: All variables are in logs. DUMI90 and DUMI94 are impulse dummy variables for 1990 and 1994, respectively. Absolute values of t-statistics in parenthesis.



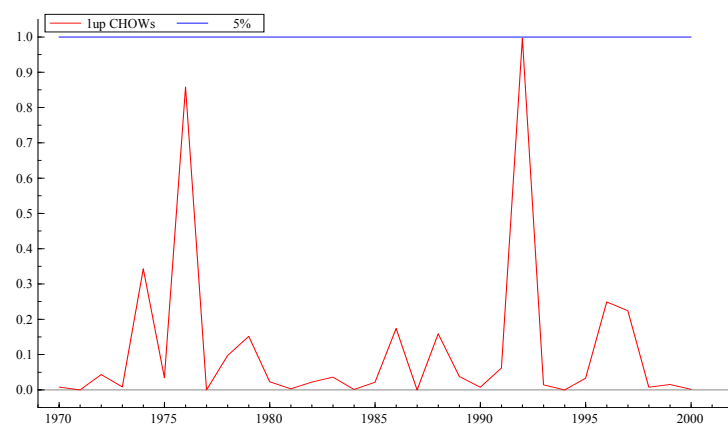
**Figure 8a: 1-Step Chow Test on  $WR = -4.4 + 0.44KL$**



**Figure 8b: 1-Step Chow Test on  $WR = -12.5 + 1.3KL - 1.1PAPM$**

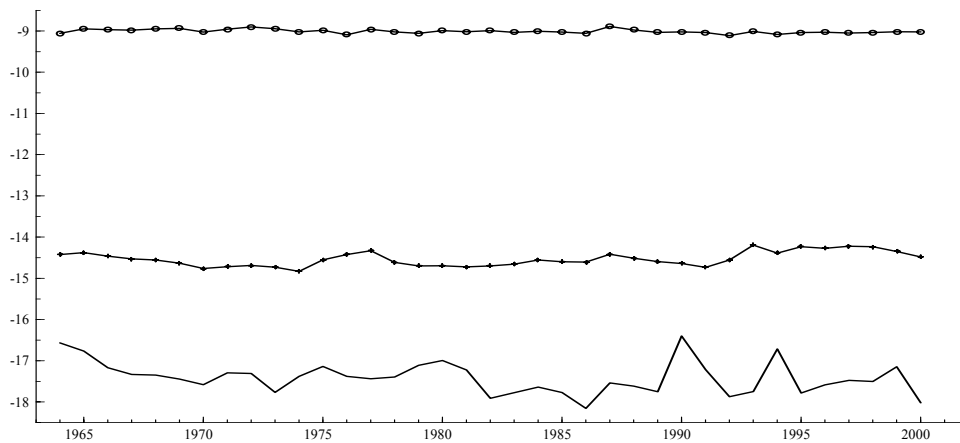


**Figure 8c: 1-Step Chow Test on  $WR = -8.9 + 0.9KL - 0.2DUMS77 + 0.04DUMT94$**



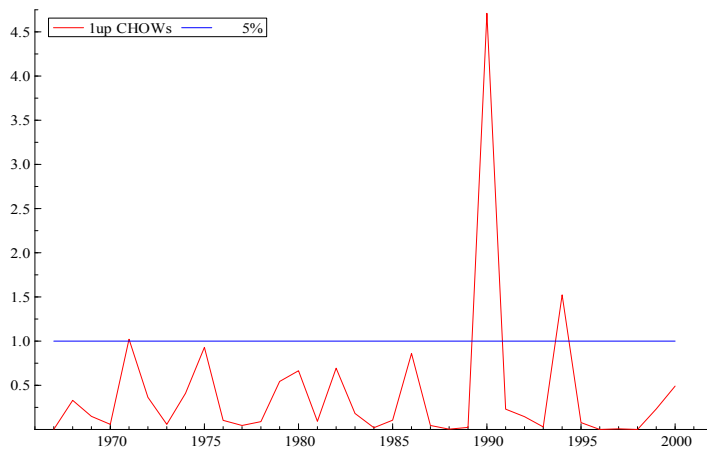
Note: The Chow statistics have been scaled with their 5% critical values. The straight line at unity shows the 5% critical level.

**Figure 9: Cointegrating vectors**

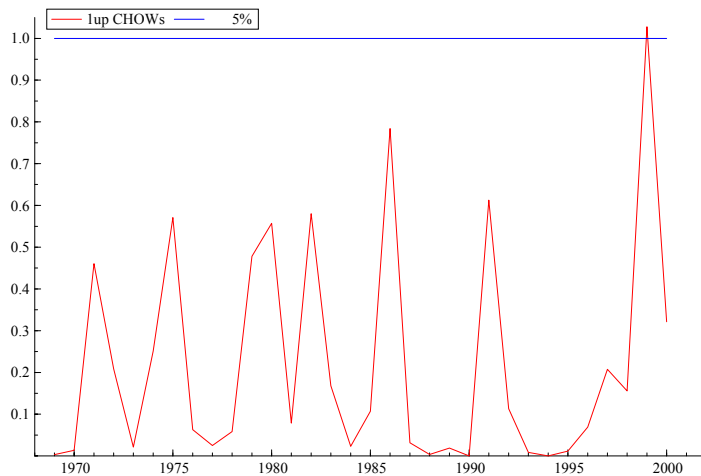


Note:  $EC_{LRR} = \text{—}$ ,  $EC_{WR} = \text{-}\cdot\text{-}\cdot\text{-}$ ,  $EC_{PAPM} = \text{-}\text{+}\text{-}\text{+}\text{-}$ .

**Figure 10a: 1-Step Chow Test on  $LRR = -15.6 + 1.8KLAN$**



**Figure 10b: 1-Step Chow Test on  $LRR = -14.9 + 1.7KLAN + 1.0DUMI90 + 0.8DUMI94$**



Note: The Chow statistics have been scaled with their 5% critical values. The straight line at unity shows the 5% critical level.

### 6.3 Modelling the Dynamics of Relative Factor Prices

To test the extent to which relative factor prices are driven by resource endowments and relative goods prices we estimated ECMs for  $WR$  and  $LRR$ .<sup>10</sup> The time period for the analysis was 1966 – 2000; two observations are lost due to differencing and the use of lags. Since the analysis produced a lot of output we report the results in detail in Appendix 3, and give the main results in this sub-section.

First a general unrestricted ECM for  $WR$  was estimated. We included one lag of  $\Delta WR$ , contemporaneous and lagged values of  $\Delta KL$ , the first differences of the two dummy variables, and  $WR$  and  $KL$  and the dummies lagged one period. Moreover, an impulse dummy for 1987 was needed to make the residual normally distributed; it captures a sharp increase in wages that year. One lag of the differenced variables was sufficient to capture the dynamics and to pass all the misspecification tests (see Table A1, Appendix 3). Insignificant variables were then excluded to obtain an unrestricted parsimonious ECM (see Table A2). The long-run coefficients are close to those reported in Table 2; the only difference is that the trend dummy has a somewhat larger value. Hence, the use of a single-equation ECM seems to be valid. Testing for cointegration with the ECM procedure gave a p-value is 0.0078 so the null of no cointegration is clearly rejected. Finally the long-run restrictions were imposed based on the estimated parameters of the variables in levels. The preferred restricted ECM is,

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<sup>10</sup> We also carried out Granger causality tests to see if relative factor returns drives factor endowments. This was not the case. These results can be obtained from the authors. The similarity between the long-run relations obtained with FMOLS and the single-equation models is an indication that there is no feedback from prices on endowments.

$$\begin{aligned} \Delta WR_t = & -7.8 + 1.7\Delta KL_t + 0.16DUMI87 + 0.091\Delta DUMT94 - 0.14\Delta DUMS77 \\ & (-5.77) \quad (9.36) \quad (4.32) \quad (6.20) \quad (-3.68) \\ - 0.87[WR_t - 0.93KL_t - 0.08DUMT94 + 0.21DumS77]_{t-1} \\ & (-5.76) \end{aligned}$$

$$\begin{aligned} R^2 = 0.842 \quad \hat{\sigma} = 0.034 \quad T = 1966 - 2000 \quad DW = 2.4 \quad F_{ar}(2, 27) = 1.83 [0.18] \\ F_{arch}(1, 27) = 0.23 [0.61] \quad F_{het}(8, 20) = 0.53 [0.82] \quad \chi^2_{norm}(2) = 1.47 [0.48] \\ F_{reset}(1, 28) = 0.14 [0.71] \quad \text{Tests of model reduction: } F(5, 24) = 0.25 [0.93] \end{aligned}$$

where t-values are shown in parentheses,  $\hat{\sigma}$  is the residual standard deviation, T is the sample period, and DW is the Durbin Watson test statistic. The diagnostic tests are approximate F-tests against, serial correlation of order 2,  $F_{ar}$ , autoregressive conditional heteroscedasticity of order 1,  $F_{arch}$ , and heteroscedasticity,  $F_{het}$ , the RESET test,  $F_{reset}$ , and a chi-square test for normality,  $\chi^2(2)$  (see Hendry and Doornik (2001) for details).

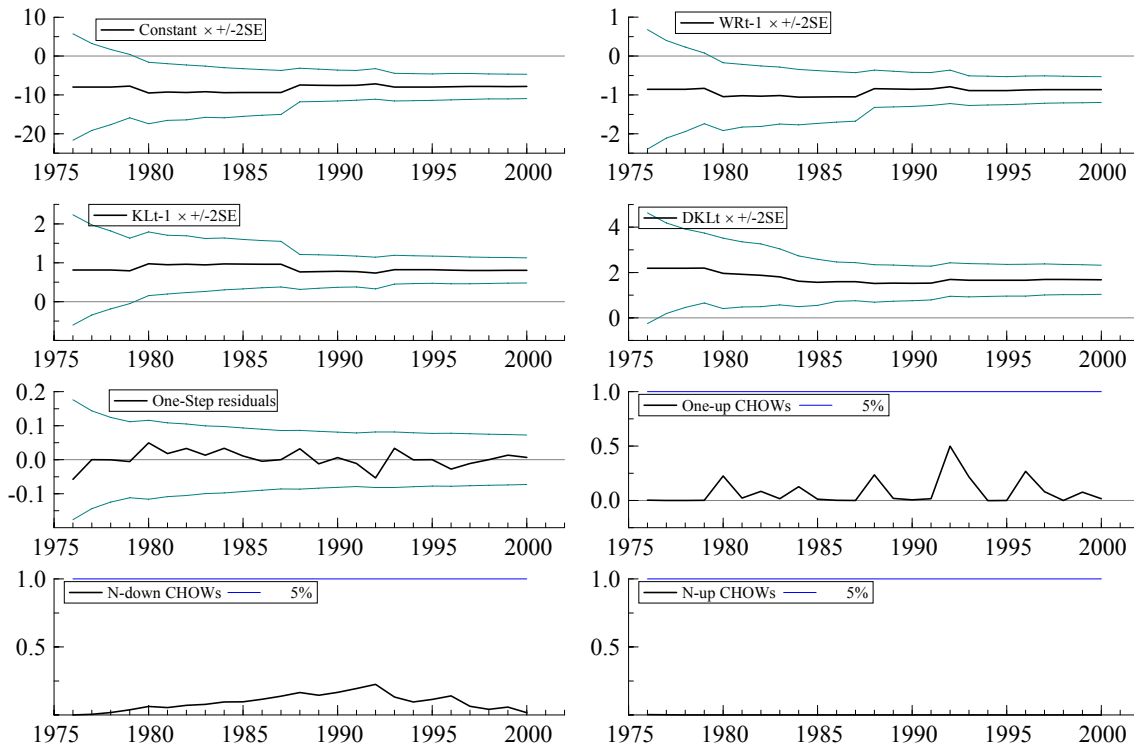
The preferred ECM is well specified since no diagnostic test is significant, and all the t-values are high. Moreover, the test for reducing the general model to the parsimonious model is insignificant. Also, the model is empirically stable over the period 1975-2000 as shown by the recursively estimated coefficients, the recursive residuals and the three types of Chow tests for the preferred (unrestricted) ECM, reported in Figure 11.

According to our model,  $WR$  is determined by  $KL$  in the long run, but there are two structural breaks. The adjustment process is fairly rapid, 87 percent of the disequilibrium is corrected within a year. Furthermore, growth in the capital-labour ratio increases growth in the wage-capital rental ratio, as expected. Note that the first break implies an improvement in returns to capital relative to labour for a given capital – labour ratio, and thus cannot be interpreted as an indication of integration into the world market. On the other hand, the second break is consistent with opening up, since it shows that labour earnings grow quicker than returns to

capital when the capital-labour ratio is held constant. However, the most likely explanation is that wages grew rapidly because of the liberalisation of the labour market (IMF, 2003).

In the ECM for  $WR$  above, relative goods prices do not enter although we found some evidence of it entering a long-run relation with  $WR$  and  $KL$ . Re-estimating the model with  $PAPM$ , entering in levels lagged one period, but without dummies for structural breaks, did not produce a significant estimate of its coefficient. And including an error correction term based on column 2 in Table 2 did not make  $PAPM$  enter the model either. However, when the trend dummy ( $DUMT94$ ) and its first difference were included, the t-value of  $PAPM_{t-1}$  declined to -3. On the other hand, adding the step dummy ( $DUMS77$ ) increases the t-value to -2. The reason for this is probably that  $PAPM$  captures the break in the end of the 1970s (see Figures 3 and 6). A t-value of -2 is insignificant for a non-stationary variable; the Ericsson and Mackinnon (2002) simulation program gives a  $p$ -value of about 0.6, which is a rough indication of this. Hence,  $PAPM$  might have mattered for  $WR$  during the late 1970s and the beginning of 1980s because its increase coincided with the decline in  $WR$ , but it does not seem to have influenced  $WR$  during the latter half of the 1990s. Moreover,  $PAPM$  has the wrong coefficient for an open economy. See Table A3 in Appendix 3.

**Figure 11: Recursive Estimates of Coefficients and Residuals, and Chow Tests for the ECM model of WR**



Note: Recursive estimates of the coefficients with  $\pm 2$  standard error (top four graphs), one-step residual with  $\pm 2$  estimated standard errors, 1-step (one-up), break-point (N-down) and forecast (N-up) Chow statistics scaled with their 5% critical values. The straight line at unity shows the 5% critical level.

Next we estimated a general ECM for the land-capital rental ratio. It contained  $LRR$  and  $KLAN$ , lagged one period,  $\Delta KLAN_t$ ,  $\Delta KLAN_{t-1}$  and  $\Delta LRR_{t-1}$ , and impulse dummies for the outliers in 1990 and 1994. The model is reported in Table A4 and A5 in Appendix 3 together with misspecification tests. The coefficient for the cointegrating vector is quite close to the one in column 1 in Table 3, indicating that  $KLAN$  is weakly exogenous and the estimation of a single equation ECM is acceptable. The parsimonious ECM is,

$$\Delta LRR_t = -15 + 5.7\Delta KLAN_t + 1.30DUMI90 + 0.94DUMI94 - 0.83[LLR - 2.04KLAN]_{t-1}$$

(-6.62) (4.05)
(4.75)
(3.57)
(-6.54)

$$R^2 = 0.760 \quad \hat{\sigma} = 0.255 \quad T = 1966 - 2000 \quad DW = 1.85 \quad F_{ar}(2, 28) = 0.57 [0.57]$$

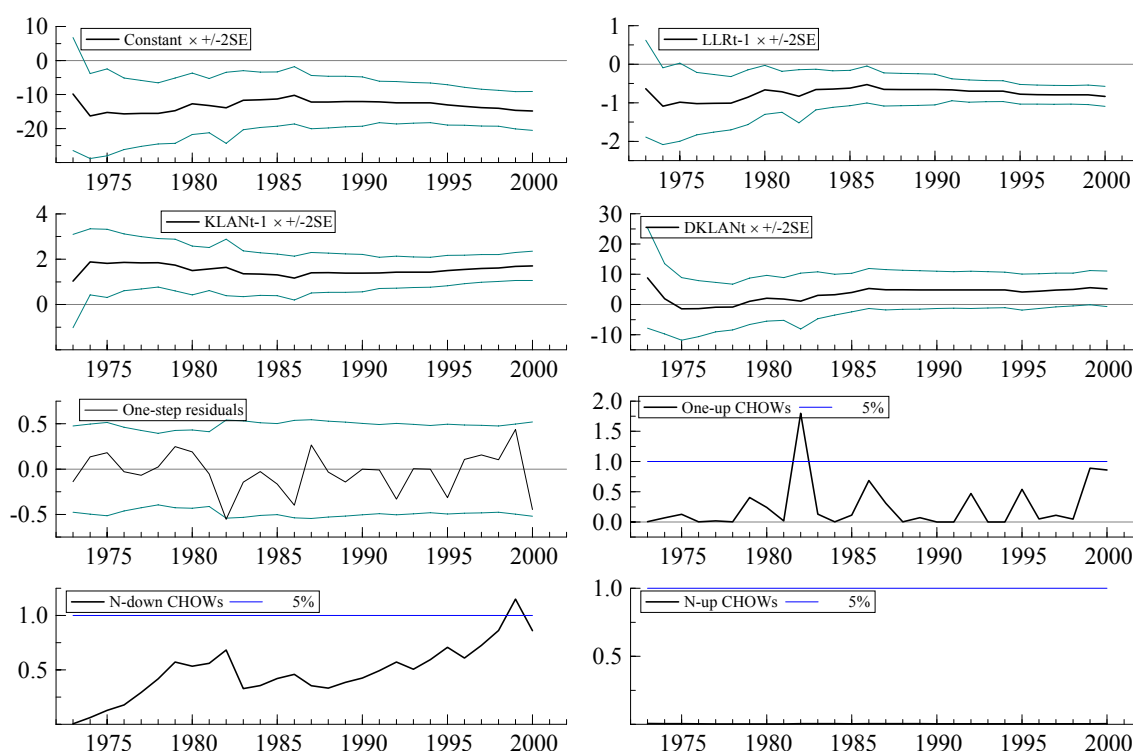
$$F_{arch}(1, 28) = 0.17 [0.69] \quad F_{het}(6, 23) = 1.00 [0.45] \quad \chi^2_{norm}(2) = 0.28 [0.87]$$

$$F_{reset}(1, 29) = 0.05 [0.83] \quad \text{Tests of model reduction } F(3, 27) = 0.23931 [0.8681]$$

The reduction from the general model is accepted, none of the diagnostic tests is significant and the model is empirically stable as shown by Figure 12. Again resource endowments, here the land – capital ratio, drive relative returns in the long run, as shown by the significance of the error correction term. In the short run the growth rate in *KLAN* has a positive impact on the growth rate of *LRR*.

We also included  $\Delta PAPM$  in the model to test if relative goods prices influence relative returns in the short run. However, this was not the case. For instance, a LM test for omitted variables gave  $F(2,28) = 0.185$  for  $\Delta PAPM_t$  and  $\Delta PAPM_{t-1}$ , which has the  $p$ -value of 0.83.

**Figure 12: Recursive Estimates of Coefficients and Residuals, and Chow Tests for the ECM model of LRR**



Note: Recursive estimates of the coefficients with  $\pm 2$  standard error (top four graphs), one-step residual with  $\pm 2$  estimated standard errors, 1-step (one-up), break-point (N-down) and forecast (N-up) Chow statistics scaled with their 5% critical values. The straight line at unity shows the 5% critical level.

## 7. Concluding Remarks

This paper provides an analysis of how the evolution of factor prices in Kenya has been affected by factor accumulation and changes in the the degree of integration with the world market. In the colonial period there were extensive market interventions and distortions that affected factor rewards. Some distortions remained into the post-colonial period, but it seems fair to say that there has been a clear shift towards competitive pricing of factors of production. In particular during the period of structural adjustment from the early 1980s this trend has been clear.

When we look at changes in the factor endowments in Kenya over the last decades, we note that labour force growth has been very rapid. Until the early 1980s, capital accumulation was even faster, which meant that the capital-labour ratio grew. However, since then the trend has been reversed, which shows that Kenya is off the well-trodden development path of increasing capital-abundance. This is a very worrying for Kenya's long-term growth prospects.

In our regression analysis we have looked at changes in relative factor prices. We regressed relative factor prices and relative goods prices, measured as the relative price between agricultural and manufactured goods, on factor proportions. We found that the wage-capital rental ratio was positively affected by the capital-labour ratio, and that the land – capital rentals ratio was determined by the capital-land ratio. As our theoretical model predicts, capital accumulation tends to push up wages relative to capital rentals, and increase return to land relative to capital.



Generally, we expected the process of liberalisation to lead to higher agricultural prices relative to manufacturing prices and to the benefit of those factors that were discriminated by the tariffs, that is, land and labour. However, we found neither that relative price changed as expected, nor that the relative prices between agricultural and manufactured goods played any important role in the determination of factor prices.

A final observation is that the economy has adjusted to the rapid growth in labour supply and the slow pace of capital accumulation by shifting towards the labour intensive informal sector. This has helped cushion the effect on unskilled labour. Still, the long-term growth prospects of the economy will be dismal unless capital accumulation again can outpace labour force growth. As yet there are no signs that this is happening.

## **Appendix 1: Data Sources**

- Land prices: We collected data for land prices in two provinces, Kiambu and Kakamega, and calculated the average price per hectare for each year. The data runs from 1960-2000 for Kiambu and 1968–2000 for Kakamega. Kiambu is close to Nairobi so prices are much higher than in Kakamega. However, when turned into indexes of real prices, the evolution of the two prices series is very similar apart from some outliers.

- Labour earnings: They are from various issues of Statistical Abstract of Kenya. In our regressions return to labour are measured by earnings, including allowances, of employees in manufacturing. We also carried out the analysis using a series for earnings in commercial farming. The reason for trying the latter was the guess that they should have been less affected by changes in the skill composition of the labour force over the last decades, thus constitute a better measure for unskilled wages. However, most likely minimum wages had a larger impact in agriculture than in manufacturing; agricultural wages actually did increase faster than manufacturing wages over the whole sample. Empirically manufacturing wages worked better. Furthermore, capital accumulation was heavily biased towards the manufacturing sector so comparing returns to capital with manufacturing wages seems reasonable.

- Commodity prices: We used the deflators for agricultural production and manufacturing production. They are from the KIPPRA database (Ryan, 2002).

- Land and labour: Both are from World Development Indicators 2002. Land is only measured irregularly so it was smoothed using nine-year moving averages. Since the values

for land is the same for the last ten years, we extended the sample in order not to lose observations. When measured in percent, the changes per year are very small.

- Capital stock: The total capital stock series from the KIPPRA database (Ryan, 2002) and covers the period 1964-2000. The series is similar to the one calculated by Nehru and Dhareshwar (1993), which ends in 1990, but the latter series peaks in 1980, while Ryan's peaks in 1982. We preferred the capital stock from the KIPRA database since it is based on far more detailed investment data than the Nehru and Dhareshwar series.

## Appendix 2: Calculation of Return to Capital

This appendix explains how capital rentals were computed. The problem of calculating the capital rentals is to find values for  $R$  in  $Y = RK + WL$ , where  $Y$  is real GDP,  $R$  the real return to capital,  $K$  the capital stock,  $W$  the wage rate and  $L$  the labour supply. If we assume a Cobb-Douglas production function,  $R$  is also the marginal product of capital. Sarel (1997) and Gollin (2002) review the difficulties of using national account data on factor income to obtain  $R$ .

In the first step the capital shares ( $\alpha_t = RK/Y$ ) for Kenya was calculated with the help of information about technical capital shares provided by Sarel (1997) and used by, among others, Fernald and Neiman (2003). Sarel estimated sectoral capital shares for a number of countries at the one-digit level of GDP and calculated their averages. Although these calculations do not give the true capital shares, they are likely to be closer to them than what can be obtained for Kenya using of factor incomes from national accounts data. The most serious problem with national accounts data is that income from self employment is included in capital income, which we cannot do anything about with the Kenyan data (see Gollin 2002). In Sarel's estimates, employment compensation is corrected for self-employment. The capital shares of Sarel were applied to each one-digit sector of GDP in Kenya and the weighted averages were calculated for each year over the period 1964 – 2000. The capital shares were slightly above 0.24 in the 1960s, and then increased slowly to close to 0.27 at the end of the 1990s.

In the second step  $R$  was calculated as  $\alpha_t(Y_t/K_t)$ , i.e. the marginal product of capital.  $R$  starts at 0.18 and declines to 0.1 in the middle of the 1970s, a value it hovers around until 2000.

## Appendix 3: Error Correction Models

**Table A1: ECM for WR: General Model**

Variable	Coefficient	Stand. Error	t-value
<i>Constant</i>	-8.51	1.95	-4.36
$\Delta WR_{t-1}$	0.05	0.12	0.44
$\Delta KL_t$	1.44	0.44	3.30
$\Delta KL_{t-1}$	0.39	0.45	0.87
$\Delta DUMT94_t$	0.09	0.02	4.72
$\Delta DUMS77$	-0.13	0.05	-2.72
<i>DUMI87</i>	0.17	0.04	4.14
$WR_{t-1}$	-0.94	0.20	-4.61
$KL_{t-1}$	0.87	0.20	4.32
$DUMT94_{t-1}$	0.07	0.02	4.13
$DUMS77_{t-1}$	-0.18	0.06	-3.20

$$R^2 = 0.850 \quad \hat{\sigma} = 0.036 \quad T = 1966 - 2000 \quad DW = 2.44 \quad F_{ar}(2, 22) = 1.95 [0.17]$$

$$F_{arch}(1, 22) = 0.09 [0.76] \quad F_{het}(17, 6) = 0.23 [0.99] \quad \chi^2_{norm}(2) = 2.09 [0.35]$$

$$F_{reset}(1, 23) = 0.59 [0.45]$$

Note:  $\hat{\sigma}$  is the residual standard deviation, T is the sample period, and DW is the Durbin Watson test statistic. The diagnostic tests are approximate F-tests against, serial correlation of order 2, Far, autoregressive conditional heteroscedasticity of order 1, Farch, and a test of heteroscedasticity, Fhet, the RESET test, Freset, and a chi-square test for normality,  $\chi^2(2)$  (see Hendry and Doornik (2001) for details).

**Table A2: ECM for WR: Unrestricted Parsimonious Model**

Variable	Coefficient	Stand. Error	t-value
<i>Constant</i>	-7.81	1.56	-5.00
$\Delta KL_t$	1.68	0.32	5.21
$\Delta DUMT94_t$	0.09	0.02	4.88
$\Delta DUMS77$	-0.14	0.05	-2.95
<i>DUMI877</i>	0.16	0.04	4.09
$WR_{t-1}$	-0.86	0.17	-5.21
$KL_{t-1}$	0.80	0.16	4.97
$DUMT94_{t-1}$	0.07	0.02	4.12
$DUMS77_{t-1}$	-0.18	0.05	-3.67

$$R^2 = 0.842 \quad \hat{\sigma} = 0.036 \quad T = 1966 - 2000 \quad DW = 2.40 \quad F_{ar}(2, 24) = 1.67 [0.20]$$

$$F_{arch}(1, 24) = 0.13 [0.72] \quad F_{het}(13, 12) = 0.48 [0.89] \quad \chi^2_{norm}(2) = 1.41 [0.49]$$

$$F_{reset}(1, 25) = 0.10 [0.75]$$

Note: See Table A1.

**Table A3: Adding PAPM to the ECM for WR**

Variable	Coefficient	Stand. Error	t-value
<i>Constant</i>	-8.48	1.69	-5.01
$\Delta KL_t$	1.24	0.39	3.19
$\Delta DUMT94_t$	0.12	0.02	4.95
$\Delta DUMS77$	-0.09	0.05	-1.93
$DUMI877$	0.14	0.04	3.97
$DUMT94_{t-1}$	0.06	0.02	4.14
$DUMS77_{t-1}$	-0.12	0.07	-1.77
$WR_{t-1}$	-0.97	0.18	-5.48
$KL_{t-1}$	0.87	0.18	4.92
$PAPM_{t-1}$	-0.18	0.07	-2.51
$\Delta PAPM_t$	-0.13	0.10	-1.36
$\Delta PAPM_{t-1}$	0.16	0.10	1.62

$$R^2 = 0.877 \quad \hat{\sigma} = 0.034 \quad T = 1966 - 2000 \quad DW = 2.43$$

F-test for removing  $PAPM_{t-1}$ ,  $DPAPM_t$ ,  $DPAPM_{t-1}$ :  $F(3,23) = 2.22$  [0.11]

Note: See Table A1.

**Table A4: ECM for LRR: General Model**

Variable	Coefficient	Stand. Error	t-value
<i>Constant</i>	-16.23	3.37	-4.82
$\Delta LRR_{t-1}$	0.11	0.13	0.84
$\Delta KLAN_t$	4.43	4.38	1.01
$\Delta KLAN_{t-1}$	0.52	3.97	0.13
$DUMI90$	1.25	0.28	4.52
$DUMI94$	0.92	0.28	3.25
$LRR_{t-1}$	-0.93	0.17	-5.34
$KLAN_{t-1}$	1.87	0.38	4.87

$$R^2 = 0.767 \quad \hat{\sigma} = 0.265 \quad T = 1966 - 2000 \quad DW = 1.81 \quad F_{ar}(2,25) = 0.26$$
 [0.77]

$$F_{arch}(1,25) = 0.40$$
 [0.82]  $F_{het}(12,14) = 0.76$  [0.67]  $\chi^2_{norm}(2) = 0.39$  [0.82]

$$F_{reset}(1,26) = 0.007$$
 [0.93]

Note: See Table A1.

**Table A5: ECM for LRR: Unrestricted Parsimonious Model**

Variable	Coefficient	Stand. Error	t-value
<i>Constant</i>	-14.82	2.86	-5.18
$\Delta KLAN_t$	5.20	2.94	1.76
<i>DUMI90</i>	1.26	0.27	4.67
<i>DUMI94</i>	0.94	0.27	3.50
$LRR_{t-1}$	-0.83	0.13	-6.43
$KLAN_{t-1}$	1.70	0.32	5.28

$$R^2 = 0.760 \quad \hat{\sigma} = 0.259 \quad T = 1966 - 2000 \quad DW = 1.85 \quad F_{ar}(2, 27) = 0.54 [0.58]$$

$$F_{arch}(1, 27) = 0.16 [0.69] \quad F_{het}(8, 20) = 0.62 [0.75] \quad \chi^2_{norm}(2) = 0.28 [0.87]$$

$$F_{reset}(1, 28) = 0.04 [0.84]$$

Note: See Table A1.

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