ABSTRACT

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We estimate the elasticity of substitution using two different production functions. The usual Constant Elasticity of Substitution (CES) production function and a Box-Cox production function for Japan (1890-1991), UK (1870-1991), and US (1890-1992; 1929-2000). The main results are that we find the ES to be non-unitary and changing over time. Our findings have implications for economic growth (theoretical and empirical), as production is an increasing function of the ES. The use of a Cobb-Douglas production function, as in most cases in the literature, hides the role of the ES not only as a source of increase in output but also as a source of technical change. Also, we found in a monte carlo simulation that usual CES production usually does not give reliable estimates for the substitution parameter. Finally, using a CES to calculate TFP across countries, we found that variance of TFP is lower than using a Cobb-Douglas. It implies that the importance of TFP to explain income differences across countries is diminished.

Keywords: Elasticity of Substitution, Economic Growth, Technical Change, Production Function, Total Factor Productivity.

Empirical Essays on the Elasticity of Substitution, Technical Change, and Economic Growth

by

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To my parents Lindolfo and Clélia,

to my brothers Luiz and Carlos Alberto, and sister Silvana,

to my friend Jéssica (in memoriam).

Biography

Claudiney M. Pereira was born in Teixeira de Freitas, Bahia State, Brazil, to parents Lindolfo Silva Pereira and Clélia Moutinho Magalhães Pereira on June 21, 1969. He earned his Bachelor's degree in Economics in April of 1992 at the Federal University of Viçosa (UFV), and his Master's of Science degree in Economics in June of 1996 at University of Brasilia (UnB) both in Brazil. He began his Ph.D. studies at North Carolina State University in January of 1997, and his thesis defense was in July the 21^{st} of 2003. After graduating, he will return to Brazil were he is going to take a position as assistant professor at the Catholic University of Brasilia.

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Contents

List of Tables

List of Figures

Chapter 1

The Problem and Its Relevance

1.1 Introduction

We study the empirics of the elasticity of substitution(ES) and its relationship with technical change and economic growth. Theoretically, the link between the ES and economic growth has been established for a long time even though still did not incorporate the fact that a change in the elasticity of substitution should be considered endogenous as we discuss below. Empirically, we have seen most of the estimation using production functions that can not account for changes in the ES (e.g., Cobb-Douglas) and slight variations in the periods or concepts producing markedly different estimates. Our general goal is to provide empirical evidence on the ES and discuss its implications for economic growth. New tests using an updated data set and comparing different estimation techniques is a valuable contribution to the shed some light on that relationship as justified below.

In particular, we first estimate the ES and test its stability over time using a Constant Elasticity of Substitution (CES) and a Variable Elasticity of Substitution (VES) production functions for Japan (1890-1991), UK (1870-1991), and the U.S.

(1890-1992; 1929-2000). Once we estimate the ES, we also check for the existence of endogenous growth. Secondly, we perform Monte Carlo simulation of the two functional forms proposed above. Finally, we establish a link among technical change, economic growth, and the ES through estimation of the correlation between the ES and Total Factor Productivity (TFP).

The main results are that we find the ES to be non-unitary and changing over time. Our findings have implications for economic growth (theoretical and empirical), as production is an increasing function of the ES. The use of a Cobb-Douglas production function, as in most cases in the literature, hides the role of the ES not only as a source of increase in output but also as a source of technical change. Also, we found in our monte carlo simulation that usual CES production usually does not give reliable estimates for the substitution parameter. Finally, using a CES to calculate TFP across countries, we found that variance of TFP is lower than using a Cobb-Douglas. It implies that the importance of TFP to explain income differences across countries is diminished.

1.2 Motivation

The ES measures the percentage change in the factor ratio divided by the percentage change in the technical rate of substitution. Assuming a 2-factor production function with capital and labor, it is a measure of the ease of substitution of labor for capital or a measure of the similarity of factors production from a technological point of view. From an individual firm standpoint, it is a measure of the responsiveness of the cost-minimizing capital-labor ratio to changes in the wage-rental ratio in the long run. When the ES is large, the factors of production resemble each other from a technological point of view. Hence, if one of the two factors is increasing the technology permits the expanding factor to be substituted relatively easily for the factor that was held constant. If the ES is small, the technology view the factors as being relatively dissimilar so that it is difficult to substitute the expanding factor (Brown, 1966).

The interpretation of the ES at the aggregate level can be related to the technological path of the economy. As pointed out by Nelson (1965), the elasticity of substitution can be interpreted as an index of the rate at which diminishing marginal returns set in as one factor is increased relative to the other. If the elasticity of substitution is large, then it is easy to substitute one factor for the other or to increase output by increasing one factor. Therefore, diminishing marginal returns will set in slowly or the greater the ES the smaller the drag due to diminishing returns. From this interpretation, it is straightforward to notice that the elasticity of substitution will affect the growth rate of output when factors of production are increasing at different rates so that their ratio is changing.

In addition, a changing ES can be intuitively associated with technological change over time as pointed out by Hicks (1963). It seems to have some cycle in the ES for an aggregate production function, with a high ES during and after a period of great technological breakthrough, then a settling down to relative inelastic substitution possibilities when technology stagnates. Or for a given technology, diminishing marginal returns will set in the long run.

As showed below, we can easily establish a link between the ES and economic growth using a production function [1] which expresses the way output is produced by inputs. The mix of inputs used to produce a particular amount of output is determined by the technology. So, the technology is embedded in the production function and can be expressed in terms of it. Technological change has been asserted as the most important determinant of economic growth (Solow, 1956; Romer, 1990 among others). Therefore, to understand how economic growth takes place we need to know how technological change occurs.

There are two general types of technological change: neutral and non-neutral. A neutral technological change produces a variation in the production, but does not

[1] Unless otherwise mentioned, we always assume a 2-factor production function with capital and labor as inputs.

alter the marginal rate of substitution. A non-neutral technological change alter the production function and can be either labor-saving or capital-saving. In terms of an abstract technology, variations in the efficiency of the technology and economies of scale produce neutral technological change. Non-neutral technological change is produced by variations in the capital-intensity of a technology and the ES. Therefore, the ES is closely linked with economic growth as represents non-neutral technical change.

The relevance of the ES and its relationship with economic growth and technical change has been established since at least Hicks(1932) and Solow (1957). However, it was only after Arrow et al.(1961) - hereafter ACMS - that we have a boost on the theoretical and empirical issues involving the ES. ACMS in the paper that popularized the Constant Elasticity of Substitution (CES) production function suggest that the knowledge of the ES may play a crucial role at least in the following fields of economic theory:

(1) the stability or not of certain growth paths implied by some growth models.

(2) the effects of varying factor endowments on the pattern of trade hinge on the shape of the production function and therefore the ES among different industries. Variations in the ES among sectors imply reversal factor intensities at different factor prices with quite different consequences for trade and factor returns (see, e.g., Jones (1965)).

(3) Assume unitary ES (the Cobb-Douglas production function case) to agree with the apparent constancy of factor shares [2].

We estimate the ES using two different production functions. The usual CES - that makes our results comparable to most of the literature - and a Variable Elasticity of Substitution (VES) production function which includes the CES as a special case. The use of new and now readily available techniques as the bootstrap and new structural break tests, may help us to get a better estimator for the ES. The contribution is

[2]The constancy of relative shares was contested in the early growth literature by Solow (1958), Kravis (1959) and more recently by Seater (2001).

twofold. First, we have more data available to estimate the ES. Secondly, the use of several estimation techniques can help find a robust estimation for the ES.

Finding (or confirming) that the ES in not unitary or constant is a very important question since eventually all growth models and its empirical applications assume a Cobb-Douglas production function. Empirically, if the ES is not unitary and changes over time using Cobb-Douglas is a misleading approximation for the behavior of the aggregate economy. Theoretically, the use of the Cobb-Douglas hides the role of the ES as source of technical change and increase in output. In the early literature such use was justified either by the theoretical problems caused by use of other production functions (e.g., we may not have a balanced growth path) or by the fair amount of inconclusive empirical work about the ES. Once we estimate the ES and check its robustness, we check for the existence of endogenous growth using Barro and Sala-i-Martin (1995) - an ES greater than one may generate endogenous growth. We perform our tests for Japan (1890-1991), U.S. (1890-1992; 1929-2000), and U.K. (1870-1991).

Since we are trying to compare alternative functional forms, an useful test is to check how those functional forms behave if we did know their generation process. Even though such experimentation (Monte Carlo) seems to be a natural step to try, it has not been fully exploited on the literature. Kumar and Gapinski (1974) and Thursby (1980) are the exceptions. However, their experiments only try to check the properties of the CES production function. In our case, we not only test the performance of the CES but also compare with the Cobb-Douglas and the VES production functions. The VES includes both the CES and the Cobb-Douglas as special cases, and therefore our experiment may shed some light on the most appropriate production function.

Our final task is to establish the link among technical change, economic growth, and the ES. The current literature has addressed these issues separately. Either only estimating the contribution of technical change to growth or the nature of it (biased or neutral). Technical change measured as TFP is usually considered as the main source of economic growth (Solow (1957) and more recently Hall and Jones (1999)). However, to estimate the contribution of technical change to growth, we usually use a Cobb-Douglas production function and assume that all technical change is neutral. If the Cobb-Douglas is an appropriate representation of the aggregate economy is still an open question and our study provides one answer to it. On other hand, trying to estimate both the contribution of technical change to growth and its nature simultaneously brings out potential misspecifications (e.g., impossibility theorem) and also it is still an open question in this literature.

If technical change is the most important source of economic growth, then differences in TFP growth may explain income differences across countries. Instead of dealing with all potential econometric misspecifications, our strategy here is to simply try to establish the correlation between the ES and TFP growth through a simulation. In a cross-section of 127 countries we solve for a production function that allows the ES to assume any value and get the correlation between the ES and TFP.

Chapter 2

The Elasticity of Substitution, Technical Change, and Economic Growth: Theory and Evidence

2.1 Introduction

On this chapter, we make a review of the the main empirical and theoretical contributions relating the elasticity of substitution (ES) and economic growth. We focus more on the empirics of the ES, but we also present some of the related theoretical literature. We first present a summary of the main theoretical contributions. Most of the theoretical work on the ES is related to the possibility of multiple steady states if the ES is not unitary. As we are going to show, no attempts for the best of our knowledge were made to consider the ES endogenous in an aggregate model. As the ES and output are positively related and changes in the ES is a form of technical change, such consideration may be an interesting research avenue to pursue in the future. Then, we explicitly show the positive relationship between the ES and economic growth using a standard production function with two inputs. In particular, we show that the path and level of growth rate of output are positively related to the ES. Finally, we present a review of the main empirical work estimating the ES as well as the relationship between the ES and economic growth. The main results are that slight variations in the periods or concepts producing markedly different estimates. Also, there is some evidence showing the positive relationship between the ES and economic growth.

Theoretically, in the early growth theory literature some attempts were made to show the importance of the ES. Solow (1957), Pitchford (1960), and K. Sato (1963) show that allowing the ES to take any value generates multiple growth paths and some of them are not balanced. And more recently, Azariadis (1993) using an overlapping generation growth model shows the possibility of poverty traps, depending on the value of the ES.

Ferguson (1965) shows that in the case that the ES in not unity, the rate of growth of output will depend on the ES as well as the rate of growth of the savings ratio. Kamien and Schwartz (1968,1969) gives some microfoundations to the relationship and explicitly show the link between the ES and technical change [1]. They show that a profit maximizing firm will respond to a change in relative factor prices 'deforming' its isoquant map so as to economize in the use of the relatively expensive factor. In their model, the firm will choose to allocate resources for neutral and non-neutral technical change. In the CES case, changes in the ES result in non-neutral technical change in almost every case and affect the optimal capital-labor ratio for almost every factor price combination. Their main result is that an optimal neutral technological change will remain so until there is a change in relative factor prices and adoption of a 'non-neutral' technical change eventually cause 'neutral' advance to become desired even in the absence of relative factor price changes.

More recently, La Grandville (1989) using the Slutsky equation gives another proof of the positive relationship between the ES and the output level. The intuition is that the larger the ES, the more an economy can benefit, in terms of additional output,

[1] As far as we know, Kamien and Schwartz is the only contribution on the literature.

from a relative price change. Barro and Sala-i-Martin (1995) shows that under certain conditions the existence of a higher ES can generate endogenous, steady-state growth. Later, Klump and La Grandville (2000) prove that a higher ES makes endogenous growth more probable and higher long term growth rates. Also, the level of the steady-state is positively related to the ES, so it implies a higher steady-state of income per capita.

An ES lower than one with a CES production function implies multiple steady-states (and poverty traps) for per capita output (e.g., Pitchford (1961), Azariadis (1991) and Galor (1995)). If the ES is greater than one, we have an unique steady-state and possibility of endogenous growth (Barro and Sala-i-Martin, 1995). In sum, it was shown that changes in the elasticity of substitution will affect the growth rate as production is an increasing function of the ES. In the CES case, the ES will affect growth in almost every case, except when both production factors were increasing at the same rate as showed by Kamien and Schwartz(1968)[2].

2.2 The ES and the Growth Rate of Output

The positive relationship between the ES and the level and growth rate of output can be showed using a very simple model. Assuming a 2-factor linear-homogenous production function with Hicks-neutral technical change:

$$Y = \phi(t)F(K, L) \tag{2.1}$$

Differentiating (2.1):

$$\frac{dY}{dt} = \frac{\partial \phi}{\partial t} F(K, L) + \phi \frac{\partial F}{\partial K}\frac{\partial K}{\partial t} + \phi \frac{\partial F}{\partial L}\frac{\partial L}{\partial t} \tag{2.2}$$

[2]We can prove this result using the Beckenbach and Bellman Theorem (1961).

Since:

$$\phi\frac{\partial F}{\partial K}\frac{\partial K}{\partial t}=\frac{\partial Y}{\partial K};\phi\frac{\partial F}{\partial L}\frac{\partial L}{\partial t}=\frac{\partial Y}{\partial L} \tag{2.3}$$

It follows that the growth rate of output will be:

$$\frac{\dot{Y}}{Y}=\frac{\dot{\phi}}{\phi}+(1-\alpha)\frac{\dot{K}}{K}+\alpha\frac{\dot{L}}{L} \tag{2.4}$$

Or in growth rates[3]:

$$\gamma_Y=\gamma_\phi+\gamma_K+\alpha(\gamma_L-\gamma_K) \tag{2.6}$$

To show the influence of the ES on the growth rate of output, note that the elasticity of production with respect to labor (α) can be written as a function of the ES:

$$\alpha=(1-\alpha)\frac{w/r}{K/L}\ ,\ w=\frac{\partial Y}{\partial L}\quad and\quad r=\frac{\partial Y}{\partial K} \tag{2.7}$$

Or in logs and differentiating with respect to time:

$$\frac{d\ ln\ \alpha}{dt}=\frac{d\ ln\ (1-\alpha)}{dt}+\frac{d\ ln\ (w/r)}{d\ ln\ (K/L)}\frac{d\ ln\ (K/L)}{dt}-\frac{d\ ln\ (K/L)}{dt} \tag{2.8}$$

Note that:

$$\frac{d\ ln\ (w/r)}{d\ ln\ (K/L)}=\frac{1}{\sigma} \tag{2.9}$$

Therefore:

[3]Note that

$$(1-\alpha)=\frac{\partial Y}{\partial K}\frac{K}{Y}\quad and\quad \alpha=\frac{\partial Y}{\partial L}\frac{L}{Y} \tag{2.5}$$

$$\frac{d\ ln\ \alpha}{dt} = \frac{d\ ln\ (1-\alpha)}{dt} + \frac{d\ ln\ (K/L)}{dt}\left(\frac{1-\sigma}{\sigma}\right) \tag{2.10}$$

And

$$\frac{\dot{\alpha}}{\alpha} = -\frac{1}{(1-\alpha)}\ \dot{\alpha} + \frac{1-\sigma}{\sigma}\ \left(\frac{\dot{K}}{K} - \frac{\dot{L}}{L}\right) \tag{2.11}$$

Or

$$\dot{\alpha} = \alpha(1-\alpha)\left(\frac{\sigma-1}{\sigma}\right)(\gamma_L - \gamma_K) \tag{2.12}$$

Given constant growth rates of technical progress and of the factors of production, the growth rate of output (γ_Y) may vary only because of variations in α. Then using (2.6) and (2.12):

$$\frac{d\ \gamma_Y}{dt} = \alpha(1-\alpha)\left(\frac{\sigma-1}{\sigma}\right)(\gamma_L - \gamma_K)^2 \tag{2.13}$$

Furthermore, if $\gamma_L \neq \gamma_K$, the sign of (2.13) will be positive if $\sigma > 1$ and negative if $\sigma < 1$. So, the magnitude of the ES effect will depend upon the difference between the rates of growth of capital and labor. If $\gamma_L \approx \gamma_K$, the variation of γ_Y through time is small or the effect of the ES over the growth rate of output will be small.

As showed by Nelson (1965), in the U.S. case (using 1947-1960 data) the rate of growth of the capital stock was not much different from that of labor, therefore the value of the ES does not make a difference on the growth rate. Nelson concluded that regardless the size or magnitude of the ES, increases in capital per worker or per-man hour explains only a small fraction of the growth in productivity in the postwar period and was not sensitive to the choice of any particular value of the ES (pp. 56-57). This result was the core of a controversy between Nelson and Nerlove (1967) in the 1960s. Nerlove reply arguing that over long periods or when the capital grows much more rapidly than the labor force, differences in the ES may play a significant role. In fact, using data from 1890-1992, the capital stock grew in real terms by almost two thousand per cent and that labor force input grew by four hundred per cent. Therefore, even small variations on the ES will have a large effect on the growth rate, contrary to Nelson's skepticism[4].

In addition, Heubes (1972) shows that not only the time path of the growth rate but also the level of the growth rate of output are functions of the ES. We have to differentiate (2.6) with respect to time and σ to get for small dt and $d\sigma$:

$$\begin{aligned} d\gamma_Y &= \left(\frac{\partial\alpha}{\partial t}dt + \frac{\partial\alpha}{\partial\sigma}d\sigma\right)(\gamma_L - \gamma_K) \\ &= \left\{\alpha(1-\alpha)\frac{\sigma-1}{\sigma}(\gamma_L-\gamma_K)dt - \frac{c\alpha}{\sigma^2}\,\frac{ln\,(K/L)}{c+(K/L)^{\frac{1-\sigma}{\sigma}}}\,d\sigma\right\}(\gamma_L-\gamma_K) \end{aligned} \tag{2.14}$$

Higher growth rates of output are associated to a larger ES if $\gamma_L > \gamma_K$ ($\gamma_L < \gamma_K$) and $(K/L) < 1$ ($(K/L) > 1$). Therefore, $\frac{\partial\gamma_Y}{\partial\sigma} > 0$. If the ES is small, there is a strong influence on the relatively scarce factor on output, i.e., its elasticity of production is high. With a rising σ, the value of the elasticity of production will diminish for the scarce factor, but it will rise for the relatively abundant factor. Also, it can be seen that γ_Y is independent of the ES for $(K/L) = 1$, and that the influence of a change in ES on the growth rate of output will be small for high values of σ.

Even though the changes in the ES affects growth in almost every case as we show above, in all these models but the micro model from Kamien and Schwartz, the ES is considered a fixed parameter. To understand how the ES changes over time in response to changes in resources endowments and relative factor prices seems to be a critical step towards a better understanding of the sources of technical change (Ruttan, 1997,2001) .

[4]Note that using Nelson's data the capital stock per capita grew 45 per cent, but considering data from 1890-1992 that number rises to 300 per cent.

2.3 Empirical Literature Review

The ES has been estimated since Arrow et al.(1961) and in most cases, the empirical estimation has used their Constant Elasticity of Substitution (CES) production function. We have two major empirical issues regarding the ES, economic growth, and technical change. The first one is to determine a link between the ES and economic growth. We need to estimate the ES, test its stability over time, and show the link with economic growth. The second one regards technical change and economic growth. On that case, we have to determine the contribution of technical change to growth and its nature as being neutral or non-neutral. These two issues are closely related but have been addressed separately on the literature. The estimation of the contribution of technical to growth is usually made through growth accounting. The method consists in breaking down the contribution of the growth of inputs and technology to the growth rate of output.

The empirical papers has used the Cobb-Douglas production function (which implies an ES equal to one) most of the time (Solow, 1957 is the pioneer) to account for the share of technical change on growth - note that in this approach technical change is always considered neutral and therefore has completely ignored changes in the ES. Technological change is measured as a residual and called total factor productivity (TFP). To determine technology as been neutral and non-neutral and the nature of the bias (labor-saving or capital-saving) is more complicated, especially because of the identification problems mentioned on the impossibility theorem (Diamond, McFadden, and Rodriguez (1978)). The impossibility theorem is related to the non-identifiability of the ES and technical change bias in the absence of a priori hypotheses on the structure of technical change(more details on chapter 5).

What is the value of the ES? Is it changing ? We still have some controversies about the true value of the elasticity of substitution (Nerlove (1967), Berndt (1976), McFadden (1978), Hamermesh (1993), and Duffy and Papageorgiou (2000), and Table

2.1).

Table 2.1: Selected Results on the Empirical Elasticity of Substitution between capital and labor.

Study	Period	Functional Form	Input Measures	Elasticity of Substitution(σ)
Arrow et al. (1961)	1909-1949	CES	K,L	.57
Brown-DeCani (1963)	1890-1958	CES	K,L	1890-1918:.55 1919-1937:.31 1938-1958:.47
David-Van de Klundert (1965)	1899-1960	CES	K,L	.32
Ferguson (1965)	1929-1963	CES	K,L	.67
Sato(1970)	1909-1960	CES and CEDD	K,L	.52
Lucas and Rapping (1970)	1930-1965.	CES	K,L	1.09
Revankar(1971)	1929-1953	CES	K,L	.56
Cronin et al. (1997)	1963-1991	Translog	K,L, Raw Materials, Telecommunications	.83
Genç and Bairam (1998)	1965-1985	VES	K,L	1.53
Boskin and Lau (2000)	1950-1998	Translog	K,L, Human Capital	.71

Nerlove on an extensive survey shows that the major finding is the diversity of results: even slight variations in the period or concepts tend to produce drastically different estimates of the ES. Berndt compares estimates of the ES for six different forms of the production function, five alternative measures of the rental price of capital, and two estimation methods. Similarly, his major conclusion is that the estimates of the ES are extremely sensitive to differences in measurement and data construction. For instance, his OLS estimates rejects the Cobb-Douglas for US Manufacturing, but the 2SLS one can not reject that the ES is equal to one. In addition, using a Chow test for the 2SLS estimation, he found that the estimate for the ES was stable. As we also show below, the value of the ES may change even with slight changes on the sample size or estimation technique.

McFadden examines the potential specification bias when estimating the ES and suggests tests for correcting it on cross-section estimation. He was interested among other things to test the constancy of the ES for the steam-electric generating industry. He found that the assumption of a constant ES can not be rejected, with a value of approximately 0.75. In another survey, Hamermesh shows that the ES varies from 0.32 to 1.16 in the US (different periods, different concepts) and from 0.49 to 6.86 in the UK.

A closer look at the empirical estimates for the manufacturing industry in the US over almost two hundred years clearly points to a changing and increasing ES. The available evidence shows an ES close to zero on the 19th century (Asher (1972),Uselding (1972), and Schmitz (1981)), close to one in mid-20th century (Zarembka(1970)), and greater than one late-20th century (Blair and Kraft (1974) and Hsing (1996)). Also, Uselding (1972) shows that the percentage change in labor productivity implied by the changes in the ES contributed with between 38 and 50 per cent of the average observed decadal increase in labor productivity in the US manufacturing between 1839-1899.

Two empirical tests based on La Grandville made by Yuhn (1991) and Cronin et al. (1997) try to establish the link between the ES and economic growth. Yuhn comparing U.S. and South Korea finds that the ES was higher for South Korea which helps explaining the high growth rates occurred after the 1960s. Cronin et al. (1997) using data from 1961 to 1991 found an ES of 13.01 between telecommunications and capital. The reasons for that may be that the incorporation of telecommunication in the production process allows many firms to expand their locational choice set for some, if not all, functional activities. Such expanded choices can dramatically affect the spatial distribution of economic activities and the type and amounts of capital consumed. For example, just-in-time inventories reduces both a firm's working capital for goods in process and its fixed capital for plant. Usage of communications increase in such cases.

Consistent with La Grandville (1989), falling telecommunications and high ES are in fact associated with substantial changes in input mix. The relative and absolute consumption of telecommunication increased significantly and substitution of telecommunication for other factor inputs produced substantial economy-wide resource savings. Thus the evolution of the American economy toward an information based structure combining computers, data, and telecommunication can be explained by the character of agents' reactions to changes in relative real prices and technology.

In addition, Duffy and Papageorgiou (2000) using a CES on a cross-section of 82 countries found an ES greater than one for developed countries and less than one for developing countries. They suggest that the value of ES may be associated with the development stage of countries. In both cases, they reject the Cobb-Douglas production function. Genç and Bairam (1998) using a Variable Elasticity of Substitution (VES) production function for 12 OECD countries found that the average ES was higher than 1.

The major empirical finding is the diversity of results; small differences in period and estimation procedure seem to produce markedly different estimates. Our purpose here is related to Berndt's paper and Brown and De Cani (1963), providing new estimates to the ES using an updated data set and comparing alternative specifications and data periods for the ES. To estimate the ES, we need to move from the standard

Cobb-Douglas production function (the elasticity of substitution is always one) used in virtually all growth models to a production function that allows the elasticity of substitution to have any value. In this case, one natural candidate is the CES production function popularized by Arrow et al., but we will also use a Variable Elasticity of Substitution (VES) production function. Using an updated data set and comparing different estimation techniques can help to shed some light on the empirical debate about the value and stability of the ES over time.

Chapter 3

Estimating the Elasticity of Substitution

3.1 Introduction

As showed above, a large number of econometric studies have estimated the ES for the US economy. The results found are generally sensitive to sample size and estimation technique. Nonetheless we still can make some inference about the general result: the ES is likely to be changing over time and it is not equal to one. Our main econometric task is to estimate the ES and test its stability over the sample period. There are several ways to estimate the ES (see Nerlove (1967) and Hamermesh (1993) for surveys), but the different techniques can divided in two main groups. One group estimates the ES through direct estimation of the production function. We call that direct estimation of the ES. The three main methods to get direct estimates use the CES and the Variable Elasticity of Substitution (VES) production functions.

The second group which is called indirect estimation use the relationship between the ES and factor shares to get the estimates. In the CES production function, the ES is estimated indirectly via the first-order profit maximization condition for the employment of labor. From a practical point of view, as pointed out by McFadden (1978), the method chosen to estimate depends on data availability. However, as shown by Mizon (1977, p. 1223), the estimation of production functions by direct estimation is often preferable to indirect estimation, as we are able to provide estimates for a larger set of production functions using a common estimation technique and data set. Here, we perform only the direct methods, as described below.

We are going to estimate the ES using a Constant Elasticity of Substitution (CES) and a Variable Elasticity of Substitution (VES) production function. Duffy and Papageorgiou (2000) use the CES production function for a panel of 82 countries over the period 1960-1987 and find that the ES is different from one (therefore it rejects the Cobb-Douglas) and the ES was higher ($ES > 1$) for developed countries than for developing countries ($ES < 1$). Genç and Bairam (1998) use the VES for 12 OECD countries (1965-1986) and show that the average ES was higher than 1.

Even though both papers points to a ES higher than 1 for developed countries, the variety of results found elsewhere in the literature (see Nerlove (1967), Berndt (1976), and Hamermesh (1993) for surveys) or the apparent lack of robustness, may indicate some potential misspecifications. A major problem estimating the ES is the impossibility theorem (Diamond, McFadden, and Rodriguez (1978)). The impossibility theorem is related to the non-identifiability of the elasticity and technical change bias in the absence of a priori hypotheses on the structure of technical change. In our case, assuming neutral technical change is sufficient for identification.

In addition, Kumar and Gapinski (1974) and Thursby (1980) comparing different estimation procedures to estimate the CES production function found that reliable results are obtained for all parameters, but the ES. The main problem is that the expected value of the estimator of the ES does not exist under certain conditions and even that it exists, the variance may be large. One can possibly avoid the problem of the nonexistence by estimating the ES directly (as we propose here), but this does not necessarily avoid the problem of a large variance. We exploit such potential problems estimating the CES below.

The VES gives us more flexibility on estimation, as the functional form of the production form is determined by the data. However, its complexity may prevent its use on theoretical work. Also, it is assumed that the transformation simultaneously yields the appropriate functional form and disturbances that are normally distributed. In general, we have seen the use of one method or the other, but not both. If the use of the VES gives us more flexibility, estimating a CES make our results more comparable to most of the existent empirical literature. Therefore, estimation of the ES using both production functions for a larger data set may shed some light on the value of the ES.

Since the true technology is unknown, the use of a flexible form may be have his legitimacy. As pointed out by Guilkey, Lovell, and Sickles (1983), evaluating the performance of flexible forms on the basis how well they fit observed data is useful if interest centers on the data, but may be misleading if interest centers on the functional forms themselves. Also, using the indirect method, ElBadawi, Gallant, and Souza (1983) using a Fourier flexible cost form estimated consistently price and elasticities of substitution without a priori knowledge of the functional form.

Two important issues when estimating the ES are the existence of an aggregate production[1] and the stability of the ES. The conditions for the existence of an aggregate production function are "far too stringent to be believable" to quote F. Fisher (1971, p. 305) . For linear aggregation of linear models, consistency is an exceptional result (Theil, 1954). For nonlinear models the odds against aggregate are generally worse (Barker, 1970) . Empirically, applied economists usually assume that aggregation give reasonable "approximation" so long as elasticities are similar and we do not have a large structural change in output.

Sterner (1990) estimates the ES at different levels of aggregation for Mexican industries. Elasticities for aggregated industries are compared to the average of the

[1]See Felipe and Fisher (2002) for a recent survey on aggregated production functions.

elasticities estimated from data at the individual industry level. The main result is that is not certain that aggregate elasticities will coincide with or even be close to average ones. A possible interpretation of elasticities at the aggregate and industry level is necessarily different since aggregate elasticities include substitution arising as a result of structural change [2].

There is no reason why average and aggregate elasticities should coincide. If, for instance, we are looking at an aggregate composed of a number of individual industries and one of these, the most labor intensive of all, happens to grow more slowly than average, than this will tend to push down the labor coefficient for the entire aggregate. Other factors may be influencing the relationship between aggregate and average elasticities, such as differences in factor prices.

Fisher et al. (1977) estimating a CES through monte carlo simulation show that aggregate estimates do give reasonable results, except for the substitution parameter. As we shall see below, the CES may produce unreliable results for the substitution parameter independent of using aggregate data or not.

The second issue in estimating the CES is whether the ES is really constant. Flexible functional forms have been suggested (Revankar(1971), Lovell (1973), R. Sato (1970), Bairam (1991) and others) that allow substitution between inputs to be unrestricted. Empirically, the use of structural break tests may shed some light on the constancy of the ES. The general conclusion is that the value of ES can vary significantly depending on the sample and estimation technique. On the next section we define the ES based on the CES and the VES production functions.

3.2 The CES Production Function

Using the Constant Elasticity of Substitution (CES) production function defined

[2] Sterns uses a translog production function with 5 inputs: electricity, fuels, intermediate materials, labor, and capital to estimate the ES.

by ACMS (1961):

$$Y = F(K,L) = A[\alpha K^{-\rho} + (1-\alpha)L^{-\rho}]^{-\frac{\upsilon}{\rho}} \tag{3.1}$$

Where Y is the output, K is Capital, L is Labor. A,α,ρ,and υ are called the efficiency, input intensity, substitution parameter and the degree of returns to scale respectively. Also, we assume that $A > 0$, $0 < \alpha < 1$, $\upsilon > 0$, and $\infty \geq \rho \geq -1$. The elasticity of substitution(σ) is defined as [3]:

$$\sigma = \frac{d(K/L)}{K/L} \Big/ \frac{d(dK/dL)}{(dK/dL)} = \frac{d(K/L)}{dMRS} \frac{MRS}{(K/L)} \tag{3.2}$$

For the ACMS production function, σ has the value $\frac{1}{1+\rho}$ which implies that the elasticity of substitution is constant and depends only on the parameter ρ.

We can estimate equation (3.1) by non-linear least squares or by least squares approximating it with a first-order Taylor approximation [4]. Allowing for Hicks neutrality, our equation (3.1) became (equivalently, we are just adding a trend term -ϕt- for technical change):

$$Y = A[\alpha K^{-\rho} + (1-\alpha)L^{-\rho}]^{-\frac{\upsilon}{\rho}} e^{\phi t + \epsilon_t} \tag{3.3}$$

Where ϵ_t is a random term, assumed to be independently and normally distributed with zero mean and constant variance. Then, taking log of both sides we get:

$$\log Y_t = logA + \phi t - \frac{\upsilon}{\rho} log[\alpha K^{-\rho} + (1-\alpha)L^{-\rho}] + \epsilon_t \tag{3.4}$$

[3] MRS is the marginal rate of substitution between capital and labor.

[4] Here we are going to get only direct estimation of the ES through non-linear least squares. As pointed out by Kmenta, the choice of approximating ρ around 0 was made for its mathematical convenience and based on the fact that empirical literature was finding a range from 0 to 0.5 for ρ. Obviously, the error of approximating the CES by equation (3.1) depends on the extent to which ρ departs from zero.

We can estimate equation (3.4) by nonlinear least squares and obtain the estimator for $\sigma = 1/1+\rho$. Note that if we assume constant returns to scale, $\upsilon = 1$. Assuming Hicks-neutral technical change implies that the output obtainable from a given combination of labor and capital is assumed to grow exponentially in a way that does not alter the marginal rate of substitution between production factors. Therefore, the parameters of our production function are stable over the period of estimation (Bodkin and Klein, 1967).

Once we estimate the elasticity of substitution, we can also test a simple endogenous growth condition implied by a CES production function. Divide both sides of equation (3.1) by L to get an expression for output per capita and assuming constant returns to scale ($\upsilon = 1$):

$$\frac{Y}{L} = f(k) = A[\alpha k^{-\rho} + (1-\alpha)]^{-\frac{1}{\rho}} \tag{3.5}$$

Our marginal and average products for equation (3.5) are respectively:

$$f'(k) = \frac{\partial y}{\partial k} = A\alpha[\alpha + (1-\alpha)k^{-\rho}]^{\frac{(1-\rho)}{\rho}} \tag{3.6}$$

And

$$\frac{f(k)}{k} = A[\alpha + (1-\alpha)k^{-\rho}]^{\frac{1}{\rho}} \tag{3.7}$$

Now, using the standard neoclassical growth model the net increase in the stock of physical capital equals gross investment less depreciation:

$$\dot{K} = I - \delta K = sF(K, L, t) - \delta K \tag{3.8}$$

Where $\dot{K}$ denotes differentiation with respect to time, s is the fraction of output that is saved, δ is the depreciation rate and $F(.)$ is the production function.

The change in the capital stock over time is given by (divide $\dot{K}$ by L):

$$\frac{\dot{K}}{L} = sf(k) - \delta k \tag{3.9}$$

Using the condition:

$$\dot{k} \equiv \frac{d(K/L)}{dt} = \frac{\dot{K}}{L} - nk, \quad n = \dot{L}/L \tag{3.10}$$

And substituting into equation (3.9) and dividing by k we get the growth rate of k, γ_k:

$$\gamma_k \equiv \frac{\dot{k}}{k} = sf(k)/k - (n + \delta) \tag{3.11}$$

Note that using the CES production function the growth rate will depend on the substitution parameter (ρ) as the average product and marginal product both depend on ρ. We can easily show that if we have a high degree of substitution ($\sigma > 1$), the limits of the marginal and average products are:

$$\lim_{k\to\infty}[f'(k)] = \lim_{k\to\infty}[f(k)/k] = A\alpha^{-\frac{1}{\rho}} > 0 \tag{3.12}$$

$$\lim_{k\to 0}[f'(k)] = \lim_{k\to 0}[f(k)/k)] = \infty \tag{3.13}$$

Therefore, the marginal and average products do not go to zero as k grows over time. As already mentioned, the elasticity of substitution can be interpreted as an index of the rate at which diminishing marginal returns set in as one factor is increased relative to the other. If the elasticity of substitution is large, then it is easy to substitute one factor for the other or to increase output by increasing one factor. Therefore, diminishing marginal returns will set in slowly - or not set at all - or the greater the ES the smaller the drag due to diminishing returns. In that case, using equation (3.11), we can have endogenous growth as long $sf(k)/k > (n + \delta)$ or $sA\alpha^{-\frac{1}{\rho}} > (n + \delta)$. Finally, it can be easily verified that if $\sigma < 1$, the marginal and average products approach 0 as k approaches infinity and the model does not generate endogenous growth.

3.3 The VES Production Function

It can be shown that the VES proposed by Bairam (1991a, 1991b) is a generalization of the CES function and has been used successfully in empirical work. In particular, the Box-Cox (1964) transformation is used to obtain the variable elasticity of substitution between the inputs and we estimate the ES without any a priori assumption about the functional form of the production function [5], as described below.

The Box-Cox transformation has been used empirically (e.g., White (1972), Zarembka (1974), Spitzer (1976), among others) to gain some flexibility on functional forms as the data determines the most appropriate one. Since, we do not known a priori the right production function to be estimated, this approach has a great deal of appeal.

Bairam (1991a,1991b) has show that the extended Box-Cox model below can be interpreted as a general production function in which the functional form will be defined by the $\lambda_i \leq 1$ $(i = 0 \ to \ 2)$ values:

$$\frac{(Y^{\lambda_0} - 1)}{\lambda_0} = A + \alpha_1 \left[\frac{(K^{\lambda_1} - 1)}{\lambda_1} \right] + \alpha_2 \left[\frac{(L^{\lambda_2} - 1)}{\lambda_2} \right] \tag{3.14}$$

Where $A, \ \alpha_1, \alpha_2 > 0$ and $\alpha_1 + \alpha_2 = \upsilon$ (degree of returns to scale). The elasticity of substitution (σ) is obtained as:

$$\sigma = -\frac{\alpha_1 K^{\lambda_1} + \alpha_2 L^{\lambda_2}}{\alpha_1 K^{\lambda_1}(\lambda_2 - 1) + \alpha_2 L^{\lambda_2}(\lambda_1 - 1)} \tag{3.15}$$

The VES production function will have the same neoclassical properties as the CES described above. The ES (σ) is not constant as long as $\lambda_1 \neq \lambda_2$. Note also that if $\lambda_0 = \lambda_1 = \lambda_2 = 0$ we get a Cobb-Douglas. That is because using a Taylor expansion, when $\lambda \to 0$, $[(X^{\lambda} - 1)/\lambda] \approx ln \ X$, where $X = Y, L$ or K.

[5] There exists a fair amount of literature late 1970s and early 1980s that use a Box-Cox cost function, e.g., Berndt and Khaled (1979) and Chalfant and Gallant (1985).

If $\lambda_0 = \lambda_1 = \lambda_2$, then we have a CES production function whose elasticity of substitution depends only on λ as $\sigma = 1/(1-\lambda)$. Also, in that case we can rewrite our Box-Cox production function to get the usual CES defined by ACMS (1961) as in our equation (3.1). To show that, let $\lambda_0 = \lambda_1 = \lambda_2 = \lambda$:

$$\frac{(Y^{\lambda}-1)}{\lambda} = A + \alpha_1 \left[\frac{(K^{\lambda}-1)}{\lambda}\right] + \alpha_2 \left[\frac{(L^{\lambda}-1)}{\lambda}\right], \alpha_1, \alpha_2 > 0 \tag{3.16}$$

Rearranging terms:

$$\begin{aligned} Y^{\lambda} &= A\lambda + \alpha_1(L^{\lambda}-1) + \alpha_2(K^{\lambda}-1) + 1 \\ Y &= [A\lambda + 1 - \alpha_1 - \alpha_2 + \alpha_1 L^{\lambda} + \alpha_2 K^{\lambda}]^{1/\lambda} \end{aligned} \tag{3.17}$$

Let $\gamma = (\alpha_1 + \alpha_2)^{1/\lambda}$:

$$\begin{aligned} Y &= \gamma\left[\frac{A\lambda + 1 - \alpha_1 - \alpha_2 + \alpha_1 L^{\lambda} + \alpha_2 K^{\lambda}}{\gamma}\right]^{1/\lambda} \\ &= \gamma\left[\frac{A\lambda + 1 - \alpha_1 - \alpha_2}{\alpha_1 + \alpha_2} + \frac{\alpha_1}{\alpha_1 + \alpha_2} L^{\lambda} + \frac{\alpha_2}{\alpha_1 + \alpha_2} K^{\lambda}\right]^{1/\lambda} \\ &= \gamma[\mu + \beta L^{\lambda} + (1-\beta) K^{\lambda}]^{1/\lambda} \end{aligned} \tag{3.18}$$

Where $\mu = \frac{A\lambda + 1 - \alpha_1 - \alpha_2}{\alpha_1 + \alpha_2}$ and $\beta = \frac{\alpha_1}{\alpha_1 + \alpha_2}$. Note if $\mu = 0$, we get the usual CES production function as defined in equation (3.1).

To estimate equation (3.14), we add an error term ϵ_t and assuming Hicks-neutral technical change as in the CES case:

$$\frac{(Y^{\lambda_0}-1)}{\lambda_0} = A + \phi t + \alpha_1 \left[\frac{(K^{\lambda_1}-1)}{\lambda_1}\right] + \alpha_2 \left[\frac{(L^{\lambda_2}-1)}{\lambda_2}\right] + \epsilon_t \tag{3.19}$$

We can estimate equation (3.19) using maximum likelihood as long as the ϵ_t is normally distributed. However, the distribution of ϵ_t for a Box-Cox is truncated, and therefore, it can not be normally distributed (see, e.g., Judge et al. 1985, pp. 839-842). To proceed with maximum likelihood estimation, we make the assumption, as Bairam (1991a,1991b) and Genç and Bairam (1998)[6] that the truncation effects are negligible and the u_t are approximately independently identically distributed with zero mean and constant variance.

We estimate three specifications of equation (3.19):

a) An unrestricted version, assuming that we have different λ_i for each of the variables (Y, K, and L);

b) Estimate a restricted version, assuming $\lambda_0 = \lambda_1 = \lambda_2$, the CES case. We also test if $\mu = 0$ as defined in equation (3.18). Also, note that the percentage rate of growth of technical change, τ, is given by:

$$\tau = [(\lambda\phi + 1)^{\frac{1}{\lambda}} - 1]100 \tag{3.20}$$

c) Estimate a restricted version, assuming $\lambda_0 = \lambda_1 = \lambda_2 = 0$, the Cobb-Douglas case.

Note that the standard errors will be conditional on the $\lambda_i \leq 1$ ($i = 0$ *to* 2). Details of the transformation necessary to obtain unconditional errors are given in Spitzer (1982). Also, because the implications of $\lambda_0 = \lambda_1 = \lambda_2 = 0$ (the Cobb-Douglas production function) and $\lambda_0 = \lambda_1 = \lambda_2 = 1$ (the linear production function), a confidence interval for the $\lambda_i \leq 1$ ($i = 0$ *to* 2) will be provided. As shown by Judge et al. (1985, pp. 842), a confidence interval can be constructed using the asymptotic normality of the maximum likelihood estimator and its standard error.

The Box-Cox transformation give us more flexibility to estimate the production process, but it has some disadvantages on its own. The most serious one can be illustrated as follows. Consider the simple Box-Cox model:

$$B(y_t, \lambda) = x_t(\beta) + \epsilon_t, \epsilon_t \sim NID(O, \sigma^2) \tag{3.21}$$

[6] See also, Spitzer (1982, pp. 307-380), Judge et al. (1985,p.840) and Greene (1997, pp. 479-485).

For most values of λ (except when $\lambda = 0$ or $\lambda = 1$) the value of $B(y_t, \lambda)$ is bounded either from below or above. In fact, when $\lambda > 0$,$B(y_t, \lambda)$ cannot be less than $-1/\lambda$ and, when $\lambda < 0$, $B(y_t, \lambda)$ cannot greater than $-1/\lambda$. But if ϵ_t is normally distributed, the right-side of equation(3.21) is not bounded and could take any value. Therefore, equation (3.21) can not be used to model y_t. The same is true if we replace $x_t(\beta)$ by a regression that depends on λ (Davidson and MacKinnon, 1993, p. 484).

Davidson and MacKinnon suggest two ways to deal with the problem described above. The first one is to assume that data on y_t are observed only when the bounds are not violated, as in Poirier (1978) and Poirier and Ruud (1979). But it is not clear why data would be generated in such way and both estimation and testing can become very complicated. A second possibility is just ignore the problem - an application of the "ostrich algorithm". As long as λ is nonnegative (or at least not much less than zero) and y_t is positive and large relative to σ for all data, we can be sure that ϵ_t will be small relative to $B(y_t, \lambda)$ and $x_t(\beta)$. Therefore, the probability that $B(y_t, \lambda)$ would violate the bound will be very small. Another potential problem is to assume that the estimated λ is fixed throughout the sample.

We also, in the case of $\lambda_0 = \lambda_1 = \lambda_2$, test an endogenous growth condition which is similar to the one described on equations (3.11-3.13). Similarly, using equation (3.18), we can have endogenous growth as long as $(\alpha_1 + \alpha_2)^{\frac{1}{\lambda}} \left(\frac{\alpha_2}{\alpha_1+\alpha_2}\right)^{\frac{2-\lambda}{\lambda}} > (n + \delta)$ and $0 < \lambda < 1$ (or $\sigma > 1$).

3.4 Data

To perform our tests the following time series data are required: output (real GDP), labor input,and capital input (Tables A.1-A.4 and Graphs B.1-B.4) . Output is real gross domestic product, labor input is labor force employed (or man-hours worked per year) and nonresidential capital stock (includes plant, equipment, and inventories). We estimate the ES for Japan, U.K., and USA. Also, to test the endogenous growth condition, we need data on savings rate. All the savings rate for the three countries were obtained in Maddison (1992) .

a) Japan. The series cover 1890-1991 ($1990). GDP data and capital stock data were obtained from Maddison (1992, 1995a, 1995b, and 2001). Labor input is labor force employed and were obtained from Ohkawa and Rosovsky (1973), Ohkawa, Shinohara and Meissner (1979) and Labor Force Statistics, OECD various years. It is a hard task to get reliable data for Japan during World II, specially labor force. In particular, all the references above do not provide data for labor force in 1945. Our approach was to try different estimates and check how our results changed. The number used on the estimation below assumes that labor force decreased by 5% when compared with 1944. Population growth decreased by 3% during the same time. The unreliability of the data during World War II asks for caution interpreting our results and robustness check are necessary, as described on section 3.5.

b) U.K. The series cover 1870-1991 ($1990) and the GDP data and capital stock data were obtained from Maddison (1992,1995a, 1995b, and 2001). Labor input is labor force employed and were obtained from Feinstein (1976) and Labor Force Statistics, OECD various years.

c) USA. We have two data sets for the U.S. The first one covers 1890-1992 ($1990) and the GDP data and capital stock data were obtained from Maddison (1992,1995a,1995b, and 2001). Labor input is measured in man-hours worked per year and was obtained from Kendrick (1961), Kendrick and Grossman (1980), and BEA, various years. The second data set was entirely collected from BEA, various years. Here we have two measures for labor input, man-hours worked and labor force employed. The series covers 1929-2000 ($1996). The use of chained (1996) dollars (and chain-type quantity indexes) provide the best available measures of how a particular series changes over time. However, we have to be caution comparing across chained (1996) dollar components of GDP. For instance, during the years of World War II, the residual (the difference between GDP and the sum of the most detailed component series) is quite large. We later will try to address such pitfalls on the data.

3.5 Robustness Analysis

On this section, we describe the structural break tests used and the bootstrap procedure. We will be focusing especially in the stability of the ES and construction of bootstrap confidence intervals for all estimators.

3.5.1 Structural Stability Tests

Structural change means that at least of one the parameters has changed at some date in the the sample [7]. We propose the most common test used in the literature, e.g., the Chow-Quandt test (see, Pesaran et al. (1985) and Greene (1997, pp. 349-369)) and the residual variance test suggested by Bai and Perron (1998,2003). Here, we are interested in two issues: the existence of a break (Chow-Quandt's test) and the timing of the change (Bai and Perron test). For the VES case, we do not apply same tests since λ affects not only the functional form of the regression function but also the properties of the residuals, a different procedure may be necessary to check structural break on Box-Cox models.

3.5.2 Testing for Structural Change of Unknown Timing

The most common structural change test, attributed to Chow(1960), is generally used to check breaks of unknown timing on a regression. The usual procedure consists in splitting the sample in G mutually exclusive groups ($n > k$), such that $n_1 + n_2 + ... + n_G = n$. Then, we test the equality of the set of parameters using a classic

[7]See Hansen (2001) , for an updated survey on structural change break tests - this section is heavily based on Hansen's paper.

F statistic. One drawback of this test is that we need to know the break point a priori. As pointed out by Hansen (2001), a researcher has only two choices: two pick up an arbitrary candidate break point or to pick a breakdate based on some known feature of the sample. In the first case, the test may be uninformative, as we may miss the true breakpoint. In the second case, the Chow test can be misleading, as the candidate breakdate is endogenous - and therefore correlated with the data. Results can be very sensitive to these arbitrary choices.

The solution is to assume the breakpoint as unknown, as suggested by Quandt (1960). The basic idea is to plot the sequence of Chow statistics as function of candidate breakpoints and choose the largest one as the possible breakdate. To compute the Chow statistic, we split the sample at each breakdate and estimate the model parameters separately on each subsample, as well as their covariance matrices. If the true parameters are constant, the subsample estimates should be roughly constant across candidate breakdates. But if there is a structural break, then the subsample estimates will vary systematically across candidate breakdates, and this will be reflected in the Chow test sequence.

Specifically, the Chow-Quandt test is implemented as:

1 We combine all the observations and obtain the residual sum of squares (RSS) - say RSS_0.

2 Divide the data (say samples n_1 and n_2) and estimate each subsample separately and obtain their RSS (say RSS_1 and RSS_2). Add these two RSS, say $RSS_3 = RSS_1 + RSS_2$.

3 Obtain $RSS_4 = RSS_0 - RSS_3$.

4 Calculate the Chow statistics as: $F = \frac{RSS_4/k}{RSS_3/(n_1+n_2-2k)}$, where k is the number of parameters estimated.

5 We test Ho:structural stability against Ha: structural change.

In practice, if we know the breakdate a priori, then the chi-square distribution can be used to assess statistical significance. If the breakdate is unknown, then the chi-square distribution is not appropriated and we have to use Andrews (1993) and Andrews and Ploberger (1994) critical values. These asymptotic critical values are considerably larger than the comparable chi-square ones. Also, we have to decide the number of breakdates. The conventional solution is to consider all breakdates in the interior τ percent to $1-\tau$ percent of the sample, where the trimming parameter is typically between 5 and 15% - we use 10%.

3.5.3 Testing the timing of Structural Change

To estimate the timing of the structural change, we use the residual variance test suggested by Bai and Perron (1998, 2003) (hereafter BP) . Their test allow to check for multiple break points, to check various hypotheses about the structure of the data and errors across subsamples, and to construct confidence intervals for the break dates. Their develop two tests for multiple structural changes. The first one is a test of no break versus a fixed number of breaks (called sup F). The second ones is labelled sup $F_T(\ell+1|\ell)$ and allows to test for ℓ versus $\ell+1$ breaks. The second method amounts of $(\ell+1)$ tests of the null hypothesis of no structural change versus the alternative hypothesis of a change. We can conclude in favor of a rejection in favor of a model with $(\ell+1)$ breaks if the overall minimal value of the sum of the squared residuals is sufficiently smaller that the sum of squared residuals from the ℓ breaks model. The break date thus selected is the one associated with this overall minimum [8].

To determine the number of breaks, their use a sequential application of the sup $F_T(\ell+1|\ell)$. The procedure to estimate the number of breaks is starting a model with no breaks (or a small number of breaks). Then perform parameter-constancy tests

[8] Critical values for these tests are given in BP(1998, 2003).

for each subsample, adding a break to a subsample associated with a rejection with the sup $F_T(\ell+1|\ell)$. This process is repeated increasing ℓ sequentially until the sup $F_T(\ell+1|\ell)$ fails to reject the null hypothesis of no additional structural changes.

Here, we are interested in estimating the number and timing of the breaks. Therefore, their method seems to be adequate to our purpose. The intuition is that when there are multiple structural breaks, the sum of squared errors (as function of the breakdate) can have a local minimum near each breakdate. Therefore, the global minimum can be used as a breakdate estimator, and the other local minima can viewed as candidate breakdate estimators. BP develop an algorithm to obtain such global minimizers of the sum of squared residuals.

To implement the tests, we used Bai and Perron Gauss program[9]. In addition, their program gives two other tests used to check multiple structural breaks, the Bayesian Information Criterion (BIC) suggested by Yao (1988) and a modified Schwarz Criterion (LWZ) as defined by Liu, Wu, and Zidek (1997)[10]. As in BP, we allowed the program to have up to 5 break points [11] and we used a trimming of 15% which corresponds to each subample having at least 10 observations in our data. One drawback of the test is that the program will allow only linear estimation and therefore we have to use a linearized constrained (with constant returns to scale) version of the CES production function[12].

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[9]The code is available at Perron's webpage: http://econ.bu.edu/perron/code.html.

[10]The BIC suggested by Yao is defined as:

$$BIC(m) = ln\hat{\sigma^2}(m) + p^* ln(T)/T \tag{3.22}$$

Where $p^* = (m+1)q+m+p$ and $\hat{\sigma^2} = T^{-}1S_T(\hat{T}_1...\hat{T_m})$. Also, S_T is the sum of squared residuals, $\hat{T}$ are the estimated break points, p and q are regressors, m is a subsample of T observations.

And the LWZ is calculated as:

$$LWZ(m) = ln(S_T(\hat{T}_1..., \hat{T_m})/(T-p^*)) + (p^*/T)c_0(ln(T))^{2+\delta_0} \tag{3.23}$$

With $\delta_0 = .1$ and $c_0 = .299$.. We are also going to report the BIC and LWZ.

[11]The reason we used 5 is because Bai and Perron give critical values only if you have such restriction.

[12]The equation used was

$$log\ y = a + \phi t + \beta_1 logk + \beta_2[logk]^2 \tag{3.24}$$

Where $y = Y/L$, $k = K/L$. Also, we can recover the parameters of the CES as: $\rho = -2\beta_2/(\beta_1(1-\beta_1))$, $\alpha = \beta_1$, and $A = e^a$.

3.5.4 Bootstrap

The bootstrap [13] is a resampling procedure that allow us to get artificial data sets who mimic the process originally used to select the real sample. Then, we can estimate the statistical accuracy of our estimators by comparing them with the results provided by analyzing the artificial data sets. More precisely, given a sample of n independent identically distributed random vectors $X_1, X_2, ..., X_n$ and a real-valued estimator $\theta(X_1, X_2, ..., X_n)$ (denoted $\hat{\theta}$) of the distribution parameter θ, a procedure (the bootstrap) to assess the accuracy of $\hat{\theta}$ is defined in terms of the empirical distribution F_n. This empirical distribution function assigns probability mass $1/n$ to each observed value of the random vectors X_i for $i = 1, 2, ..., n.$. The bootstrap distribution for $\hat{\theta} - \theta$ is the distribution obtained by generating $\hat{\theta}$ by sampling independently with replacement from the empirical distribution F_n. The bootstrap estimate of the standard error of $\hat{\theta}$ is then the standard deviation of the bootstrap distribution for $\hat{\theta} - \theta$.

In practice, we take a random sample of n observations, with replacement, and get a estimator for the artificial data set. From the bootstrap sampling a Monte Carlo approximation of the bootstrap estimate is obtained:

(1) Generate a sample of size n (where n is the original sample size) with replacement from the empirical distribution (a bootstrap sample).

(2) Compute θ^*, the value of $\hat{\theta}$ obtained by using the bootstrap sample is place of the original sample.

(3) Repeat steps 1 and 2 k times. For standard error estimation, k is recommended to be at least 100.

We construct bootstrap confidence intervals for all parameters estimated in both the CES and the Box-Cox production functions.

[13] This section is based on Chernick (1999), pp 1-11.

3.6 Analysis of the Results

The results for the CES production function are shown on tables A.5 to A.8, by country and data set. We have four set of results for each data set. We estimate an unrestricted and restricted versions (constant returns to scale or $\upsilon = 1$ of the CES on equation (3.4))with and without trend. For the U.S. both Maddison and BEA's data show some problems in the estimated parameters, as some of the coefficients do not have the expected sign or are not significantly different from zero and some are outside the parameter space permitted by production theory. (e.g., some values of α, the input intensity parameter are greater than one). The trend term seems to be important and is significant in all cases. Our focus will be on the substitution parameter and we noticed that for Maddison's data, we get the right sign and is significant in two out of four cases. For the BEA's data, the parameter implies a negative ES for threes cases, but is significant in three cases also. Using UK data, we found the substitution parameter be significant in three cases. In the Japan case, the substitution parameter is not significant, but it has the expected sign in all cases. Overall, we get mixed results for the CES production function and some of potential mispecifications will be addressed below.

In the VES case (tables A.9 to A.12), we have two set of estimators, with a trend and without trend. Unfortunately, we did not get convergence for the general case with different λ_i for each of the variables. All results below assume $\lambda_0 = \lambda_1 = \lambda_2$ or that we have also a CES production function. As showed before, we still can test against the Cobb-Douglas and the standard CES production function.

We first test $\lambda_0 = \lambda_1 = \lambda_2 = \lambda = 0$, the Cobb-Douglas case. For the U.S., we reject $\lambda = 0$ in three out of four cases. Using U.K. and Japan data, we reject $\lambda = 0$ half of the time. Considering that the trend is significant in all cases, we reject $\lambda = 0$ to U.S. and Japan, but we do not reject for the U.K.. Also, the substitution parameter (λ) is significant in all cases, but for the U.K. Therefore, we can rule out the Cobb-Douglas production function for U.S. and Japan.

The calculated ES are shown on tables A.13 to A.16.

Compared with the usual CES production function, the Box-Cox CES seems to give better estimates for our substitution parameter. We also test our Box-Cox CES production function against the usual CES production function, as described on equation (32). As shown on table A.17, we reject $\mu = 0$ in almost every case. The only exception is Maddison data for the U.S. with no trend. Since the trend is significant in all cases, we do reject the usual CES production function in favor of the Box-Cox one in all cases.

Even though we found evidence to reject the the Cobb-Douglas and the CES to represent the behavior of the aggregate economy, the use of the Box-Cox CES may impose some constrains in the interpretation of the parameters. The fact that $\mu \neq 0$ implies for example that the production function is non-homogenous and we may have positive production with zero inputs. Nonetheless our results have a striking implication for applied and theoretical work as we reject the two most used functional forms.

We finally test the endogenous growth condition with both the ACMS and the Box-Cox production functions (tables A.18 to A.29). We try three different set of parameters (see appendix). In the U.S. case, we do not get endogenous growth using Maddison's data in all cases, but we get two out of 12 cases for BEA's data. In both cases, with the unrestricted model and no trend. For Japan, we get endogenous growth in 3 out of 12 cases, all with the restricted model and no trend. In the UK, we do not get endogenous growth in any of the cases. The use of fixed parameters in our simulations may represent a limitation, but since we are testing a steady-state condition the use of "reasonable" values is still a valid exercise.

3.6.1 Robustness Analysis

We first construct bootstrap confidence intervals (tables A.1 to A.12) to estimate the accuracy of our estimators. In the CES production function the confidence intervals are very wide in all cases for all countries. The bootstrap confidence interval for the Box-Cox CES production function is small for the U.S. and Japan in the model with a trend, but wide for U.K. As already mentioned above, the substitution parameter is not significant for the U.K. and we do not reject Cobb-Douglas for the U.K. The most striking result is the poor performance of the CES production function. We are going to exploit more of its estimators properties on the next chapter.

Then, we check for structural break in our estimators. We use for the CES production function the usual Chow-Quandt test and BP test. The Chow-Quandt test check for an undetermined structural change in the data. We found (graphs B.5 to B.12) the existence of an structural change in all data sets at 10 % level of confidence. Further, we try to determine the timing of the change using BP test (table A.30). We found at least one structural break in every series. In particular, the two world wars and the great depression appears as breaks for almost every data set. Considering only the model with trend (once the trend is significant in all cases), we found breaks for wars (WWI or WWII) or the great depression or both in every data set. Our conclusion is that we can not rule out breaks in our estimation. However, the ideal procedure is to pin down the exact estimator that is changing and that is a point for future research. In any case, we illustrate on chapter 4 how a particular estimator is changing over time using BEA (1929-2000) data.

The strategy used to account for structural breaks is to reestimate the model before and after such breaks. In addition, since most of the official data start to be collected around or after WWII, we reestimate our model using data before and after WWII. For the CES production function, the results are similar to the ones described above. Some parameters are not significant or outside the bound expected by the production theory and the bootstrap confidence intervals are quite wide. The

Box-Cox CES gives better results as before. The elasticities of substitution are shown on graphs B.13 to B.23 and Tables A.31 to A.34.

Based on the robustness analysis, we dismiss the CES production function as a reasonable approximation of the aggregate behavior of the economy. The Box-Cox CES production function gives more reliable estimators and exploiting in more details the econometric properties of such production function should be an interesting topic for further research. If we estimate the ES before and after the WWII, we clearly have an increasing ES in all models with a trend. We finally present the results for the Box-Cox CES production function considering only data after WWII, tables A.35 to A.38. Considering that the trend is significant in all cases, the implied elasticities of substitution are:

a) U.S.: Maddison's data, 1.49 (1946-1992) ; BEA's data, 1.67 (1946-2000);

b) U.K. (1946-1991): 0.76;

c) Japan (1946-1991): 2.94.

Even though we may lack robustness about the 'true' value of the ES, the estimation suggests that the value is changing over time with an upward trend. The implications of such results for growth theory are quite strong. An increasing ES over time can help to explain the economic growth process over at least the last one hundred years as output is an increasing function of the ES. In addition, as pointed out by Ruttan (1997,2001), to understand how the ES changes over time in response to changes in resources endowments and relative factor price seems to be a critical step towards a better understanding of the sources of technical change.

Empirically, most of the literature still relies either on the Cobb-Douglas or the CES production function. Our results are showing that the use of such functional forms may be misleading or at best interpreted with caution. As we are going to show on chapter 5, it may bring some potential problems to estimate the usual Total Factor Productivity parameter for example. Even though our alternative functional form may impose some additional constraints on the interpretation of the parameters, the search of a most reliable aggregate production function seems to be a important gap to be filled in the literature.

3.7 Concluding Remarks

The main conclusion is that the estimates of the ES is likely to be non-unitary and may be increasing over time. The striking implications of such results for economic growth (theoretical and empirical) can be summarized as follows. First, it implies the possibility of multiple growth paths as already pointed in the early theoretical literature.

Second, the use of a Cobb-Douglas production function as the workhorse of almost every growth model (both theoretical and empirical) is a misleading approximation for the behavior of the aggregate economy. The use of a productivity index (as TFP) based on a Cobb-Douglas not only hides the role of the ES as a source of increase in output but also as a source of technical change.

It seems that the fact that the ES was increasing over time passed unnoticed for most economists and therefore were not incorporated in their models. An increasing ES over time as already mentioned plays an important role to understand economic growth and technical change as production is an increasing function of the ES. Our findings shed light on that relationship and incorporating that feature in a growth model may be an important step to understand the microfoundations of technical change.

Finally, some of the techniques available to estimate the ES may give unreliable estimates, give the relevance of the ES for economic growth, to develop a more robust estimator is also a contribution that has to be made.

Chapter 4

Monte Carlo Study

4.1 Introduction

Since we are are trying to compare alternative functional forms, an useful test is to check how those functional form behave if we did know their generation process. Even though such experimentation seems to be a natural step to try, it has not been fully exploited in the literature. Kumar and Gapinski (1974) and Thursby (1980) are the exceptions. However, their experiments only check the properties of the CES production function. In our case, we not only test the performance of the CES but also compare with the Cobb-Douglas and the VES production functions. Our strategy here is to generate data on output using a pre-determined functional form and check the estimators of our flexible Box-Cox model (VES) and the CES production functions. As already shown, we can easily test for a Cobb- Douglas and the usual CES production functions. For instance, if the true data were generated by a Cobb-Douglas, then we should not reject $\lambda_0 = \lambda_1 = \lambda_2 = 0$ in our flexible Box-Cox.

Also, an early literature already have show that you can not get reliable estimators for the substitution parameter of the CES production function. Kumar and Gapinski

(1974) examines the small-sample properties of the non-linear least squares estimators and found that the sum of the squared error function has a high degree of flatness in the substitution parameter direction near the point of the true parameter values. The bias for all estimators of the CES, but the substitution one, was always small regardless of whether the true production surface was specified with multiplicative or additive errors. The bias of the substitution parameter was of order 10^{109}.

Thursby (1980) found similar results comparing four different techniques used to estimate the substitution parameter with the CES. Thursby shows that the main problem with the substitution parameter is that it may not exist under certain conditions and if even it exists, the variance of estimator will be very large. Therefore, the general case is likely to be unreliable estimators for the substitution parameter. We follow the same strategy used by Kumar and Gapinski and Thursby to check the robustness of the substitution parameter.

We also, test our more general Box-Cox CES production function. In particular, we are interested in checking if the "true" production function was generated by our equation (3.18), then rejecting the usual CES with our more flexible functional form. Specifically:

(1) We generate a Cobb-Douglas production function and estimate the CES and the Box-Cox production functions;

(2) We generate the CES production function and estimate the CES and the Box-Cox production functions;

(3) We generate the Box-Cox CES production function and then estimate the Box-Cox.

In all three cases, we randomly generate some error term and use with the selected parameter values and the n observations (the actual sample size) on capital and labor to generate a series for output. The n observations on Y,K,and L are then used to estimate the parameters of the CES and the Box-Cox production functions. One thousand trials of each the experiments are conducted and for each trial we calculate the estimators. The mean and variance of a particular experiment are calculated using the estimates of the parameter and the starting values were always equal to the true values.

4.2 Experiment Design

We have to generate three different production functions to perform our experiments. The Cobb-Douglas production function is defined as:

$$Y = e^{\phi} A K^{\alpha} L^{\alpha-1} e^{\epsilon} \tag{4.1}$$

Where Y is output, K is capital, L is labor, ϕ is a trend term, and ϵ is a random error. To generate our series of output, we use the capital and labor from our data set and assume $\alpha = .3$, $A = 1$, $\phi = .03$ and $\epsilon \sim N(0, 1.75)$.

The stochastic version of CES production function used is the same proposed by Kumar and Gapinski (1974) and Thursby (1980)[1]:

$$Y = e^{\phi} A[\alpha K^{-\rho} + (1-\alpha)L^{-\rho}]^{\frac{-\upsilon}{\rho}} + \epsilon \tag{4.2}$$

Where Y, K, L are output, capital, and labor respectively. We assume $\alpha = .4$, $A = 1$, $\phi = .03$ and $\epsilon \sim N(0, 1.75)$. The substitution parameter (ρ) is set at .35 and 1.35 and υ set at .8 and 1.2. Therefore, we have four parameter combinations for our equation (4.2). The values of ρ and ϵ were chosen to check whether the estimate of the ES ($\frac{1}{1+\rho}$) was biased toward unity (the Cobb-Douglas case) and whether the value of ϵ has any systematic effect on the ES bias. For a given trial, we generate a series of ϵ and used with the 5 parameter values and data on K and L to generate a

[1] Kumar and Gapinski and Thursby also use a multiplicative error term, but the qualitative results are the same.

series for Y. Then, we estimate the parameters of the production function using the information on Y, K, and L. One thousand trials of each of the four different set of parameters is estimated and for each trial we calculate estimates of α, A, ϕ, ϵ and ρ. The mean and standard error of a particular trial are calculated using the $1,000$ estimates of the parameter. Also, the starting values for our procedure are always equal to the true ones.

The data generator process for the Box-Cox CES was defined as:

$$Y = e^{\phi}[\mu + \beta L^{\lambda} + (1-\beta)K^{\lambda}]^{1/\lambda} + \epsilon \tag{4.3}$$

As before, Y, K, L are output, capital, and labor respectively. Where $\mu = \frac{A\lambda+1-\alpha_1-\alpha_2}{\alpha_1+\alpha_2}$ and $\beta = \frac{\alpha_1}{\alpha_1+\alpha_2}$. Note if $\mu = 0$, we get the usual CES production function as defined in equation (3.1). We assume $A = 1$, $\lambda = .5$, $\alpha = .4$, $\phi = .03$, and $\epsilon \sim N(0, 1.75)$.

4.3 Analysis of the Results

We generate data on output using a pre-determined functional form and check the estimators of the CES and Box-Cox CES production functions. Results are shown on tables A.39 to A.44. We first generate the data as a Cobb-Douglas production function (table A.39). The results shown that the Box-Cox CES will not reject a Cobb-Douglas specification [2]. In both models (with and without trend) for all four data sets, the Box-Cox seems to be able to identify the data generator process as being Cobb-Douglas. The usual CES performs poorly in all cases and fails to identify the data generator process as being Cobb-Douglas.

Then, we generate output as a CES production function. When we estimate the

[2]Note that the Cobb-Douglas is a special case for both the Box-Cox CES ($\lambda = 0$) and the usual CES production function.

CES production function [3] three main results emerge (tables A.40 to A.43). If we get the estimated value close to the true one, the variance is usually high. Secondly, we may not get an estimator close to the true value and with a very high variance. Finally, the estimator for ρ performs better with $\epsilon = 1.2$ in the sense that we may be able to get a reasonable estimator with a low variance.

These results were not so surprising considering Gumar and Gapinski (1974) and Thursby (1980). As already pointed out, Gumar and Gapinski show that the sum of the squared error function has a high degree of flatness in the substitution parameter near the point of the true parameter values. Thursby comparing four different techniques to estimate the CES production function found that reliable results are possible for all parameters, but the substitution one. The general conclusion is that is unlikely that we can get a reliable estimator for the substitution parameter using the CES production function, independently of the estimation technique. It is seems that getting "good" results with such production function is a matter of luck, but inferences about the substitution parameter is likely to be misleading.

The controversy and the enormous literature that follows about the "true" production function until 1970s were mostly based on the estimation of the CES production function. Not surprisingly we could not reach a conclusion about such "true" production function and the parameters estimated from it. Even small differences in period and estimation procedure produce markedly different estimates. As an illustration, suppose that we estimate our production function including the observation one by one, so we get an idea how is the estimator is behaving over time. The results are shown on graph B.24. The substitution parameter is by far the parameter that has been changing the most in almost every case.

Third, we generate the data as the Box-Cox CES. The main result (table A.44) is that the Box-Cox production function behaves quite well for all data sets, with the estimated parameter close to the true one with a low variance.

[3] Note that we use the true parameter values as starting values in our estimation.

4.4 Concluding Remarks

Our monte carlo simulations compared the performance of both the usual CES and the Box-Cox CES production functions. The main results can be summarized as follow. First, the usual CES production function seems to be unable to perform well if we force the substitution parameter to go to zero (the Cobb-Douglas case). The results may be related to the unreliability of that functional form to get any reasonable value for the substitution parameter in any situation.

Second, the CES production is also not reliable to estimate the substitution parameter even if the data generator process is CES and we use the true values as starting values. These results have strong implications for the empirical use of this functional form, as it was originally designed to give more flexibility to estimate the substitution parameter. Third, the Box-Cox CES production function performs better in both cases, to recover a Cobb-Douglas production function and to estimate the substitution parameter if the data generator process is also a Box-Cox. The search for flexible functional forms has been a major challenge since the introduction of the usual CES. Our work shows that more needs to be done to be able to get a reliable and flexible functional form that be can used in both theoretical and empirical work.

Chapter 5

The Elasticity of Substitution and Total Factor Productivity

5.1 Introduction

The recent literature on developmental accounting has focussed on the question of decomposition of output per worker. In particular two papers, Hall and Jones (1999) and Klenow and Rodriguez-Clare (1997) showed that most of the variation in output per worker could be attributed to variations in total factor productivity and not to differences in physical capital or human capital stock. This led to a revival in interest in the causes of "TFP growth". Most papers in this literature tend to assume a Cobb Douglas Production Function which forces a unit elasticity of substitution and fixed shares of capital and labor across countries. While this is a useful device for allowing TFP comparisons across countries, in keeping with the spirit of the rest of this dissertation in this chapter we investigate the consequences for these decomposition results if the elasticity of substitution (ES) is no longer one. Specifically, we solve for a production function that allows the ES to assume any value (e.g., CES) and using data for a cross-section of countries, also derive the correlation between the ES and TFP.

As already pointed out, estimation of the contribution of technical change to growth and its nature (neutral or biased) simultaneously brings out potential identification problems. Instead of dealing with such potential econometric misspecifications, our strategy is simply establish the correlation between the ES and TFP growth through a simulation. In this case, we are not only able to get some indication about the nature of technical change but also its role on economic development- a change in the ES is by definition one form of biased technical change.

There are two general types of technological change: neutral and non-neutral. A neutral technological change produces a variation in the production, but does not alter the marginal rate of substitution. A non-neutral technological change alter the production function and can be either labor-saving or capital-saving. In terms of an abstract technology, variations in the efficiency of the technology and economies of scale produce neutral technological change. Non-neutral technological change is produced by variations in the capital-intensity of a technology and the elasticity of substitution (ES).

In theory, assuming that there exists a well-defined production function we should be able to sort out the influence of each individual component on output. In practice, it is very hard to distinguish the contribution of each of them since these characteristics are highly interdependent. Based on the relationship between output and factor inputs, we can empirically estimate the contribution of technological differences. The main approach used to capture such contribution is based on the existence of an aggregate production function, but the very existence of such simple and stable relationship is uncertain and controversial - see Jesus and Fisher (2003) and chapters 3 and 4 - especially on empirical grounds. However, an aggregate production function is still a powerful theoretical tool to help exploit the determinants of economic growth.

The main issues are how to estimate TFP and how to explain its variation across countries. Recently, several attempts have been made to explain TFP and its relationship with economic growth (Klenow and Rodriguez, 1997; Prescott, 1998; Hall and

Jones, 1999; Easterly and Levine, 2001 ; Chanda and Dalgaard, 2002). They have shown that variation in TFP explains the differences in income per capita across country and then some attempts were made to explain such differences. Hall and Jones (1999) found large variation in the level of TFP across countries and attributes such variation to differences in institutions and government policies (which they called social infrastructure). Prescott (1998) concludes that factor accumulation can only account for a small portion of the income differences across countries and to quote Prescott "what is all-important is TFP". Easterly and Levine (2001) also shows that although physical and human capital may play a role in accounting for economic progress, it is something else - TFP - that accounts for the bulk of cross-country differences in both the level and growth rate of per capita GDP. Chanda and Dalgaard (2002) shows that the structure of the economy may matter to account for the differences in TFP across countries. In particular, they show that the allocation of resources across sectors of the economy seems to be important. Their decomposition suggest that between 30 to 50 percent of the TFP variation across countries can be attributed to the composition of output.

Their work builds a step towards a better understanding of what is the contribution of technology to economic growth and how to account for income differences across countries. However, all of them still rely on the Cobb-Douglas production function whose fragility has been shown in chapters 3 and 4. Even though all the organizing principle of developmental accounting has been based on a Cobb-Douglas aggregate production function, their results may be misleading or be interpreted with caution. We reject the Cobb-Douglas specification as a fair representation of the aggregate economy for three countries using more that one hundred years of data. In addition, under a Cobb-Douglas, all technical progress is by definition neutral. Most of the studies that deals with this issue (Chin, 1993 for a survey) find technical change to be labor-augmenting.

Our contributions are twofold. First, we introduce a production function that may have any elasticity of substitution - non-neutral technical change. In our simulations, we allow for different values of the ES. In chapter 2, we tested two different production functions that allow the ES to assume any value. In particular, we have show that a Box-Cox production function may represent better the behavior of the aggregate economy than the usual CES. Also, in chapter 3, we showed that the CES may not be reliable to provide information about the substitution parameter. However, here we are going to use only the usual CES as justified below. Secondly, we consider differences in capital intensity to explain the variance in TFP across countries. Our main findings are that CES produces considerably lower values for TFP ratio compared to the ones using a Cobb-Douglas. But still the variation in TFP across countries is very important to explain income per worker differences. Dividing the data in high and low capital-adjusted labor ratio countries implies that role of the ES and factors of production increases substantially to explain income differences. In section II, we describe estimation methods for TFP growth and the data set used. In section III, we discuss the results. Section IV concludes.

5.2 Measuring TFP growth: Theory and Evidence

Estimation of the contribution of technical change to growth is usually made through growth accounting. The method consists in breaking down the contribution of the growth of inputs and technology to the growth rate of output. We usually have two ways to get the contribution of technological change to economic growth even though in both cases the its contribution to growth is found as a residual called Total Factor Productivity (TFP). The first approach just calculates the average growth rates of output and inputs (usually labor and capital) and the residual is assumed to represent the contribution of technical change to the growth rate of output. The second approach uses regression techniques to estimate the contribution of each input to output growth and once again the residual is assumed to be the contribution of technological change to output growth. Both approaches are described below.

Using a general 2-factor production function with capital (K) and labor (L) as inputs:

$$Y(t) = \phi(t)F(K(t), L(t)) \tag{5.1}$$

Where Y is output and $\phi(t)$ is an index of the level of the technology - also called total factor productivity (TFP). Taking logs and derivatives of equation (5.1), the growth rate of output is:

$$\begin{aligned}\frac{\dot{Y}}{Y} &= \frac{\dot{\phi}}{\phi} + \phi\frac{\partial F}{\partial K}\frac{\partial K}{\partial t} + \phi\frac{\partial F}{\partial L}\frac{\partial L}{\partial t} \\ &= \frac{\dot{\phi}}{\phi} + \phi\frac{F_K}{Y}\dot{K} + \phi\frac{F_L}{Y}\dot{L} \\ &= \frac{\dot{\phi}}{\phi} + (1-\beta)\frac{\dot{K}}{K} + \beta\frac{\dot{L}}{L} \end{aligned} \tag{5.2}$$

Note that $(1-\beta) = \frac{\partial Y}{\partial K}\frac{K}{Y}$ and $\beta = \frac{\partial Y}{\partial L}\frac{L}{Y}$ which under perfect competition and constant returns to scale are the shares of capital and labor respectively.

The growth rate of output equals the growth rate of TFP and an weighted average of the growth rates of the inputs. Once we have data on Y, K, and L and we can get the weights calculating factor shares, the only missing term is the growth rate of TFP ($\frac{\dot{\phi}}{\phi}$). Then, rearranging equation (5.2):

$$\frac{\dot{\phi}}{\phi} = \frac{\dot{Y}}{Y} - \left[(1-\beta)\frac{\dot{K}}{K} + \beta\frac{\dot{L}}{L}\right] \tag{5.3}$$

Therefore, TFP growth rate can be measured as a residual. Strictly speaking, the residual accounts for anything other than labor and capital. Usually the functional form used to calculate TFP growth is a Cobb-Douglas (Solow 1957 is the pioneer). In almost every case, technology is considered neutral.

If we have a Cobb-Douglas production function with capital and labor as inputs:

$$Y = AL^{\beta}K^{1-\beta} \tag{5.4}$$

It implies that the growth rate of Total Factor Productivity (TFP) as in equation (5.3):

$$\frac{\dot{\phi}}{\phi} = \frac{\dot{Y}}{Y} - \left[(1-\beta)\frac{\dot{K}}{K} + \beta\frac{\dot{L}}{L}\right] \tag{5.5}$$

Considering a hypothetical country with growth rate of output per person equal to 2%, growth of rate of capital per capita equal to 3%,zero growth rate of labor and $\beta = .7$ then TFP growth is 1.1% and therefore the contribution of TFP to output growth is 55%(1.1/2).

And, if we have a Constant Elasticity of Substitution (CES)production function with constant returns to scale:

$$Y = A[\alpha K^{-\rho} + (1-\alpha)L^{-\rho}]^{-\frac{1}{\rho}} \tag{5.6}$$

And assuming constancy of $\frac{\dot{A}}{A}$,$\frac{\dot{L}}{L}$, and $\frac{\dot{K}}{K}$, implies that the TFP growth is:

$$\frac{\dot{\phi}}{\phi} = \frac{\dot{Y}}{Y} - \left[(1-\beta)\frac{\dot{K}}{K} + \beta\frac{\dot{L}}{L}\right] + \frac{1}{2}\beta(1-\beta)\left[\frac{\sigma-1}{\sigma}\right]\left[\frac{\dot{K}}{K} - \frac{\dot{L}}{L}\right]^2 \tag{5.7}$$

Notice that the TFP growth for a CES production function is the Cobb-Douglas one plus an extra term. If the elasticity of substitution is equal to one, the second term disappears and we have a Cobb-Douglas again.

In both cases, the contribution of technical change is estimated as a residual. Once we have the growth rates of output, capital, labor, and the values of the elasticity of output with respect to the inputs - which under perfect competition and a Cobb-Douglas production are just the factor shares - we can easily calculate the contribution of technical change to the growth rate of output.

The values of factor shares can be used to approximate the values of the elasticities or we can estimate them by regression. Usually, the regression estimators are higher than the values that come out from the national accounts. A lower capital share implies a large change in $\frac{\dot{A}}{A}$ and a high capital share implies a small variation of $\frac{\dot{A}}{A}$. This problem raises an important question about which one is more appropriate to use. We can of course constrained our regression to use the value of the factor shares, but we still need to justify the use of any of them. In a regression, this problem arises because the variation in $\frac{\dot{A}}{A}$ is calculated as a residual. In a production function with capital and labor, β will be the one that minimizes the variation in $\frac{\dot{A}}{A}$. Since the growth rate of labor is relatively constant over time, our regression chooses a $1-\beta$ best suited to explain changes in $\frac{\dot{Y}}{Y}$ from changes in $\frac{\dot{K}}{K}$.

It is straightforward to notice that the size and stability of the residual depends on at least three factors: the form of the production function; adequate measurement of the inputs; other variables not included on the production function.

Assuming that we have included and measured appropriately all relevant inputs, our only concern should be the form of the production function. Most of the literature uses a Cobb-Douglas production function to estimate TFP. However, its uses is at best controversial. One of the main limitations is the fact that all technical change is considered neutral. As already showed, changes in the ES and capital intensity are also part of technical change and should be included. The use of a Cobb-Douglas was justified by the fair amount of inconclusiveness about the appropriate specification and by the convenience of its interpretation. However, as showed in chapters 3 and 4, the Cobb-Douglas is not a fair representation of the aggregate behavior of the economy. In addition, we have evidence that the ES is not unitary and may be changing over there. Therefore, the Cobb-Douglas can not be even considered as an approximation of the economy. Even though the Cobb-Douglas may be misleading, the use of alternative specifications can be problematic as well.

The main empirical problem in measuring technical change when we move away from the Cobb-Douglas environment is the impossibility theorem (Diamond, McFadden, and Rodriguez, 1978). In practice, its hard to isolate the contribution of each individual component that represents technical change. For instance, changes in the capital intensity, the ES, returns to scale, and efficiency of the technology are all forms of technical change. The fact that they are highly interdependent may bring serious identification problems to the empiricist even though we can formally derive an expression for TFP growth as in equation (5.7).

Technically, two neoclassical production functions, F and G will be said to be consistent with the data if:

$$Y = F(E_K^F.K, E_L^F.L, t) = G(E_K^G.K, E_L^G.L, t) \tag{5.8}$$

and the marginal products (MPK and MPL):

$$\begin{aligned} MPK &= F_1 E_K^F.K = G_1 E_K^G.K \\ MPL &= F_2 E_L^F.L = G_2 E_L^G.L \end{aligned} \tag{5.9}$$

They show that with no further restrictions on the "errors" E_i^F, E_i^G with $(i = K, l)$, there exists more than one neoclassical production function consistent with any given set of observations provided that the capita-labor ratio does vary over time and the ES is not if fact equal to unity. The two conditions used for identification are:

(1) Considering all technical change as neutral - as we did in chapter 3.

(2) If we drop (1), then all technical change has to be factor-augmenting. It implies restrictions on observations which limit the range of non-identification of the ES. If at a point in time relative shares are unchanging, factor-augmentation is consistent with only two hypothesis - either an ES equal to one or a constant effective capital-labor ratio. If, further, one of the marginal products is declining, it implies that we can rule out the possibility of a constant effective capital-labor ratio.

Instead of dealing with all potential econometric misspecifications, our strategy here is to simply try to establish the correlation between the ES and TFP through a simulation. In a cross-section of countries and given a production function, we should be able to solve for output and get the relationship between technical change (neutral and non-neutral) and economic growth. In particular, we will be focusing on non-neutral technical change (capital intensity and the ES) and how changes on them may affect the variation of output per person across countries.

We use a CES production function for two reasons. It allows us to include non-neutral technical change and has a well-know and straightforward interpretation of the estimated parameters. The CES production is defined as in equation (5.6):

$Y = F(K, L) = A[\alpha K^{-\rho} + (1-\alpha)L^{-\rho}]^{-\frac{\upsilon}{\rho}}$

Where Y is the output, K is Capital, L is Labor. A,α,ρ,and υ are called the efficiency (level of technology), input intensity, substitution parameter and the degree of returns to scale respectively. Also, we assume that $A > 0$, $0 < \alpha < 1$, $\upsilon > 0$, and $\infty \geq \rho \geq -1$. Therefore, we need information on Y, K, L, α, and the substitution parameter. The elasticity of substitution is constant and equal to $\sigma = 1/(1+\rho)$. Note that α is loosely defined as the input intensity and it is not the share of capital. However, we can get the information about the value of α through the factor share equation. Using equation (5.6), we calculate the marginal product of capital:

$$\begin{aligned} MPK &= \frac{dY}{dK} = A(-\frac{1}{\rho})[\alpha K^{-\rho} + (1-\alpha)\,(hL)^{-\rho}]^{-\left(\frac{1+\rho}{\rho}\right)}\alpha\rho K^{-\rho-1} \\ &= \frac{dY}{dK} = A[\alpha K^{-\rho} + (1-\alpha)\,(hL)^{-\rho}]^{-\left(\frac{1+\rho}{\rho}\right)}\alpha K^{-\rho-1} \end{aligned} \tag{5.10}$$

And then we can calculate capital share:

$$\begin{aligned} s_K &= \frac{MPK \times K}{Y} = \frac{A[\alpha K^{-\rho} + (1-\alpha)\,(hL)^{-\rho}]^{-\left(\frac{1+\rho}{\rho}\right)}\alpha K^{-\rho}}{A[\alpha K^{\rho} + (1-\alpha)\,(hL)^{\rho}]^{-\frac{1}{\rho}}} \\ &= \alpha_i \left(\frac{K}{Y}\right)_i^{-\rho_i} \end{aligned} \tag{5.11}$$

Therefore, it depends on values of K, L, α and ρ. The restriction that factor shares must be between zero and one implies that $\alpha \in [0, 1]$. We use (5.11) to get various combinations of α and ρ. In particular, to get the substitution parameter (ρ), we solve for the marginal rate of technical substitution (MRTS):

$$\begin{aligned} MRTS &= \frac{MPL}{MPK} = \frac{A[\alpha K^{-\rho} + (1-\alpha)(hL)^{-\rho}]^{-\left(\frac{1+\rho}{\rho}\right)}(1-\alpha)L^{-\rho-1}}{A[\alpha K^{-\rho} + (1-\alpha)(hL)^{-\rho}]^{-\left(\frac{1+\rho}{\rho}\right)}\alpha K^{-\rho-1}} \\ &= \frac{1-\alpha}{\alpha}\left(\frac{K}{L}\right)^{\rho+1} \\ &= \frac{w}{r} \end{aligned} \tag{5.12}$$

The above implies:

$$\begin{aligned} \frac{1-\alpha}{\alpha}\left(\frac{K}{L}\right)^{\rho+1} &= \frac{w}{r} \\ \frac{1-\alpha}{\alpha}\left(\frac{K}{L}\right)^{\rho+1} &= \frac{wL}{rK}\frac{K}{L} \\ \frac{1-\alpha}{\alpha}\left(\frac{K}{L}\right)^{\rho+1} &= \frac{1-s_K}{s_K}\frac{K}{L} \end{aligned} \tag{5.13}$$

And assuming capital-share (s_K) equal to 1/3:

$$\begin{aligned} \frac{1-\alpha}{\alpha}\left(\frac{K}{L}\right)^{\rho+1} &= \frac{2/3}{1/3}\frac{K}{L} \\ \frac{1-\alpha}{\alpha}\left(\frac{K}{L}\right)^{\rho} &= 2 \\ \left(\frac{K}{L}\right)^{\rho} &= 2\frac{\alpha}{1-\alpha} \end{aligned}$$

Finally, taking logs:

$$\begin{aligned} \rho \log\left(\frac{K}{L}\right) &= \log\left(2\frac{\alpha}{1-\alpha}\right) \\ \Rightarrow \rho &= \frac{\log\left(2\frac{\alpha}{1-\alpha}\right)}{\log\left(\frac{K}{L}\right)} \end{aligned} \tag{5.14}$$

We construct a table for the substitution parameter (ρ) using different values for the capital-intensity parameter (α) in the equation above [1].

Consider two firms choosing their capital labor ratios. Firms with a higher α will choose more capital intensive techniques (ie higher K/L). At the country level, firms with higher K/L may still exhibit lower wage rental ratios if α is too high or if the elasticity of substitution is too low.

Finally to get the variation of output using equation(5.6):

$$\begin{aligned}
Y &= A[\alpha K^{-\rho} + (1-\alpha)(hL)^{-\rho}]^{-\frac{1}{\rho}} \\
&= A[\alpha Y^{\rho} Y^{-\rho} K^{-\rho} + (1-\alpha) Y^{\rho} Y^{-\rho} (hL)^{-\rho}]^{-\frac{1}{\rho}} \\
&= A\left[Y^{-\rho}\left[\alpha\left(\frac{K}{Y}\right)^{-\rho} + (1-\alpha)(\frac{hL}{Y})^{-\rho}\right]\right]^{-\frac{1}{\rho}} \\
Y^2 &= A\left[\alpha\left(\frac{K}{Y}\right)^{-\rho} + (1-\alpha)(\frac{hL}{Y})^{-\rho}\right]^{-\frac{1}{\rho}} \\
\left(\frac{Y}{L}\right) &= \frac{1}{L}A^{1/2}\left[\alpha\left(\frac{K}{Y}\right)^{-\rho} + (1-\alpha)(\frac{hL}{Y})^{-\rho}\right]^{-\frac{1}{2\rho}} \qquad (5.15)
\end{aligned}$$

And taking logs:

$$\ln\left(\frac{Y}{L}\right) = 1/2\ln A + \ln\left(\frac{1}{L}\left[\alpha\left(\frac{K}{Y}\right)^{-\rho} + (1-\alpha)(\frac{hL}{Y})^{-\rho}\right]^{-\frac{1}{2\rho}}\right) \qquad (5.16)$$

Let $X = \frac{1}{L}\left[\alpha\left(\frac{K}{Y}\right)^{-\rho} + (1-\alpha)(\frac{hL}{Y})^{-\rho}\right]^{-\frac{1}{2\rho}}$, the part that is not explained by differences in total factor productivity and therefore explained by elasticities of substitution

[1]Note that in equation (5.14), the values of ρ may have some scale influence because it depends on the capital-labor ratio (or an alternative measure for labor, corrected by human-capital). An alternative way to calculate can be used through equation (5.11), assuming once again that capital-share is 1/3:
$\frac{1}{3}=\alpha\left(\frac{K}{Y}\right)^{-\rho}$
$\Rightarrow \log\frac{1}{3}=\log\alpha - \rho\log\left(\frac{K}{Y}\right)$
$\Rightarrow \log\frac{1}{3} - \log\alpha = -\rho\log\left(\frac{K}{Y}\right)$
Note that in this case whether its K/L or K/hL (h is human capital per worker) that does not matter at all. However, there were no qualitative differences on the results.

and factors.

Now we can derive the variation in output per person as (using equation (5.16)):

$$Var\left[\ln\left(\frac{Y}{L}\right)\right] = \frac{1}{4}Var(\ln A) + Var(\ln X) + \frac{1}{2}CoVar(\ln A, \ln X) \tag{5.17}$$

Therefore:

$$1 = \frac{1}{4}\frac{Var(\ln A)}{Var\left[\ln\left(\frac{Y}{L}\right)\right]} + \frac{Var(\ln X)}{Var\left[\ln\left(\frac{Y}{L}\right)\right]} + \frac{1}{2}\frac{CoVar(\ln A, \ln X)}{Var\left[\ln\left(\frac{Y}{L}\right)\right]} \tag{5.18}$$

Ultimately we need to get a table that can give us three numbers for the above three ratios. Note that in explaining the variance in log output per worker even if the ratio of variance of $ln(A)$ to variance of Y/L is high, it still is reduced to 1/4th of its actual number in explaining the variation in Y/L.

5.2.1 Data

We use the Hall and Jones (1999) data set for 127 countries (table A.45) on output, labor input, human capital and physical capital for the year of 1988. Output and labor input are taken from the Penn World Tables Mark 5.6 revision of Summers and Heston (1991). Human capital measured as average educational attainment for the population aged 25 and over from Barro and Lee (1993). Physical capital stocks are constructed using the perpetual inventory method [2].

Human capital is measured by:

$$H_i = e^{\phi(E_i)}L_i \tag{5.19}$$

[2] They assume the depreciation rate to be equal to 6%.

The function $\phi(E)$ reflects the efficiency of a unit of labor with E years of schooling relative to one with no schooling ($\phi(0) = 0$). An additional year of schooling raises a worker's efficiency proportionally by $\phi'(E)$. If $\phi(E) = 0$ for all E then we have a production function with undifferentiated labor.

5.3 Analysis of Results

Given factor shares, ES decreases as capital intensity increases for all countries. Intuitively, we expect the ES to decrease as the technology become more capital-intensive, as shown on graphs B.25 to B.28. As pioneered by Griliches (1969) and shown more recently by Krusell et al. (2000), capital and labor become more complementary and therefore decreasing the ES. Also, the ES decreases as income per worker increases for α less than .5 and it increases for α greater than .5 (Graphs B.29 to B.33). However, its variance is small across different values of α. It implies that the ES is higher for poorer countries with a low capital-intensity. As capital-intensity increases, the ES decreases, but countries with higher income per capita have a higher ES. This may imply that country with a lower capital-intensity may benefit from an increase in the capital-labor ratio and therefore increase its income per capita (a sort of "big-push" as in the in the development literature, Rosenstain-Rodan (1943) and more recently Murphy et al.(1989)). Note that if the ES remains unchanged in both economies, we would expect that the country in which the K/L is growing faster increases its income with respect with other countries with a lower K/L. For example, if two economies choose investments which are more capital-intensive than their existing technology by the same amount, the gap in income between them will widen even if the factors continue to grow at the same rates. These results resemble Duffy and Papageorgiou (2000) that found in a panel of countries that the ES to be higher for higher income countries.

TFP ratio may increase or decrease as capital-intensity increases (Graphs B.34

to B.36). In particular, TFP ratio to U.S. is decreasing for high income countries but increasing for low income countries. Therefore, low income countries (with low capital-labor ratio as well) may benefit not only from a rise in capital intensity but also through an increase in TFP. However, the most striking result is that TFP relative to the US is significantly lower than Hall and Jones. In fact, our numbers are unusually lower compared with the existent literature (Tables A.46 to A.54 and A.55).

Finally, we present the results for our equation (5.17), table A.56. Variance in A is very high and comparable to Hall and Jones. Variance of countries with higher K/HL is notable higher and variance in Y/L is higher as well. Covariance of (X, A) is negative. Even though covariances may be affected by scales of measurement, it does indicate some negative relationship between X and A. Correlation between relative TFP with different $\alpha's$ is close to one in all cases. Variation in TFP across countries is still very important as in Hall and Jones, according with table A.56. For example, if $\alpha = .1$ our decomposition result shows that:

$$A1 = \frac{1}{4}\frac{Var(lnA)}{Var\ ln[Y/L]} = \frac{1}{4}\frac{19.678}{4.553} = 1.0805 > 1 \tag{5.20}$$

This may imply that the variation in TFP can explain more than 100% of the variation in output per worker. The part that is explained by the elasticity of substitution and factors:

$$X1 = \frac{Var(lnX)}{Var\ ln[Y/L]} = \frac{3.027}{4.553} = 0.664 \tag{5.21}$$

So, factor shares can explain 66% of the variation in output. Then, finally accounting for the negative covariance:

$$AX = \frac{1}{2}\frac{CoVar(lnA, lnX)}{Var\ ln[Y/L]} = -\frac{1}{2}\frac{6.786}{4.553} = -.745 \tag{5.22}$$

We need to apportion the covariance to either TFP$(A1)$ or elasticity and factors $(X1)$. If we apportion it all to TFP, then TFP can explain only $1.08 - .745 \approx .335$

or at best 33.5%. On the other hand, we can not apportion it all to $X1$ since that would mean that TFP explains more than 100% of the variation in output per worker. Using Hall and Jones approach, we could divvy it up and then apportion it and that would give us: $1.0805 - (.5 \times .745) = .708$. So, we get 70% due to TFP and the 30% remaining due to the elasticity of substitution and factors. Therefore, variation if TFP across countries is still very important to explain differences in income per worker as in Hall and Jones.

We also decompose the variance for two different groups of countries[3] that we call high capital-intensity (K/hL greater than 20,000) and low capital-intensity (K/hL less than 1,000)[4]. The results are on table A.57. Now, our variance decomposition exercise shows that TFP(A) differences and the ES and factors of production(X) share almost a half of the variance in income per capita in both groups. For countries with higher K/hL, if we apportion the variance as in Hall and Jones for $\alpha = .1$ it implies that 51% of the variance in income per worker is due to TFP differences ($.969 - (.5 \times .907 = 51.5\%)$) and the remaining 48.5% is due to X. For lower K/hL countries with $\alpha = .1$, apportioning the covariance to X and A it implies that TFP differences accounts for 49.6% of the differences in income per worker ($.899 - (.5 \times .806 = 49.6\%)$) and the remaining 50.4% to the ES and factors of production. Even that we have to interpret these results with caution and more needs to be done, our findings may indicate that the TFP differences may play a more important role for higher K/hL than for lower K/hL countries, but in both cases factor accumulation and the ES may play a big role as well to explain income differences.

[3]The twenty-seven countries that has a K/hL higher than \$20,000 are: Algeria, Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Iceland, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Oman, Puerto Rico, Saudi Arabia, Singapore, Spain, Sweden, Switzerland, U.S.A., U.S.S.R., and Venezuela. The seventeen countries with K/hL lower than \$1,000 are: Angola, Burkina Faso, Burundi, Central Afr.R., Chad, Ghana, Guinea, Madagascar, Malawi, Mali, Mozambique ,Myanmar, Rwanda, Sierra Leone, Tanzania, Uganda, and Zaire.

[4]Duffy and Papageorgiou (2000) does a similar exercise, but they divided the two groups according with income per worker.

5.4 Concluding Remarks

Using a more general production function accounting for changes in the elasticity of substitution and capital-intensity produce considerably lower values for TFP ratio compared to the ones using a Cobb-Douglas. But still the variation in TFP across countries is still very important to explain income per worker differences. Dividing the data in higher and lower K/hL countries implies that role of the ES and factors of production increases substantially. We still have a lot of room to make our findings more sounding. We are assuming that factor shares are fixed across countries. If the capital-intensity and the elasticities are changing, there is no reason a priori for shares to be fixed. Therefore, it is a natural step to consider not only different factor shares across countries but also that they may change as well. Comparing more than one period is also a natural step on the research. Finally, we shall try to use the Box-Cox production function even tough its highly non-linear structure may impose some additional constraints to calculate and interpret TFP.

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APPENDICES

Appendix A

Tables

Table A.1: Data Set. Maddison, USA. 1890-1992.

Year	K	Y	L	Year	K	Y	L
1890	652931	214966	39532	1942	3004823	1320357	97056
1891	681801	224290	40915	1943	3050086	1582978	101633
1892	708880	246045	42773	1944	3088216	1715583	100124
1893	735721	234132	41845	1945	3133168	1646690	94920
1894	760002	227398	39386	1946	3195452	1306889	96671
1895	783108	254851	42968	1947	3279660	1287205	100072
1896	810339	249671	42743	1948	3378052	1335896	99104
1897	841022	273499	44579	1949	3467477	1341076	95641
1898	872310	279197	44771	1950	3551081	1,455,916	100072
1899	906958	304578	49471	1951	3643855	1,566,784	108639
1900	947153	312866	50136	1952	3750173	1,625,245	110898
1901	990833	348089	53195	1953	3875991	1,699,970	112346
1902	1043104	351715	56357	1954	4011186	1,688,804	107976
1903	1104675	368809	58560	1955	4144295	1,808,126	111525
1904	1164051	364147	57174	1956	4278085	1,843,455	113932
1905	1218823	391082	61035	1957	4408092	1,878,063	113581
1906	1276429	436148	64236	1958	4523220	1,859,088	109975
1907	1341062	442881	66046	1959	4628872	1,997,061	113443
1908	1401743	406622	61985	1960	4749400	2,046,727	115018
1909	1455813	456349	66563	1961	4874169	2,094,396	114867
1910	1514213	461011	68831	1962	4990050	2,220,732	118286
1911	1574436	476033	70102	1963	5122629	2,316,765	120243
1912	1636496	498306	72786	1964	5280482	2,450,915	123020
1913	1702796	517990	73839	1965	5463511	2,607,294	127648
1914	1761113	478105	71210	1966	5672606	2,778,086	134003
1915	1807936	491573	70859	1967	5889860	2,847,549	136203
1916	1856425	559429	78007	1968	6112499	2,983,081	139176
1917	1908218	545444	79459	1969	6347846	3,076,517	143070
1918	1958076	594653	78283	1970	6588664	3,081,900	140865
1919	2004790	599832	75422	1971	6839325	3,178,106	140083
1920	2049662	594135	76336	1972	7121745	3,346,554	144171
1921	2087084	580667	68167	1973	7443691	3,536,622	150364
1922	2130095	612782	74269	1974	7778669	3,526,724	150591
1923	2196212	693589	81994	1975	8077663	3,516,825	146515
1924	2270592	714826	79197	1976	8340215	3,701,163	150739
1925	2347316	731402	82429	1977	8614306	3,868,829	155828
1926	2426173	779057	86127	1978	8919285	4,089,548	163112
1927	2501046	786827	86508	1979	9249389	4,228,647	168381
1928	2577302	795633	87083	1980	9568320	4,230,558	167111
1929	2660227	844324	89467	1981	9873454	4,336,141	167779
1930	2736682	769215	81854	1982	10178342	4,254,870	164512
1931	2784271	710164	72386	1983	10467685	4,433,129	166646
1932	2796230	616408	62069	1984	10784472	4,755,958	175036
1933	2789051	603458	61248	1985	11152728	4,940,383	179222
1934	2785993	650078	62366	1986	11514747	5,110,480	180911
1935	2794769	699805	66023	1987	11830664	5,290,129	186477
1936	2819138	799259	73426	1988	12127793	5,512,845	191540
1937	2851955	833446	77568	1989	12460034	5,703,521	197120
1938	2877383	800295	70460	1990	12814617	5,803,200	198829
1939	2899456	864007	75131	1991	13122665	5,774,364	194550
1940	2923258	930828	79694	1992	13377454	5,951,295	195956
1941	2957092	1100211	89276				

Table A.2: Data Set. BEA, USA. 1929-2000.

YEAR	Y	K	L1	L2
1929	10.52	8.65	89467	45606
1930	9.62	7.13	81854	43507
1931	9.01	4.67	72386	40484
1932	7.83	2.80	62069	37042
1933	7.72	2.52	61248	37533
1934	8.55	3.21	62366	40880
1935	9.32	4.07	66023	42388
1936	10.53	5.51	73426	45445
1937	11.08	6.60	77568	46632
1938	10.70	4.84	70460	44779
1939	11.56	5.40	75131	46122
1940	12.55	6.69	79694	48013
1941	14.70	7.88	89276	52603
1942	17.41	4.64	97056	57421
1943	20.27	3.88	101633	63080
1944	21.94	5.15	100124	64252
1945	21.67	7.24	94920	62639
1946	19.27	10.47	96671	56967
1947	19.14	12.20	100072	57260
1948	19.97	12.83	99104	58233
1949	19.85	11.65	95641	56848
1950	21.59	12.72	100072	58527
1951	23.23	13.31	108639	62291
1952	24.16	13.06	110898	63378
1953	25.26	14.23	112346	64165
1954	25.09	13.93	107976	62238
1955	26.87	15.48	111525	63275
1956	27.40	16.37	113932	64426
1957	27.95	16.62	113581	64678
1958	27.68	14.76	109975	62658
1959	29.68	15.94	113443	64136
1960	30.42	16.84	115018	65029
1961	31.13	16.74	114867	64781
1962	33.01	18.19	118286	66134
1963	34.43	19.20	120243	66701
1964	36.43	21.47	123020	67923
1965	38.76	25.20	127648	70180
1966	41.31	28.35	134003	73357
1967	42.34	27.95	136203	75195
1968	44.36	29.19	139176	76990
1969	45.71	31.39	143070	78939
1970	45.80	31.22	140865	78342
1971	47.33	31.21	140083	78007
1972	49.90	34.04	144171	79929
1973	52.78	38.99	150364	83374
1974	52.46	39.30	150591	84690
1975	52.28	35.41	146515	82907
1976	55.19	37.14	150739	85232
1977	57.75	41.32	155828	
1978	60.93	47.15	163112	
1979	62.87	51.88	168381	
1980	62.73	51.85	167111	
1981	64.26	54.77	167779	
1982	62.96	52.72	164512	
1983	65.69	52.19	166646	
1984	70.46	61.37	175036	
1985	73.17	65.49	179222	
1986	75.67	63.73	180911	
1987	78.24	63.65	186477	
1988	81.51	67.11	191540	
1989	84.37	70.83	197120	
1990	85.85	71.35	198829	
1991	85.45	67.83	194550	
1992	88.06	70.11	195956	
1993	90.39	76.00	200002	
1994	94.04	82.78	205644	
1995	96.55	90.89	211074	
1996	100.00	100.00	213881	
1997	104.43	112.22	220201	
1998	108.91	126.29	226867	
1999	113.35	136.60	231281	
2000	118.06	150.17	236014	

Table A.3: Data Set. Maddison, UK. 1870-1991.

Year	K	Y	L	Year	K	Y	L	Year	K	Y	L
1870	86266	95651	13200	1919	177772	216394	19030	1968	697368	574775	26481
1871	88191	100798	13580	1920	179979	203312	19537	1969	734643	585207	26512
1872	90455	101013	13770	1921	183161	186798	17417	1970	772319	599016	26414
1873	92821	103372	13860	1922	186419	196449	17483	1971	811549	611705	26076
1874	95358	105087	13880	1923	189620	202669	17758	1972	849605	633352	26062
1875	98063	107661	13900	1924	193368	211033	18032	1973	887672	675941	26677
1876	100723	108733	13820	1925	198167	221327	18238	1974	925227	666755	26764
1877	103293	109806	13770	1926	202704	213177	18244	1975	959532	665984	26673
1878	105587	110235	13590	1927	206826	230335	18789	1976	992775	680933	26437
1879	107544	109806	13040	1928	211661	233123	18868	1977	1026038	695699	26474
1880	109164	114953	13950	1929	217272	239985	19146	1978	1058087	720501	26634
1881	110707	119028	14300	1930	223842	238720	18788	1979	1091657	740370	27044
1882	112280	122459	14626	1931	230352	226045	18340	1980	1125401	728224	26997
1883	113797	123317	14740	1932	234792	227761	18430	1981	1154599	718733	25978
1884	115266	123531	14040	1933	236755	234049	18813	1982	1182582	729861	25522
1885	116400	122888	14000	1934	238818	249851	19360	1983	1212924	755779	25231
1886	117084	124818	13990	1935	242114	259502	19704	1984	1247248	774665	25920
1887	117665	129751	14530	1936	246402	271297	20321	1985	1284606	802000	26226
1888	118341	135541	15100	1937	252005	280734	20987	1986	1323941	837280	26272
1889	119175	142833	15720	1938	257798	284165	20986	1987	1366394	877143	26797
1890	120324	143477	15880	1939	263115	286953	21800	1988	1415705	920841	27761
1891	121684	143477	15810	1940	267674	315691	20800	1989	1474185	940908	28631
1892	123226	140045	15530	1941	269671	344430	20600	1990	1536432	944610	28913
1893	124923	140045	15500	1942	268901	353008	20700	1991	1593399	930757.8	27978
1894	126717	149482	15780	1943	266160	360729	20200				
1895	128721	154200	16150	1944	261756	346574	19700				
1896	130931	160634	16760	1945	253252	331347	19100				
1897	133429	162778	16950	1946	248958	316978	20300				
1898	136521	170714	17230	1947	254315	312260	21600				
1899	140199	177791	17560	1948	261505	322125	22124				
1900	144121	176504	17530	1949	269487	334135	22300				
1901	148263	176504	17550	1950	278747	347850	22582				
1902	152589	181008	17610	1951	288653	358234	22751				
1903	156706	179078	17720	1952	297995	357585	22677				
1904	160431	180150	17640	1953	307693	371646	22841				
1905	163917	185512	18000	1954	319230	386789	23216				
1906	167331	191731	18440	1955	333954	400850	23542				
1907	170432	195377	18600	1956	352406	405825	23736				
1908	172682	187442	17960	1957	374171	412315	23775				
1909	174463	191731	18140	1958	398593	411450	23609				
1910	176220	197736	18890	1959	423394	428107	25252				
1911	177794	203527	19390	1960	448863	452768	25707				
1912	179091	206529	19490	1961	476219	467694	26001				
1913	180285	214464	19910	1962	503542	472454	26194				
1914	181487	216609	19440	1963	529346	490625	26230				
1915	181693	233981	18400	1964	556910	516584	26545				
1916	180364	239128	17700	1965	588270	529996	26825				
1917	178542	241272	17100	1966	622245	540163	26998				
1918	177384	242774	17060	1967	658923	552277	26633				

Table A.4: Data Set. Maddison, Japan. 1890-1992.

Year	K	Y	L	Year	K	Y	L
1890	27713	40556	23042	1941	247087	214392	31382
1891	28029	38621	23182	1942	263144	214853	30877
1892	28716	41200	23329	1943	279771	211431	30375
1893	29141	41334	23466	1944	298517	206747	29877
1894	30156	46287	23589	1945	271214	156805	28380
1895	31144	46933	23724	1946	238687	120017	32824
1896	32639	44353	23843	1947	248613	125433	33329
1897	34430	45284	23998	1948	259846	135352	34095
1898	35666	53883	24132	1949	269779	138867	34860
1899	36693	49870	24246	1950	276632	160966	36160
1900	37968	52020	24378	1951	282714	181025	36600
1901	38850	53883	24495	1952	290340	202005	37750
1902	39704	51088	24619	1953	299164	216889	39890
1903	40385	54672	24764	1954	308629	229151	40550
1904	41102	55101	24900	1955	318209	248855	41940
1905	42410	54169	24982	1956	330971	267567	42680
1906	44242	61263	25061	1957	347702	287130	43630
1907	46427	63198	25190	1958	366508	303857	43870
1908	48450	63628	25317	1959	392418	331570	42340
1909	50634	63556	25397	1960	431786	375090	43370
1910	52705	64559	25475	1961	485426	420246	43950
1911	55183	68070	25602	1962	550160	457742	44450
1912	58061	70507	25764	1963	622871	496514	44840
1913	60989	71563	25951	1964	704342	554449	45500
1914	63888	69504	26129	1965	790772	586744	46210
1915	66556	75952	26305	1966	881615	649189	47200
1916	69308	87702	26525	1967	995398	721132	48180
1917	73409	90641	26760	1968	1131661	813984	49100
1918	78861	91572	26906	1969	1286191	915556	49570
1919	85443	100959	26986	1970	1466124	1013602	50140
1920	92781	94653	27260	1971	1660155	1061230	50480
1921	99121	105043	27405	1972	1864415	1150516	50590
1922	104635	104756	27635	1973	2087259	1242932	51910
1923	108892	104828	27872	1974	2309053	1227706	51710
1924	112905	107766	27873	1975	2513598	1265661	51530
1925	117492	112208	28105	1976	2713055	1315966	52710
1926	123609	113211	28434	1977	2914942	1373741	53420
1927	130216	114859	28484	1978	3127130	1446165	54080
1928	136842	124246	28826	1979	3359322	1525477	54790
1929	143760	128115	29169	1980	3606127	1568457	55360
1930	150662	118800	29619	1981	3856766	1618185	55810
1931	155767	119803	29936	1982	4102061	1667653	55380
1932	158439	129835	30223	1983	4334008	1706380	57330
1933	160389	142589	30544	1984	4566656	1773223	57660
1934	163600	142876	30827	1985	4812631	1851315	58070
1935	169336	146817	31211	1986	5067987	1904918	58530
1936	177417	157493	31607	1987	5332066	1984142	59110
1937	186789	165017	31695	1988	5630441	2107060	60110
1938	198052	176050	31858	1989	5986053	2208858	61280
1939	213101	203780	32198	1990	6390909	2321153	62490
1940	230111	209728	34177	1991	6827654	2409304	63690

Table A.5: CES, NonLinear Estimation. Unrestricted and Restricted ($\upsilon = 1$, constant returns to scale) Models with Trend and No Trend. USA, 1890-1992.

	1890-1992 Unrestricted	95% Bootstrap Confidence Interval	Bootstrap Bias	1890-1992 Restricted(υ=1)	95% Bootstrap Confidence Interval	Bootstrap Bias
A	.561* (.097)	[.441 ; .752]	.0001	.196* (.009)	[.161;.210]	-.006
ϕ	.029* (.001)	[.026 ; .032]	-.00001	.02* (.0006)	[.019;.023]	.0005
δ	-.65* (.135)	[-1.110;-.348]	-.010	-.067 (.045)	[-.373;-.010]	-.059
ρ	.246** (.099)	[.030 ; .654]	.033	2.060* (.782)	[.093 ; 4.252]	-.076
υ	.622* (.055)	[.518 ; .713]	.0417102			
$\frac{1}{1+\rho}=1$	9.55 p >(.002)			64.98 p>(.0001)		
A	.034* (.010)	[.022 ; .069]	.002	.804* (.02)	[.751;.847]	-.0004
δ	.375* (.061)	[.268 ; .533]	.007	1.339* (.064)	[1.281;1.401]	-.003
ρ	-.512 (.415)	[-1.102 ; .077]	-.035	.565 (.61)	[-.134 ; 1.673]	.042
υ	1.708* (.066)	[1.546 ; 1.802]	-.003			
$\frac{1}{1+\rho}=1$	.36 p>(.5473)			2.10 p>(.1473)		

Note: 1) *, **,and *** means significantly different from zero at 1, 5, and 10% respectively.
2) Standard Errors are given in parentheses
3) Bootstrap samples: a) Restricted Model, 1,197 and 1,200 samples respectively.
b) Unrestricted Model, 1, 200 and 1,198 samples respectively.

Table A.6: CES, NonLinear Estimation. Unrestricted and Restricted ($\upsilon = 1$, constant returns to scale) Models with Trend and No Trend. USA, 1929-2000.

	1929-2000 Unrestricted	95% Bootstrap Confidence Interval	Bootstrap Bias	1929-2000 Restricted(υ=1)	95% Bootstrap Confidence Interval	Bootstrap Bias
A	.102* (.044)	[.027 ; .318]	.014	.372* (.026)	[.338;.406]	-.003
φ	.018* (.002)	[.010 ; .024]	-.0002	.024* (.001)	[.021;.026]	.0003
δ	-.126* (.048)	[-.238 ; -.056]	-.002	-.148** (.070)	[-.259;-.083]	-.027
ρ	-1.439* (.424)	[-2.005 ; -.923]	-.055	-1.467** (.522)	[-1.984 ; -.935]	-.027
υ	1.326* (.107)	[1.061 ; 1.700]	.015			
$\frac{1}{1+\rho}=1$	2.22 p>(.136)			1.73 p>(.1886)		
A	.009** (.004)	[.003 ; .029]	.004	.942* (.017)	[.915;.966]	.0006
δ	.0386 (.0383)	[-.015 ; .160]	.010	.732* (.042)	[.632;.844]	.008
ρ	-.174 (.589)	[-2.993 ; .499]	-.041	-1.685* (.33)	[-2.949 ; -1.028]	-.111
υ	1.911* (.113)	[1.753 ; 2.208]	-.022			
$\frac{1}{1+\rho}=1$	7.76 p>(.005)			12.24 p>(.0005)		

Note: 1) *, **,and *** means significantly different from zero at 1, 5, and 10% respectively.
2) Standard Errors are given in parentheses.
3) Bootstrap samples: a) Restricted Model, 1,182 and 1,200 samples respectively.
b) Unrestricted Model, 1,191 and 1,184 samples respectively.

Table A.7: CES, NonLinear Estimation. Unrestricted and Restricted ($\upsilon = 1$, constant returns to scale) Models with Trend and No Trend. UK, 1870-1991.

	1870-1991 Unrestricted	95 % Bootstrap Confidence Interval	Bootstrap Bias	1870-1991 Restricted(υ=1)	95% Bootstrap Confidence Interval	Bootstrap Bias
A	.870** (.343)	[.342 ; 2.550]	.095	.474* (.033)	[.430;.521]	.0007
ϕ	.008* (.0009)	[.007 ; .010]	-.00007	.007* (.0006)	[.006;.008]	-.00001
δ	.345* (.049)	[.282 ; .503]	.004	.295* (.027)	[.245;.329]	.0002
ρ	-.712*** (.382)	[-1.123 ; -.232]	-.016	-.699*** (.357)	[-1.138 ; -.164]	-.021
υ	.884* (.099)	[.580 ; 1.084]	.009			
$\frac{1}{1+\rho}=1$	.29 p>(.59)			19.06 p>(.0001)		
A	.167** (.071)	[.075 ; .325]	.009	1.086* (.017)	[1.060;1.116]	.001
δ	.333* (.035)	[.288 ; .390]	-.001	.568* (.018)	[.526;.598]	-.002
ρ	.723** (.205)	[.286 ; 1.208]	.013	1.982* (.322)	[1.494 ; 2.530]	.054
υ	1.406* (.093)	[1.262 ; 1.577]	.003			
$\frac{1}{1+\rho}=1$	.35 p>(.5563)			335.85 p>(.0001)		

Note: 1) *, **,and *** means significantly different from zero at 1, 5, and 10% respectively.
2) Standard Errors are given in parentheses.
3) Bootstrap samples: a) Restricted Model, 1,200 samples.
b) Unrestricted Model, 1,200 and 1,199 samples respectively.

Table A.8: CES, NonLinear Estimation. Unrestricted and Restricted ($\upsilon = 1$, constant returns to scale) Models with Trend and No Trend. Japan, 1890-1991.

	1890-1991 Unrestricted	95% Bootstrap Confidence Interval	Bootstrap Bias	1890-1991 Restricted(υ=1)	95% Bootstrap Confidence Interval	Bootstrap Bias
A	1.916* (.397)	[.005 ; 2.240]	-.089	2.011* (.092)	[1.896;2.098]	-.012
ϕ	-.012*** (.006)	[-.025 ; -.004]	-.001	-.01* (.0007)	[-.012;-.009]	.00009
δ	.95* (.094)	[.288 ; .480]	-.027	.965* (.037)	[.921;.988]	-.002
ρ	2.128 (1.806)	[.226 ; 2.725]	-.007	2.355*** (1.175)	[1.386 ; 3.175]	.078
υ	1.046* (.148)	[.867 ; 1.357]	.088			
$\frac{1}{1+\rho}=1$	.16 p>(.6874)			45.19 p>(.0001)		
A	2.377* (.106)	[.255 ; 2.492]	-.183	.825* (.016)	[.781;.866]	.001
δ	.997* (.016)	[.428 ; .999]	-.043	.723* (.015)	[.700;.759]	.001
ρ	3.847 (5.539)	[-1.211 ; 5.960]	-.304	-.127 (.078)	[-.311 ; .029]	-.002
υ	.776* (.014)	[.757 ; .801]	.057			
$\frac{1}{1+\rho}=1$	11.34 p>(.0008)			2.01 p>(.1566)		

Note: 1) *, **,and *** means significantly different from zero at 1, 5, and 10% respectively.
2) Standard Errors are given in parentheses.
3) Bootstrap samples: a) Restricted Model, 1,152 and 1,200 samples respectively.
b) Unrestricted Model, 1,101 and 1,186 samples respectively.

Table A.9: Same Power Transformation ($\lambda_0 = \lambda_1 = \lambda_2$) with Trend and No Trend. USA, 1890-1992.

	Model with a Trend	95% Bootstrap Confidence Interval	Bootstrap Bias	Model without Trend	95% Bootstrap Confidence Interval	Bootstrap Bias
A	-34.829	[-113.902;-.336]	.489	-3.316	[-19.117;-1.876]	-1.806
λ	1.067 *	[-.050 ; 1.465]	-.359	-.017	[-.678 ; .868]	.058
	(.201)			(-.12)		
α_1	.707 *	[.660;.840]	-.477	.585*	[.411;.731]	.045
	(-.005)			(.01)		
α_2	.708*	[.479;.842]	.172	1.142*	[.456;1.556]	-.051
	(-.02)			(.02)		
ϕ	-.337*	[-2.303;.029]	.489			
	(-.04)					
LRT (λ = 0)	-192			.01		
	p >(.)			p>(.907)		
LRT (λ = 1)	.1			23.75		
	p >(.752)			p>(.0001)		
LRT (λ = -1)	27.3			38.07		
	p>(.0001)			p>(.0001)		

Note: : 1) *, **,and *** mean significantly different from zero at 1, 5, and 10% respectively.
2) Standard Errors are given in parentheses. P> means p-value.
3) 1,000 bootstrap samples.

Table A.10: Same Power Transformation ($\lambda_0 = \lambda_1 = \lambda_2$) with Trend and No Trend. USA, 1929-2000.

	Model with a Trend	95% Bootstrap Confidence Interval	Bootstrap Bias	Model without Trend	95% Bootstrap Confidence Interval	Bootstrap Bias
A	-3.371	[-4.653;-1.718]	.012	-18.097	[-48.467;-8.069]	-.511
λ	.317* (.013)	[.291 ; .344]	.00002	.601* (.121)	[.218 ; .914]	-.046
α_1	-.076* (.004)	[-.133;.020]	.002	.169** (.02)	[.007;.388]	-.023
α_2	1.071* (.01)	[.802;1.245]	-.003	1.573* (.02)	[1.129;1.993]	.067
ϕ	.086* (.001)	[.072;.104]	4.35e-6			
LRT (λ = 0)	140.67 p>(.0001)			39.16 p>(.0001)		
LRT (λ = 1)	144.36 p>(.0001)			12.36 p>(.0001)		
LRT (λ = -1)	319.69 p>(.0001)			187.2 p>(.0001)		

Note: : 1) *, **,and *** mean significantly different from zero at 1, 5, and 10% respectively.
2) Standard Errors are given in parentheses. P> means p-value.
3) 1,000 bootstrap samples.

Table A.11: Same Power Transformation ($\lambda_0 = \lambda_1 = \lambda_2$) with Trend and No Trend. UK, 1870-1991.

	Model with a Trend	95% Bootstrap Confidence Interval	Bootstrap Bias	Model without Trend	95% Bootstrap Confidence Interval	Bootstrap Bias
A	.026	[-1.074;1.746]	-.065	-7.061	[-23.780;-2.659]	-1.923
λ	.137	[-.141 .401	-.0004	.438**	[-.119; .897	.0004
	(.114)			(.178)		
α_1	.369*	[.265;.433]	-.002	.476*	[.442;.503]	-.003
	(.01)			(.004)		
α_2	.450*	[.192;.760]	.025	1.018*	[.870;1.342]	.016
	(.02)			(.01)		
ϕ	.01*	[.003;.031]	.001			
	(.0002)					
LRT (λ = 0)	1.51			6		
	p>(.218)			p>(.014)		
LRT (λ = 1)	47.83			11.64		
	p>(.0001)			p>(.0001)		
LRT (λ = -1)	124.57			66.66		
	p>(.0001)			p>(.0001)		

Note: : 1) *, **,and *** mean significantly different from zero at 1, 5, and 10% respectively.
2) Standard Errors are given in parentheses. P> means p-value.
3) 1,000 bootstrap samples.

Table A.12: Same Power Transformation ($\lambda_0 = \lambda_1 = \lambda_2$) with Trend and No Trend. Japan, 1870-1991.

	Model with a Trend	95% Bootstrap Confidence Interval	Bootstrap Bias	Model without Trend	95% Bootstrap Confidence Interval	Bootstrap Bias
A	-6.132	[-9.098;-4.230]	.080	-2.536	[-3.777;-1.058]	-.153
λ	-.216*	[-.256 ; -.168]	-.003	.040	[-.482 ; .174]	-.080
	(.024)			(.066)		
α_1	.985*	[.786;1.174]	-.002	.593*	[.422; .664]	-.030
	(.01)			(.01)		
α_2	2.569*	[1.805;3.969]	.057	.877*	[.506; 2.222]	.232
	(.04)			(.04)		
ϕ	-.017*	[-.023;-.009]	.00007			
	(.0004)					
LRT ($\lambda = 0$)	22.43			.34		
	p>(.0001)			p>(.559)		
LRT ($\lambda = 1$)	213.27			181.32		
	p>(.0001)			p>(.0001)		
LRT ($\lambda = -1$)	95.99			52.32		
	p>(.0001)			p>(.0001)		

Note: : 1) *, **,and *** mean significantly different from zero at 1, 5, and 10% respectively.
2) Standard Errors are given in parentheses. P> means p-value.
3) 1,000 bootstrap samples.

Table A.13: Comparing Elasticities. USA, 1890-1992.

CES

1890-1992

	Unrestricted Model		Restricted Model (ν=1)	
	Trend	No Trend	Trend	No Trend
ρ	.246	-.512	2.06	.565
σ	.802	2.049	.326	.638

Box-Cox

1890-1992

	Trend	No Trend
λ	1.067	-.017
σ	-14.925	.983

Table A.14: Comparing Elasticities. USA, 1929-2000.

CES

1929-2000

	Unrestricted Model		Restricted Model (ν=1)	
	Trend	No Trend	Trend	No Trend
ρ	-1.439	-.174	-1.467	-1.685
σ	-2.277	1.210	-2.141	-1.459

Box-Cox

1929-2000

	Trend	No Trend
λ	.317	.601
σ	1.464	2.506

Table A.15: Comparing Elasticities. UK, 1870-1991.

CES

1870-1991

	Unrestricted Model		Restricted Model (ν=1)	
	Trend	No Trend	Trend	No Trend
ρ	-.712	.723	-.699	1.982
σ	3.472	.580	3.322	.335

Box-Cox

1870-1991

	Trend	No Trend
λ	.137	.438
σ	1.158	1.779

Table A.16: Comparing Elasticities. Japan, 1890-1991.

CES

1890-1991

	Unrestricted Model		Restricted Model (ν=1)	
	Trend	No Trend	Trend	No Trend
ρ	2.128	3.874	2.335	-.127
σ	.319	.205	.299	1.145

Box-Cox

1890-1991

	Trend	No Trend
λ	-.216	.04
σ	.822	1.041

Table A.17: Testing $\mu = 0$.

BEA: 1929-2000.

	Trend	*No Trend*
Complete	552.98(.0002)	27.85(.0133)
No WWII	791 (.0001)	43.65(.0071)
After WWII	207.37(.0007)	100.55(.0021)

USA, Maddison: 1890-1992.

	Trend	*No Trend*
Complete	28.59(.0128)	1.83(.2695)
No WWII	49.99(.0058)	.46(.5445)
Before WWII	72.63(.0034)	.00(.9560)
After WWII	39.46(.0081)	111.02(.0018)

UK: 1870-1991.

	Trend	*No Trend*
Complete	1749.85(.0000)	8.12(.0651)
No WWII	4.21(.1326)	16.10(.0278)
Before WWII	.00(.9953)	.00(.9804)
After WWII	2.35(.2228)	15.71(.0287)

Japan: 1890-1991.

	Trend	*No Trend*
Complete	66.41(.0039)	11.67(.0420)
No WWII	16.42(.0271)	11.29(.0438)
Before WWII	1.13(.3660)	.03(.8704)
After WWII	51.46(.0056)	14.35(.0323)

Note: 1) p-values in parenthesis.

2) $\mu = \dfrac{A\lambda + 1 - \alpha - \beta}{\alpha + \beta}$ and if we add a trend to our model:

$$\mu = \frac{\lambda(A+t) + 1 - \alpha - \beta}{\alpha + \beta}$$

3) $\mu = 0$ if $\alpha + \beta - A\lambda = 1$ or $A\lambda + 1 - \alpha - \beta = 0$.
If we add a trend, $\mu = 0$ if $\alpha + \beta - \lambda(A+t) = 1$ or $\lambda(A+t) + 1 - \alpha - \beta = 0$

Table A.18: Testing the Endogenous Growth Condition. USA, 1890-1992.

USA-Maddison
Complete
CES

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.2	0.2	0.2	0.2
A	0.02	0.02	0.02	0.02
K-share	0.375	0.375	0.375	0.375
Rho	0.246	-0.512	2.06	0.565
E.S.	0.802568	2.04918	0.3267974	0.638978
Pop'n	0.02	0.02	0.02	0.02
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	0.018553241	6.79157	0.621182	0.176227
s*A*alpha(1/p)	7.4213E-05	0.027166	0.002485	0.000705
n+delta	0.12	0.12	0.12	0.12
Result	*-0.119925787*	*-0.09283*	*-0.11752*	*-0.1193*

Accounting for breaking points (1942,1950,1942,1948)

BEFORE

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.18	0.18	0.18	0.18
A	0.02	0.02	0.02	0.02
K-share	0.375	0.375	0.375	0.375
Rho	-0.115	-3.187	3.31	-9.639
E.S.	1.129944	-0.457247	0.2320186	-0.115754
Pop'n	0.02	0.02	0.02	0.02
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	5059.131	1.360374	0.7435472	1.107114
s*A*alpha(1/p)	18.21287	0.004897	0.0026768	0.003986
n+delta	0.12	0.12	0.12	0.12
Result	18.09287	-0.115103	-0.1173232	-0.116014

AFTER

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.2	0.2	0.2	0.2
A	0.01	0.01	0.01	0.01
K-share	0.375	0.375	0.375	0.375
Rho	1.493	5.957	12.294	-6.923
E.S.	0.401123145	0.14374	0.075222	-0.168833
Pop'n	0.02	0.02	0.02	0.02
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	0.518429129	0.848189	0.923318	1.152204
s*A*alpha(1/p)	0.001036858	0.001696	0.001847	0.002304
n+delta	0.12	0.12	0.12	0.12
Result	*-0.118963142*	*-0.1183*	*-0.11815*	*-0.1177*

Excluding WWII

BEFORE

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.18	0.18	0.18	0.18
A	0.02	0.02	0.02	0.02
K-share	0.375	0.375	0.375	0.375
Rho	-0.124	-1.527	-2.407	3.529
E.S.	1.141553	-1.897533	-0.7107321	0.220799
Pop'n	0.02	0.02	0.02	0.02
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	2724.154	1.900894	1.5030409	0.757347
s*A*alpha(1/p)	9.806956	0.006843	0.0054109	0.002726
n+delta	0.12	0.12	0.12	0.12
Result	9.686956	-0.113157	-0.1145891	-0.117274

AFTER

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.2	0.2	0.2	0.2
A	0.01	0.01	0.01	0.01
K-share	0.375	0.375	0.375	0.375
Rho	7.261	5.957	8.69	-7.197
E.S.	0.12105072	0.14374	0.103199	-0.161368
Pop'n	0.02	0.02	0.02	0.02
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	0.873644408	0.848189	0.893268	1.146006
s*A*alpha(1/p)	0.001747289	0.001696	0.001787	0.002292
n+delta	0.12	0.12	0.12	0.12
Result	-0.118252711	-0.118304	-0.118213	-0.117708

Note: Savings=18 and 20%; A=1 and 2%;Capital-Share(K-share)=30, 37.5 and 40%;
Rho=estimated value; Population growth=2% and Depreciation=10%.

Table A.19: Testing the Endogenous Growth Condition. USA, 1890-1992.

USA-Maddison
Complete
CES

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.2	0.2	0.2	0.2
A	0.02	0.02	0.02	0.02
K-share	0.4	0.4	0.4	0.4
Rho	0.246	-0.512	2.06	0.565
E.S.	0.802568	2.04918	0.326797	0.638978
Pop'n	0.02	0.02	0.02	0.02
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	0.024119	5.987239	0.640952	0.197552
s*A*alpha(1/p)	9.65E-05	0.023949	0.002564	0.00079
n+delta	0.12	0.12	0.12	0.12
Result	*-0.1199*	*-0.09605*	*-0.11744*	*-0.11921*

Accounting for breaking points (1942,1950,1942,1948)

BEFORE

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.18	0.18	0.18	0.18
A	0.02	0.02	0.02	0.02
K-share	0.4	0.4	0.4	0.4
Rho	-0.115	-3.187	3.31	-9.639
E.S.	1.129944	-0.45725	0.232019	-0.11575
Pop'n	0.02	0.02	0.02	0.02
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	2886.343	1.333102	0.758187	1.099726
s*A*alpha(1/p)	10.39083	0.004799	0.002729	0.003959
n+delta	0.12	0.12	0.12	0.12
Result	10.27083	-0.1152	-0.11727	-0.11604

AFTER

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.2	0.2	0.2	0.2
A	0.01	0.01	0.01	0.01
K-share	0.4	0.4	0.4	0.4
Rho	1.493	5.957	12.294	-6.923
E.S.	0.401123	0.14374	0.075222	-0.16883
Pop'n	0.02	0.02	0.02	0.02
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	0.541331	0.857429	0.928178	1.141513
s*A*alpha(1/p)	0.001083	0.001715	0.001856	0.002283
n+delta	0.12	0.12	0.12	0.12
Result	*-0.11892*	*-0.11829*	*-0.11814*	*-0.11772*

Excluding WWII

BEFORE

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.18	0.18	0.18	0.18
A	0.02	0.02	0.02	0.02
K-share	0.4	0.4	0.4	0.4
Rho	-0.124	-1.527	-2.407	3.529
E.S.	1.141553	-1.89753	-0.71073	0.220799
Pop'n	0.02	0.02	0.02	0.02
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	1618.802	1.822227	1.463276	0.771325
s*A*alpha(1/p)	5.827686	0.00656	0.005268	0.002777
n+delta	0.12	0.12	0.12	0.12
Result	5.707686	-0.11344	-0.11473	-0.11722

AFTER

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.2	0.2	0.2	0.2
A	0.01	0.01	0.01	0.01
K-share	0.4	0.4	0.4	0.4
Rho	7.261	5.957	8.69	-7.197
E.S.	0.121051	0.14374	0.103199	-0.16137
Pop'n	0.02	0.02	0.02	0.02
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	0.881444	0.857429	0.899927	1.135775
s*A*alpha(1/p)	0.001763	0.001715	0.0018	0.002272
n+delta	0.12	0.12	0.12	0.12
Result	-0.11824	-0.11829	-0.1182	-0.11773

Table A.20: Testing the Endogenous Growth Condition. USA, 1890-1992.

USA-Maddison
Complete
CES

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.2	0.2	0.2	0.2
A	0.02	0.02	0.02	0.02
K-share	0.3	0.3	0.3	0.3
Rho	0.246	-0.512	2.06	0.565
E.S.	0.802568	2.04918	0.326797	0.638978
Pop'n	0.02	0.02	0.02	0.02
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	0.007489911	10.50141	0.557411	0.118727
s*A*alpha(1/p)	2.99596E-05	0.042006	0.00223	0.000475
n+delta	0.12	0.12	0.12	0.12
Result	*-0.11997004*	*-0.07799*	*-0.11777*	*-0.11953*

Accounting for breaking points (1942,1950,1942,1948)

BEFORE

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.18	0.18	0.18	0.18
A	0.02	0.02	0.02	0.02
K-share	0.3	0.3	0.3	0.3
Rho	-0.115	-3.187	3.31	-9.639
E.S.	1.129944	-0.457247	0.232019	-0.115754
Pop'n	0.02	0.02	0.02	0.02
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	35218.57	1.459036	0.695073	1.133042
s*A*alpha(1/p)	126.7868	0.005253	0.002502	0.004079
n+delta	0.12	0.12	0.12	0.12
Result	126.6668	-0.114747	-0.117498	-0.115921

AFTER

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.2	0.2	0.2	0.2
A	0.01	0.01	0.01	0.01
K-share	0.3	0.3	0.3	0.3
Rho	1.493	5.957	12.294	-6.923
E.S.	0.401123145	0.14374	0.075222	-0.168833
Pop'n	0.02	0.02	0.02	0.02
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	0.446457177	0.817005	0.906711	1.189947
s*A*alpha(1/p)	0.000892914	0.001634	0.001813	0.00238
n+delta	0.12	0.12	0.12	0.12
Result	*-0.119107086*	*-0.11837*	*-0.11819*	*-0.11762*

Excluding WWII

BEFORE

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.18	0.18	0.18	0.18
A	0.02	0.02	0.02	0.02
K-share	0.3	0.3	0.3	0.3
Rho	-0.124	-1.527	-2.407	3.529
E.S.	1.141553	-1.897533	-0.710732	0.220799
Pop'n	0.02	0.02	0.02	0.02
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	16472.67	2.199998	1.649045	0.710941
s*A*alpha(1/p)	59.30162	0.00792	0.005937	0.002559
n+delta	0.12	0.12	0.12	0.12
Result	59.18162	-0.11208	-0.114063	-0.117441

AFTER

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.2	0.2	0.2	0.2
A	0.01	0.01	0.01	0.01
K-share	0.3	0.3	0.3	0.3
Rho	7.261	5.957	8.69	-7.197
E.S.	0.12105072	0.14374	0.103199	-0.161368
Pop'n	0.02	0.02	0.02	0.02
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	0.847204109	0.817005	0.870622	1.182095
s*A*alpha(1/p)	0.001694408	0.001634	0.001741	0.002364
n+delta	0.12	0.12	0.12	0.12
Result	-0.118305592	-0.118366	-0.118259	-0.117636

Table A.21: Testing the Endogenous Growth Condition. USA, 1929-2000.

USA-BEA
Complete
CES

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.2	0.2	0.2	0.2
A	0.02	0.02	0.02	0.02
K-share	0.375	0.375	0.375	0.375
Rho	-1.439	-0.174	-1.467	-1.685
E.S.	-2.277904	1.210654	-2.141328	-1.459854
Pop'n	0.02	0.02	0.02	0.02
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res-NoT
alpha^(1/p)	1.97704788	280.6055	1.951494	1.789783
s*A*alpha(1/p)	0.007908192	1.122422	0.007806	0.007159
n+delta	0.12	0.12	0.12	0.12
Result	*-0.112091808*	*1.002422*	*-0.11219*	*-0.11284*

Accounting for breaking points (1947,1964,1951,1945)

BEFORE

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.18	0.18	0.18	0.18
A	0.02	0.02	0.02	0.02
K-share	0.375	0.375	0.375	0.375
Rho	-1.514	-4.511	-1.293	4.873
E.S.	-1.945525	-0.284819	-3.412969	0.170271
Pop'n	0.02	0.02	0.02	0.02
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	1.911407	1.242879	2.135218	0.817685
s*A*alpha(1/p)	0.006881	0.004474	0.007687	0.002944
n+delta	0.12	0.12	0.12	0.12
Result	-0.113119	-0.115526	-0.112313	-0.117056

AFTER

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.2	0.2	0.2	0.2
A	0.01	0.01	0.01	0.01
K-share	0.375	0.375	0.375	0.375
Rho	3.798	5.551	3.692	-1.716
E.S.	0.208420175	0.152648	0.213129	-1.396648
Pop'n	0.02	0.02	0.02	0.02
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	0.772402971	0.838036	0.766697	1.771061
s*A*alpha(1/p)	0.001544806	0.001676	0.001533	0.003542
n+delta	0.12	0.12	0.12	0.12
Result	*-0.118455194*	*-0.11832*	*-0.11847*	*-0.11646*

After WWII

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.18	0.18	0.18	0.18
A	0.02	0.02	0.02	0.02
K-share	0.375	0.375	0.375	0.375
Rho	3.608	2.722	3.224	2.048
E.S.	0.217014	0.268673	0.236742	0.328084
Pop'n	0.02	0.02	0.02	0.02
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	0.761969719	0.697443	0.737693	0.619452
s*A*alpha(1/p)	0.002743091	0.002511	0.002656	0.00223
n+delta	0.12	0.12	0.12	0.12
Result	-0.117256909	-0.117489	-0.117344	-0.11777

Note: Savings=18 and 20%; A=1 and 2%;Capital-Share(K-share)=30, 37.5 and 40%;
Rho=estimated value; Population growth=2% and Depreciation=10%.

Table A.22: Testing the Endogenous Growth Condition. USA, 1929-2000.

USA-BEA
Complete
CES

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.2	0.2	0.2	0.2
A	0.02	0.02	0.02	0.02
K-share	0.4	0.4	0.4	0.4
Rho	-1.439	-0.174	-1.467	-1.685
E.S.	-2.277904	1.210654	-2.141328	-1.459854
Pop'n	0.02	0.02	0.02	0.02
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res-NoT
alpha^(1/p)	1.89033715	193.6473	1.867502	1.722528
s*A*alpha(1/p)	0.007561349	0.774589	0.00747	0.00689
n+delta	0.12	0.12	0.12	0.12
Result	*-0.112438651*	*0.654589*	*-0.11253*	*-0.11311*

Accounting for breaking points (1947,1964,1951,1945)

BEFORE

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.18	0.18	0.18	0.18
A	0.02	0.02	0.02	0.02
K-share	0.4	0.4	0.4	0.4
Rho	-1.514	-4.511	-1.293	4.873
E.S.	-1.945525	-0.284819	-3.412969	0.170271
Pop'n	0.02	0.02	0.02	0.02
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	1.83164	1.225224	2.031257	0.828586
s*A*alpha(1/p)	0.006594	0.004411	0.007313	0.002983
n+delta	0.12	0.12	0.12	0.12
Result	-0.113406	-0.115589	-0.112687	-0.117017

AFTER

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.2	0.2	0.2	0.2
A	0.01	0.01	0.01	0.01
K-share	0.4	0.4	0.4	0.4
Rho	3.798	5.551	3.692	-1.716
E.S.	0.208420175	0.152648	0.213129	-1.396648
Pop'n	0.02	0.02	0.02	0.02
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	0.785640385	0.847836	0.780217	1.705689
s*A*alpha(1/p)	0.001571281	0.001696	0.00156	0.003411
n+delta	0.12	0.12	0.12	0.12
Result	*-0.118428719*	*-0.1183*	*-0.11844*	*-0.11659*

After WWII

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.18	0.18	0.18	0.18
A	0.02	0.02	0.02	0.02
K-share	0.4	0.4	0.4	0.4
Rho	3.608	2.722	3.224	2.048
E.S.	0.217014	0.268673	0.236742	0.328084
Pop'n	0.02	0.02	0.02	0.02
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	0.775722174	0.714177	0.752609	0.639283
s*A*alpha(1/p)	0.0027926	0.002571	0.002709	0.002301
n+delta	0.12	0.12	0.12	0.12
Result	-0.1172074	-0.117429	-0.117291	-0.117699

Table A.23: Testing the Endogenous Growth Condition. USA, 1929-2000.

USA-BEA
Complete
CES

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.2	0.2	0.2	0.2
A	0.02	0.02	0.02	0.02
K-share	0.3	0.3	0.3	0.3
Rho	-1.439	-0.174	-1.467	-1.685
E.S.	-2.2779	1.210654	-2.14133	-1.45985
Pop'n	0.02	0.02	0.02	0.02
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res-No T
alpha^(1/p)	2.308674	1011.697	2.272099	2.043214
s*A*alpha(1/p)	0.009235	4.046786	0.009088	0.008173
n+delta	0.12	0.12	0.12	0.12
Result	*-0.11077*	*3.926786*	*-0.11091*	*-0.11183*

Accounting for breaking points (1947,1964,1951,1945)

BEFORE

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.18	0.18	0.18	0.18
A	0.02	0.02	0.02	0.02
K-share	0.3	0.3	0.3	0.3
Rho	-1.514	-4.511	-1.293	4.873
E.S.	-1.94553	-0.28482	-3.41297	0.170271
Pop'n	0.02	0.02	0.02	0.02
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	2.214942	1.305906	2.537417	0.781086
s*A*alpha(1/p)	0.007974	0.004701	0.009135	0.002812
n+delta	0.12	0.12	0.12	0.12
Result	-0.11203	-0.1153	-0.11087	-0.11719

AFTER

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.2	0.2	0.2	0.2
A	0.01	0.01	0.01	0.01
K-share	0.3	0.3	0.3	0.3
Rho	3.798	5.551	3.692	-1.716
E.S.	0.20842	0.152648	0.213129	-1.39665
Pop'n	0.02	0.02	0.02	0.02
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	0.728329	0.805016	0.721731	2.017009
s*A*alpha(1/p)	0.001457	0.00161	0.001443	0.004034
n+delta	0.12	0.12	0.12	0.12
Result	*-0.11854*	*-0.11839*	*-0.11856*	*-0.11597*

After WWII

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.18	0.18	0.18	0.18
A	0.02	0.02	0.02	0.02
K-share	0.3	0.3	0.3	0.3
Rho	3.608	2.722	3.224	2.048
E.S.	0.217014	0.268673	0.236742	0.328084
Pop'n	0.02	0.02	0.02	0.02
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	0.716272	0.642549	0.688362	0.555505
s*A*alpha(1/p)	0.002579	0.002313	0.002478	0.002
n+delta	0.12	0.12	0.12	0.12
Result	-0.11742	-0.11769	-0.11752	-0.118

Table A.24: Testing the Endogenous Growth Condition. UK, 1870-1991.

UK
Complete
CES

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.15	0.15	0.15	0.15
A	0.013	0.013	0.013	0.013
K-share	0.39	0.39	0.39	0.39
Rho	-0.712	0.723	-0.699	1.982
E.S.	3.472222	0.580383	3.322259	0.335345
Pop'n	0.005	0.005	0.005	0.005
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	3.752731	0.271889	3.846176	0.621835
s*A*alpha(1/p)	0.007318	0.00053	0.0075	0.001213
n+delta	0.105	0.105	0.105	0.105
Result	*-0.09768*	*-0.10447*	*-0.0975*	*-0.10379*

Accounting for breaking points (1933,1917,1917,1929)

BEFORE

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.12	0.13	0.13	0.12
A	0.005	0.005	0.005	0.005
K-share	0.39	0.39	0.39	0.39
Rho	5.914	-1.813	-99.606	-5.593
E.S.	0.144634	-1.23001	-0.01014	-0.21772
Pop'n	0.005	0.005	0.005	0.005
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	0.852811	1.68096	1.009498	1.183356
s*A*alpha(1/p)	0.000512	0.001093	0.000656	0.00071
n+delta	0.105	0.105	0.105	0.105
Result	-0.10449	-0.10391	-0.10434	-0.10429

AFTER

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.18	0.17	0.17	0.18
A	0.01	0.01	0.01	0.01
K-share	0.39	0.39	0.39	0.39
Rho	-5.984	-0.0261	-0.69	0.054
E.S.	-0.20064	1.026799	3.225806	0.948767
Pop'n	0.005	0.005	0.005	0.005
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	1.17041	4.66E+15	3.914353	2.67E-08
s*A*alpha(1/p)	0.002107	7.92E+12	0.006654	4.81E-11
n+delta	0.105	0.105	0.105	0.105
Result	*-0.10289*	*7.92E+12*	*-0.09835*	*-0.105*

Excluding WWII

BEFORE

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.12	0.12	0.12	0.12
A	0.005	0.005	0.005	0.005
K-share	0.39	0.39	0.39	0.39
Rho	6.082	2.755	5.742	28.233
E.S.	0.141203	0.266312	0.148324	0.034208
Pop'n	0.005	0.005	0.005	0.005
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	0.85657	0.710503	0.848754	0.967199
s*A*alpha(1/p)	0.000514	0.000426	0.000509	0.00058
n+delta	0.105	0.105	0.105	0.105
Result	-0.10449	-0.10457	-0.10449	-0.10442

AFTER

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.18	0.18	0.18	0.18
A	0.01	0.01	0.01	0.01
K-share	0.39	0.39	0.39	0.39
Rho	-0.277	-0.884	-0.754	-0.81
E.S.	1.383126	8.62069	4.065041	5.263158
Pop'n	0.005	0.005	0.005	0.005
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	29.9434	2.901326	3.486219	3.197853
s*A*alpha(1/p)	0.053898	0.005222	0.006275	0.005756
n+delta	0.105	0.105	0.105	0.105
Result	-0.0511	-0.09978	-0.09872	-0.09924

Note: Savings=12, 15 and 20%; A=.5, 1 and 1.3%;Capital-Share(K-share)=19, 31 and 39%;
Rho=estimated value; Population growth=.5% and Depreciation=10%.

Table A.25: Testing the Endogenous Growth Condition. UK, 1870-1991.

UK
Complete
CES

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.15	0.15	0.15	0.15
A	0.013	0.013	0.013	0.013
K-share	0.19	0.19	0.19	0.19
Rho	-0.712	0.723	-0.699	1.982
E.S.	3.472222	0.580383	3.322259	0.335345
Pop'n	0.005	0.005	0.005	0.005
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	10.30354	0.10056	10.76034	0.432615
s*A*alpha(1/p)	0.020092	0.000196	0.020983	0.000844
n+delta	0.105	0.105	0.105	0.105
Result	*-0.08491*	*-0.1048*	*-0.08402*	*-0.10416*

Accounting for breaking points (1933,1917,1917,1929)

BEFORE

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.12	0.13	0.13	0.12
A	0.005	0.005	0.005	0.005
K-share	0.19	0.19	0.19	0.19
Rho	5.914	-1.813	-99.606	-5.593
E.S.	0.144634	-1.23001	-0.01014	-0.21772
Pop'n	0.005	0.005	0.005	0.005
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	0.755169	2.499305	1.016813	1.345722
s*A*alpha(1/p)	0.000453	0.001625	0.000661	0.000807
n+delta	0.105	0.105	0.105	0.105
Result	-0.10455	-0.10338	-0.10434	-0.10419

AFTER

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.18	0.17	0.17	0.18
A	0.01	0.01	0.01	0.01
K-share	0.19	0.19	0.19	0.19
Rho	-5.984	-0.0261	-0.69	0.054
E.S.	-0.20064	1.026799	3.225806	0.948767
Pop'n	0.005	0.005	0.005	0.005
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	1.319864	4.3E+27	11.09902	4.4E-14
s*A*alpha(1/p)	0.002376	7.32E+24	0.018868	7.92E-17
n+delta	0.105	0.105	0.105	0.105
Result	*-0.10262*	*7.32E+24*	*-0.08613*	*-0.105*

Excluding WWII

BEFORE

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.12	0.12	0.12	0.12
A	0.005	0.005	0.005	0.005
K-share	0.19	0.19	0.19	0.19
Rho	6.082	2.755	5.742	28.233
E.S.	0.141203	0.266312	0.148324	0.034208
Pop'n	0.005	0.005	0.005	0.005
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	0.76105	0.547274	0.748844	0.942874
s*A*alpha(1/p)	0.000457	0.000328	0.000449	0.000566
n+delta	0.105	0.105	0.105	0.105
Result	-0.10454	-0.10467	-0.10455	-0.10443

AFTER

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.18	0.18	0.18	0.18
A	0.01	0.01	0.01	0.01
K-share	0.19	0.19	0.19	0.19
Rho	-0.277	-0.884	-0.754	-0.81
E.S.	1.383126	8.62069	4.065041	5.263158
Pop'n	0.005	0.005	0.005	0.005
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	401.5851	6.544698	9.048159	7.770119
s*A*alpha(1/p)	0.722853	0.01178	0.016287	0.013986
n+delta	0.105	0.105	0.105	0.105
Result	0.617853	-0.09322	-0.08871	-0.09101

Table A.26: Testing the Endogenous Growth Condition. UK, 1870-1991.

UK
Complete
CES

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.15	0.15	0.15	0.15
A	0.013	0.013	0.013	0.013
K-share	0.31	0.31	0.31	0.31
Rho	-0.712	0.723	-0.699	1.982
E.S.	3.472222	0.580383	3.322259	0.335345
Pop'n	0.005	0.005	0.005	0.005
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	5.180595	0.19792	5.34153	0.553823
s*A*alpha(1/p)	0.010102	0.000386	0.010416	0.00108
n+delta	0.105	0.105	0.105	0.105
Result	*-0.0949*	*-0.10461*	*-0.09458*	*-0.10392*

Accounting for breaking points (1933,1917,1917,1929)

BEFORE

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.12	0.13	0.13	0.12
A	0.005	0.005	0.005	0.005
K-share	0.31	0.31	0.31	0.31
Rho	5.914	-1.813	-99.606	-5.593
E.S.	0.144634	-1.23001	-0.01014	-0.21772
Pop'n	0.005	0.005	0.005	0.005
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	0.820341	1.907878	1.011828	1.23294
s*A*alpha(1/p)	0.000492	0.00124	0.000658	0.00074
n+delta	0.105	0.105	0.105	0.105
Result	-0.10451	-0.10376	-0.10434	-0.10426

AFTER

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.18	0.17	0.17	0.18
A	0.01	0.01	0.01	0.01
K-share	0.31	0.31	0.31	0.31
Rho	-5.984	-0.0261	-0.69	0.054
E.S.	-0.20064	1.026799	3.225806	0.948767
Pop'n	0.005	0.005	0.005	0.005
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	1.216185	3.08E+19	5.459551	3.81E-10
s*A*alpha(1/p)	0.002189	5.23E+16	0.009281	6.86E-13
n+delta	0.105	0.105	0.105	0.105
Result	*-0.10281*	*5.23E+16*	*-0.09572*	*-0.105*

Excluding WWII

BEFORE

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.12	0.12	0.12	0.12
A	0.005	0.005	0.005	0.005
K-share	0.31	0.31	0.31	0.31
Rho	6.082	2.755	5.742	28.233
E.S.	0.141203	0.266312	0.148324	0.034208
Pop'n	0.005	0.005	0.005	0.005
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	0.82484	0.653697	0.815489	0.959366
s*A*alpha(1/p)	0.000495	0.000392	0.000489	0.000576
n+delta	0.105	0.105	0.105	0.105
Result	-0.10451	-0.10461	-0.10451	-0.10442

AFTER

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.18	0.18	0.18	0.18
A	0.01	0.01	0.01	0.01
K-share	0.31	0.31	0.31	0.31
Rho	-0.277	-0.884	-0.754	-0.81
E.S.	1.383126	8.62069	4.065041	5.263158
Pop'n	0.005	0.005	0.005	0.005
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	68.58662	3.761687	4.727011	4.245692
s*A*alpha(1/p)	0.123456	0.006771	0.008509	0.007642
n+delta	0.105	0.105	0.105	0.105
Result	0.018456	-0.09823	-0.09649	-0.09736

Table A.27: Testing the Endogenous Growth Condition. Japan, 1890-1991.

Japan
Complete
CES

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.25	0.25	0.25	0.25
A	0.025	0.025	0.025	0.025
K-share	0.4	0.4	0.4	0.4
Rho	2.128	3.874	2.335	-0.127
E.S.	0.319693	0.20517	0.29985	1.145475
Pop'n	0.01	0.01	0.01	0.01
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	0.65012687	0.789368	0.675423	1359.521
s*A*alpha(1/p)	0.004063293	0.004934	0.004221	8.497006
n+delta	0.11	0.11	0.11	0.11
Result	*-0.105936707*	*-0.10507*	*-0.10578*	*8.387006*

Accounting for breaking points (1942,1950,1942,1948)

BEFORE

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.18	0.18	0.18	0.18
A	0.005	0.005	0.005	0.005
K-share	0.4	0.4	0.4	0.4
Rho	-0.1742	-0.047	-0.218	-0.085
E.S.	1.210947	1.049318	1.278772	1.092896
Pop'n	0.01	0.01	0.01	0.01
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	192.4801	2.93E+08	66.89796	48044.89
s*A*alpha(1/p)	0.173232	263664.2	0.060208	43.2404
n+delta	0.11	0.11	0.11	0.11
Result	0.063232	263664.1	-0.049792	43.1304

AFTER

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.3	0.3	0.3	0.3
A	0.025	0.025	0.025	0.025
K-share	0.4	0.4	0.4	0.4
Rho	1.027	1.073	2.817	2.29
E.S.	0.493339911	0.482393	0.261986	0.303951
Pop'n	0.01	0.01	0.01	0.01
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	0.409752772	0.425729	0.722331	0.670235
s*A*alpha(1/p)	0.003073146	0.003193	0.005417	0.005027
n+delta	0.11	0.11	0.11	0.11
Result	*-0.106926854*	*-0.10681*	*-0.10458*	*-0.10497*

Excluding WWII

BEFORE

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.18	0.18	0.18	0.18
A	0.005	0.005	0.005	0.005
K-share	0.4	0.4	0.4	0.4
Rho	-0.176	0.549	-0.049	0.287
E.S.	1.213592	0.645578	1.051525	0.777001
Pop'n	0.01	0.01	0.01	0.01
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	182.3991	0.188432	1.32E+08	0.041063
s*A*alpha(1/p)	0.164159	0.00017	118978.1	3.7E-05
n+delta	0.11	0.11	0.11	0.11
Result	0.054159	-0.10983	118978	-0.109963

AFTER

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.3	0.3	0.3	0.3
A	0.025	0.025	0.025	0.025
K-share	0.4	0.4	0.4	0.4
Rho	1.027	1.073	2.817	2.245
E.S.	0.493339911	0.482393	0.261986	0.308166
Pop'n	0.01	0.01	0.01	0.01
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	0.409752772	0.425729	0.722331	0.664881
s*A*alpha(1/p)	0.003073146	0.003193	0.005417	0.004987
n+delta	0.11	0.11	0.11	0.11
Result	-0.106926854	-0.106807	-0.104583	-0.105013

Note: Savings=18, 25 and 30%; A=.5, 2.5%;Capital-Share(K-share)=27, 31 and 40%;
Rho=estimated value; Population growth=1% and Depreciation=10%.

Table A.28: Testing the Endogenous Growth Condition. Japan, 1890-1991.

Japan
Complete
CES

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.25	0.25	0.25	0.25
A	0.025	0.025	0.025	0.025
K-share	0.27	0.27	0.27	0.27
Rho	2.128	3.874	2.335	-0.127
E.S.	0.319693	0.20517	0.29985	1.145475
Pop'n	0.01	0.01	0.01	0.01
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	0.540485	0.71321	0.570785	30022.76
s*A*alpha(1/p)	0.003378	0.004458	0.003567	187.6423
n+delta	0.11	0.11	0.11	0.11
Result	*-0.10662*	*-0.10554*	*-0.10643*	*187.5323*

Accounting for breaking points (1942,1950,1942,1948)

BEFORE

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.18	0.18	0.18	0.18
A	0.005	0.005	0.005	0.005
K-share	0.27	0.27	0.27	0.27
Rho	-0.1742	-0.047	-0.218	-0.085
E.S.	1.210947	1.049318	1.278772	1.092896
Pop'n	0.01	0.01	0.01	0.01
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	1837.69	1.25E+12	405.9038	4895962
s*A*alpha(1/p)	1.653921	1.13E+09	0.365313	4406.366
n+delta	0.11	0.11	0.11	0.11
Result	1.543921	1.13E+09	0.255313	4406.256

AFTER

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.3	0.3	0.3	0.3
A	0.025	0.025	0.025	0.025
K-share	0.27	0.27	0.27	0.27
Rho	1.027	1.073	2.817	2.29
E.S.	0.49334	0.482393	0.261986	0.303951
Pop'n	0.01	0.01	0.01	0.01
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	0.279456	0.295155	0.628263	0.56453
s*A*alpha(1/p)	0.002096	0.002214	0.004712	0.004234
n+delta	0.11	0.11	0.11	0.11
Result	*-0.1079*	*-0.10779*	*-0.10529*	*-0.10577*

Excluding WWII

BEFORE

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.18	0.18	0.18	0.18
A	0.005	0.005	0.005	0.005
K-share	0.27	0.27	0.27	0.27
Rho	-0.176	0.549	-0.049	0.287
E.S.	1.213592	0.645578	1.051525	0.777001
Pop'n	0.01	0.01	0.01	0.01
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	1701.718	0.092094	4.03E+11	0.01044
s*A*alpha(1/p)	1.531547	8.29E-05	3.62E+08	9.4E-06
n+delta	0.11	0.11	0.11	0.11
Result	1.421547	-0.10992	3.62E+08	-0.10999

AFTER

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	0.3	0.3	0.3	0.3
A	0.025	0.025	0.025	0.025
K-share	0.27	0.27	0.27	0.27
Rho	1.027	1.073	2.817	2.245
E.S.	0.49334	0.482393	0.261986	0.308166
Pop'n	0.01	0.01	0.01	0.01
Deprec	0.1	0.1	0.1	0.1

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	0.279456	0.295155	0.628263	0.558097
s*A*alpha(1/p)	0.002096	0.002214	0.004712	0.004186
n+delta	0.11	0.11	0.11	0.11
Result	-0.1079	-0.10779	-0.10529	-0.10581

Table A.29: Testing the Endogenous Growth Condition. Japan, 1890-1991.

Japan
Complete
CES

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	**0.25**	**0.25**	**0.25**	**0.25**
A	**0.025**	**0.025**	**0.025**	**0.025**
K-share	**0.31**	**0.31**	**0.31**	**0.31**
Rho	**2.128**	**3.874**	**2.335**	**-0.127**
E.S.	**0.319693**	**0.20517**	**0.29985**	**1.145475**
Pop'n	**0.01**	**0.01**	**0.01**	**0.01**
Deprec	**0.1**	**0.1**	**0.1**	**0.1**

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	**0.576737565**	**0.739102**	**0.605575**	**10116.4**
s*A*alpha(1/p)	**0.00360461**	**0.004619**	**0.003785**	**63.22751**
n+delta	**0.11**	**0.11**	**0.11**	**0.11**
Result	***-0.10639539***	***-0.10538***	***-0.10622***	***63.11751***

Accounting for breaking points (1942,1950,1942,1948)

BEFORE

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	**0.18**	**0.18**	**0.18**	**0.18**
A	**0.005**	**0.005**	**0.005**	**0.005**
K-share	**0.31**	**0.31**	**0.31**	**0.31**
Rho	-0.1742	-0.047	-0.218	-0.085
E.S.	**1.210947**	**1.049318**	**1.278772**	**1.092896**
Pop'n	**0.01**	**0.01**	**0.01**	**0.01**
Deprec	**0.1**	**0.1**	**0.1**	**0.1**

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	**831.4813**	**6.64E+10**	**215.3789**	**963784.8**
s*A*alpha(1/p)	**0.748333**	**59749480**	**0.193841**	**867.4063**
n+delta	**0.11**	**0.11**	**0.11**	**0.11**
Result	**0.638333**	**59749480**	**0.083841**	**867.2963**

AFTER

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	**0.3**	**0.3**	**0.3**	**0.3**
A	**0.025**	**0.025**	**0.025**	**0.025**
K-share	**0.31**	**0.31**	**0.31**	**0.31**
Rho	1.027	1.073	2.817	2.29
E.S.	**0.493339911**	**0.482393**	**0.261986**	**0.303951**
Pop'n	**0.01**	**0.01**	**0.01**	**0.01**
Deprec	**0.1**	**0.1**	**0.1**	**0.1**

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	**0.319693554**	**0.335711**	**0.659842**	**0.599635**
s*A*alpha(1/p)	**0.002397702**	**0.002518**	**0.004949**	**0.004497**
n+delta	**0.11**	**0.11**	**0.11**	**0.11**
Result	***-0.107602298***	***-0.10748***	***-0.10505***	***-0.1055***

Excluding WWII

BEFORE

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	**0.18**	**0.18**	**0.18**	**0.18**
A	**0.005**	**0.005**	**0.005**	**0.005**
K-share	**0.31**	**0.31**	**0.31**	**0.31**
Rho	-0.176	0.549	-0.049	0.287
E.S.	**1.213592**	**0.645578**	**1.051525**	**0.777001**
Pop'n	**0.01**	**0.01**	**0.01**	**0.01**
Deprec	**0.1**	**0.1**	**0.1**	**0.1**

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	**776.2299**	**0.118446**	**2.4E+10**	**0.016894**
s*A*alpha(1/p)	**0.698607**	**0.000107**	**21608076**	**1.52E-05**
n+delta	**0.11**	**0.11**	**0.11**	**0.11**
Result	**0.588607**	**-0.109893**	**21608076**	**-0.109985**

AFTER

	Unr-T	Unr-No T	Res-T	Res -NoT
Savings	**0.3**	**0.3**	**0.3**	**0.3**
A	**0.025**	**0.025**	**0.025**	**0.025**
K-share	**0.31**	**0.31**	**0.31**	**0.31**
Rho	1.027	1.073	2.817	2.245
E.S.	**0.493339911**	**0.482393**	**0.261986**	**0.308166**
Pop'n	**0.01**	**0.01**	**0.01**	**0.01**
Deprec	**0.1**	**0.1**	**0.1**	**0.1**

	Unr-T	Unr-No T	Res-T	Res -NoT
alpha^(1/p)	**0.319693554**	**0.335711**	**0.659842**	**0.59352**
s*A*alpha(1/p)	**0.002397702**	**0.002518**	**0.004949**	**0.004451**
n+delta	**0.11**	**0.11**	**0.11**	**0.11**
Result	**-0.107602298**	**-0.107482**	**-0.105051**	**-0.105549**

Table A.30: Bai and Perron's test.

	No Trend		Trend	
	Breaks		Breaks	
	BIC	LWZ	BIC	LWZ
BEA	1941,1961	1941,1961	1977,1988	1977,1988
USA	1910,1932	1910,1932,1942	1917,1935,1945	1917,1935,1945
UK	1877,1910,1920,	1883,1893,1910,1920,1931	1909,1919,1931	1909,1919,1931
Japan	NA	NA	1932,1941	1932,1941

BIC=Bayesian Information Criterion
LWZ=modified Schwarz Criterion

Table A.31: Comparing Elasticities. USA, 1890-1992.

CES

Accounting for breaking points (1942, 1950, 1942, 1948)

	Unrestricted Model		Restricted Model (ν=1)	
	Trend	No Trend	Trend	No Trend
ρ (before)	-.115	-3.187	3.31	-9.639
σ	1.129	-.457	.232	-.115
ρ (after)	1.493	5.957	12.294	-6.923
σ	.401	.143	.075	-.168

Excluding WW II (1890-1939; 1946-1992)

	Unrestricted Model		Restricted Model (ν=1)	
	Trend	No Trend	Trend	No Trend
ρ (before)	-.124	-1.527	-2.407	3.529
σ	1.141	-1.897	-.710	.220
ρ (after)	1.493	5.957	12.294	-6.923
σ	.401	.143	.075	-.0168

Box-Cox

Excluding WW II (1890-1939; 1946-1992)

	Before (1890-1939)		After (1946-1992)	
	Trend	No Trend	Trend	No Trend
ρ	-.072	-.754	.33	1.02
σ	.932	.570	1.492	-50

Table A.32: Comparing Elasticities. USA, 1929-2000.

CES

Accounting for breaking points (1947,1964,1951,1945)

	Unrestricted Model		Restricted Model (ν=1)	
	Trend	No Trend	Trend	No Trend
ρ (before)	-1.514	-4.511	-1.293	4.873
σ	-1.945	-.284	-3.412	.170
ρ (after)	3.798	5.551	3.692	-1.716
σ	.208	.152	.213	-1.396

Excluding WW II (1946-1992)

	Unrestricted Model		Restricted Model (ν=1)	
	Trend	No Trend	Trend	No Trend
ρ (before)	3.608	2.722	3.224	2.048
σ	.217	.268	.236	.328

Box-Cox

Excluding WW II (1946-2000)

	Before (1890-1939)	
	Trend	No Trend
ρ	.402	.762
σ	1.672	4.201

Table A.33: Comparing Elasticities. UK, 1870-1991.

CES

Accounting for breaking points (1933, 1917, 1917, 1929)

	Unrestricted Model		Restricted Model (ν=1)	
	Trend	No Trend	Trend	No Trend
ρ (before)	5.914	-1.813	-99.606	-5.593
σ	.144	-1.230	-.01	-.217
ρ (after)	-5.985	-.026	-.69	.054
σ	-.20	1.026	3.225	.948

Excluding WW II (1870-1939; 1946-1991)

	Unrestricted Model		Restricted Model (ν=1)	
	Trend	No Trend	Trend	No Trend
ρ (before)	6.082	2.755	5.742	28.233
σ	.141	.266	.148	.034
ρ (after)	-.277	-.884	-.754	-.81
σ	1.383	8.620	4.065	5.263

Box-Cox

Excluding WW II (1870-1939; 1946-1991)

	Before (1870-1939)		After (1946-1991)	
	Trend	No Trend	Trend	No Trend
ρ	-1.639	-1.125	-.303	.746
σ	.379	.470	.767	3.937

Table A.34: Comparing Elasticities. Japan, 1890-1991.

CES

Accounting for breaking points (1946, 1946, 1946, 1945)

	Unrestricted Model		Restricted Model (ν=1)	
	Trend	No Trend	Trend	No Trend
ρ (before)	-.174	-.047	-.218	-.085
σ	1.210	1.049	1.278	1.092
ρ (after)	1.027	1.073	2.817	2.29
σ	.493	.482	.261	.303

Excluding WW II (1890-1939; 1946-1991)

	Unrestricted Model		Restricted Model (ν=1)	
	Trend	No Trend	Trend	No Trend
ρ (before)	-.176	.549	-.049	.287
σ	1.213	.645	1.051	.777
ρ (after)	1.027	1.073	2.817	2.245
σ	.493	.482	.261	.308

Box-Cox

Excluding WW II (1890-1939; 1946-1991)

	Before (1890-1939)		After (1946-1991)	
	Trend	No Trend	Trend	No Trend
ρ	-.411	-.61	.661	.424
σ	.708	.621	2.949	1.736

Table A.35: Same Power Transformation ($\lambda_0 = \lambda_1 = \lambda_2$) with Trend and No Trend. USA, 1946-1992.

	Model with a Trend	Bootstrap Confidence Interval	Bootstrap Bias	Model without Trend	Bootstrap Confidence Interval	Bootstrap Bias
A	-6.578	[-9.285 ; -3.871]	.030	-70.041	[-173.219 ; 33.136]	-12.912
λ	.330* (.048)	[.259 ; .401]	-.002	1.02* (.097)	[.807 ; 1.233]	.022
α_1	-.128*** (.07)	[-.296 ; .0405]	.001	.412	[.313 ; .511]	-.001
α_2	.966* (.01)	[.794 ; 1.138]	-.001	1.230	[1.010 ; 1.451]	.003
ϕ	.106* (.003)	[.079 ; .133]	-.001			
LRT (λ = 0)	67.03 p>(.0001)			62.04 p>(.0001)		
LRT (λ = 1)	33.12 p>(.0001)			.05 p>(.830)		
LRT (λ = -1)	105.84 p>(.0001)			105.53 p>(.0001)		

Note: : 1) *, **,and *** mean significantly different from zero at 1, 5, and 10% respectively.
2) Standard Errors are given in parentheses. P> means p-value.
3) 1,000 bootstrap samples.

Table A.36: Same Power Transformation ($\lambda_0 = \lambda_1 = \lambda_2$) with Trend and No Trend. USA, 1946-2000.

	Model with a Trend	Bootstrap Confidence Interval	Bootstrap Bias	Model without Trend	Bootstrap Confidence Interval	Bootstrap Bias
A	-2.411	[-4.029 ; -.793]	.045	-43.453	[-69.311 ; -17.595]	-2.195
λ	.402*	[.348 ;.456]	-.001	.762*	[.597 ; .926]	.003
	(.022)			(.078)		
α_1	.104*	[.072 ; .136]	.0007	.067**	[.009 ; .126]	.001
	(.003)			(.01)		
α_2	.725*	[.590 ;.860]	-.007	1.970*	[1.812 ; 2.128]	-.004
	(.01)			(.02)		
ϕ	.118*	[.0910 ; .1461]	.0003			
	(.001)					
LRT (λ = 0)	123.250			62.60		
	p>(.0001)			p>(.0001)		
LRT (λ = 1)	-144.667			7.54		
	p>(.0001)			p>(.006)		
LRT (λ = -1)	-202.154			116.07		
	p>(.0001)			p>(.0001)		

Note: : 1) *, **,and *** mean significantly different from zero at 1, 5, and 10% respectively.
2) Standard Errors are given in parentheses. P> means p-value.
3) 1,000 bootstrap samples

Table A.37: Same Power Transformation ($\lambda_0 = \lambda_1 = \lambda_2$) with Trend and No Trend. UK, 1946-1991.

	Model with a Trend	Bootstrap Confidence Interval	Bootstrap Bias	Model without Trend	Bootstrap Confidence Interval	Bootstrap Bias
A	.593	[-44.817 ; 46.004]	5.320	-1.524	[-17.697 ; 14.648]	-2.674
λ	-.303 (.195)	[-1.550 ; .944]	.686	.746* (.195)	[.368 ; 1.124]	.008
α_1	.234* (.02)	[-.096 ; .564]	.172	.503* (.003	[.474 ; .531]	-.0002
α_2	.405* (.03)	[-.025 ; .837]	.149	.541* (.03	[.342 ; .740]	..001
ϕ	.003* (.0001)	[-1.362 ; 1.368]	-.258			
LRT (λ = 0)	2.89 p>(.089)			12.31 p>(.0001)		
LRT (λ = 1)	22.44 p>(.0001)			1.69 p>(.193)		
LRT (λ = -1)	8.71 p>(.003)			47.44 p>(.0001)		

Note: : 1) *, **,and *** mean significantly different from zero at 1, 5, and 10% respectively.
2) Standard Errors are given in parentheses. P> means p-value.
3) 1,000 bootstrap samples.

Table A.38: Same Power Transformation ($\lambda_0 = \lambda_1 = \lambda_2$) with Trend and No Trend. USA, 1946-2000.

	Model with a Trend	Bootstrap Confidence Interval	Bootstrap Bias	Model without Trend	Bootstrap Confidence Interval	Bootstrap Bias
A	-49.686	[-110.917; 11.543]	3.186	-27.869	[-98.887 ; 43.149]	-12.296
λ	.661*	[-.165; 1.488]	-.239	.425*	[.055;.795]	.032
	(.087)			(.130)		
α_1	.164*	[-.381 ; .709]	.174	.336*	[.256 ; .417]	-.008
	(.02)			(.01)		
α_2	-.697	[-6.235 ; 4.841]	1.790	2.586*	[2.215 ; 2.956]	.073
	(.53)			(.05)		
ϕ	1.233*	[-.290 ; 2.757]	-.235			
	(.06)					
LRT (λ = 0)	18.85			12.99		
	p>(.0001)			p>(.0001)		
LRT (λ = 1)	9.53			12.89		
	p>(.002)			p>(.0001)		
LRT (λ = -1)	66.77			121.13		
	p>(.0001)			p>(.0001)		

Note: : 1) *, **,and *** mean significantly different from zero at 1, 5, and 10% respectively.
2) Standard Errors are given in parentheses. P> means p-value.
3) 1,000 bootstrap samples.

Table A.39: DGP: Cobb-Douglas.

Data Set		Box-Cox				CES			
		λ				ρ			
		No Trend		Trend		No Trend		Trend	
US:BEA	Mean	-.002	[-.296;.379]	-.009	[-.325;.261]	-4.77	[-117.1;59.3]	-.295	[-117.1;21.1]
	S.E.	.086		.087		26.456		7.332	
US:Maddison	Mean	.002	[-.232;.202]	.001	[-.229;.208]	-.234	[-1.79; 1.65]	8.02	[-121.6;142.7]
	S.E.	.069		.073		.491		30.84	
UK	Mean	.0009	[-.265;.205]	.0005	[-.255;.205]	1.096	[-44.61;5.94]	-.551	[-70.1;60.8]
	S.E.	.070		.071		2.484		12.51	
Japan	Mean	.001	[-.211;.216]	.001	[-.231;.234]	-.015	[-4.25;12.78]	1.068	[-18.9;12.8]
	S.E.	.066		.067		1.159		2.442	

Note: 1,000 samples. S.E. is the Standard Error. Range of the parameter estimator is on brackets.

Table A.40: DGP: CES (additive error).

Data Set		ρ			
		ρ=1.86 (υ=.8)			
		No Trend		**Trend**	
US:BEA	Mean	2.41	[.814;8.012]	2.31	[-.059; 15.588]
	S.E.	.785		.978	
US: Maddison	Mean	1.99	[.382;4.219]	2.05	[.348; 46.472]
	S.E.	.559		1.593	
U.K.	Mean	1.95	[.445;3.892]	2.17	[.513;75.732]
	S.E.	.581		2.591	
Japan	Mean	1.80	[.885;6.303]	1.84	[.932;7.003]
	S.E.	.485		.697	
		ρ=1.86 (υ=1.2)			
US:BEA	Mean	1.93	[1.689;2.766]	1.895	[1.481;2.731]
	S.E.	.143		.217	
US: Maddison	Mean	1.86	[1.537;2.202]	1.86	[1.79;2.150]
	S.E.	.103		.080	
U.K.	Mean	1.86	[1.533;2.229]	1.86	[1.578;2.231]
	S.E.	.099			
Japan	Mean	1.82	[1.264;2.331]	1.81	[1.256;2.499]
	S.E.	.178		.208	

Note: 1,000 samples. S.E. is the Standard Error. Range of the parameter estimator is on brackets.

Table A.41: DGP: CES (additive error).

Data Set		ρ			
		ρ=-.26 (υ=.8)			
		No Trend		Trend	
US:BEA	Mean	-.26	[-2.635;1.384]	-.26	[-2.078;2.080]
	S.E.	.323		.298	
US: Maddison	Mean	-.21	[-1.651;1.397]	-.25	[-2.806;.971]
	S.E.	.474		.504	
U.K.	Mean	-.24	[-1.245;.784]	-.26	[-1.060;1.288]
	S.E.	.268		.290	
Japan	Mean	-.25	[-.413;-.072]	-.43	[-16.741;.017]
	S.E.	.051		1.230	
		ρ=-.26 (υ=1.2)			
US:BEA	Mean	-.25	[-.390;-.140]	-.26	[-.377;-.141]
	S.E.	.041		.038	
US: Maddison	Mean	-.24	[-.531;-.036]	-.25	[-.503;-.016]
	S.E.	.081		.079	
U.K.	Mean	-.26	[-.396;-.126]	-.26	[-.377;-.135]
	S.E.	.036		.038	
Japan	Mean	-.25	[-.298;-.229]	-.26	[-.313;-.209]
	S.E.	.009		.016	

Note: 1,000 samples. S.E. is the Standard Error. Range of the parameter estimator is on brackets.

Table A.42: DGP: CES (additive error). No Trend.

Data Set		A	α	ρ	υ
				ρ=1.86	**υ=.8**
US:BEA	Mean	1.00	.382	2.412	.856
	S.E.	.617	.218	.785	.181
US: Maddison	Mean	.987	.394	1.994	.805
	S.E.	.153	.072	.559	.034
U.K.	Mean	.982	.393	1.950	.819
	S.E.	.350	.063	.581	.083
Japan	Mean	.772	.343	1.800	.897
	S.E.	.376	.099	.485	.170
				ρ=1.86	**υ=1.2**
US:BEA	Mean	1.039	.396	1.936	1.213
	S.E.	.440	.097	.143	.102
US: Maddison	Mean	.999	.399	1.867	1.200
	S.E.	.038	.012	.103	.008
U.K.	Mean	1.000	.399	1.862	1.201
	S.E.	.103	.011	.099	.022
Japan	Mean	.936	.389	1.822	1.219
	S.E.	.199	.029	.178	.049
				ρ=-.26	**υ=.8**
US:BEA	Mean	1.065	.408	-.268	.804
	S.E.	.475	.126	.323	.090
US: Maddison	Mean	1.006	.402	-.211	.801
	S.E.	.154	.066	.474	.034
U.K.	Mean	1.050	.403	-.249	.803
	S.E.	.396	.061	.268	.080
Japan	Mean	1.076	.409	-.256	.797
	S.E.	.391	.062	.051	.076
				ρ=-.26	**υ=1.2**
US:BEA	Mean	1.002	.40	-.259	1.200
	S.E.	.094	.017	.041	.020
US: Maddison	Mean	.998	.399	-.249	1.200
	S.E.	.036	.010	.081	.008
U.K.	Mean	1.000	.399	-.261	1.200
	S.E.	.082	.088	.036	.017
Japan	Mean	1.006	.400	-.259	1.199
	S.E.	.077	.008	.009	.016

Note: 1,000 samples. S.E. is the Standard Error

Table A.43: DGP: CES (additive error). Trend.

Data Set		A	φ	α	ρ	υ
					ρ=1.86	**υ=.8**
US:BEA	Mean	1.020	-.007	.370	2.314	.886
	S.E.	.686	.003	.200	.978	.271
US: Maddison	Mean	1.044	-.008	.396	2.053	.806
	S.E.	.289	.001	.067	1.593	.089
U.K.	Mean	1.133	.0001	.406	2.172	.806
	S.E.	.635	.001	.089	2.591	.133
Japan	Mean	.785	-.001	.350	1.849	.949
	S.E.	.474	.004	.097	.697	.250
					ρ=1.86	**υ=1.2**
US:BEA	Mean	1.041	-.002	.395	1.895	1.220
	S.E.	.433	.001	.068	.217	.108
US: Maddison	Mean	1.028	-.002	.399	1.865	1.201
	S.E.	.074	.0004	.008	.080	.023
U.K.	Mean	1.034	.0008	.399	1.863	1.200
	S.E.	.140	.0002	.012	.100	.032
Japan	Mean	.947	-.0005	.389	1.810	1.235
	S.E.	.263	.001	.030	.208	.089
					ρ=-.26	**υ=.8**
US:BEA	Mean	1.198	.008	.417	-.268	.797
	S.E.	.671	.002	.128	.298	.132
US: Maddison	Mean	1.051	-.001	.398	-.257	.801
	S.E.	.253	.001	.064	.504	.076
U.K.	Mean	1.070	-.000061	.401	-.263	.810
	S.E.	.451	.0008	.061	.290	.096
Japan	Mean	1.230	.0002	.426	-.432	.790
	S.E.	.805	.002	.119	1.230	.155
					ρ=-.26	**υ=1.2**
US:BEA	Mean	1.038	-.006	.400	-.260	1.200
	S.E.	.135	.0005	.016	.038	.032
US: Maddison	Mean	1.029	-.0001	.399	-.256	1.200
	S.E.	.062	.0003	.008	.079	.019
U.K.	Mean	1.030	-1.97e-06	.399	-.261	1.200
	S.E.	.084	.0001	.008	.038	.019
Japan	Mean	1.029	-6.19e-06	.399	-.260	1.201
	S.E.	.108	.0005	.009	.016	.031

Note: 1,000 samples. S.E. is the Standard Error.

Table A.44: DGP: Box-Cox.

Data Set		Box-Cox			
		λ=.5			
		No Trend		Trend	
US:BEA	Mean	.506	[.434;.592]	.506	[.399;.670]
	S.E.	.022		.025	
US:Maddison	Mean	.600	[.382;.811]	.891	[.405;1.228]
	S.E.	.069		.129	
UK	Mean	.556	[.179; .746]	.563	[.042;.794]
	S.E.	.056		.058	
Japan	Mean	.512	[.456;.659]	.521	[.422; .661]
	S.E.	.018		.019	

Note: 1,000 samples. S.E. is the Standard Error. Range of the parameter estimator is on brackets.

Table A.45: Hall and Jones (1999) data.

Country	Y	h	K	L	Country	Y	h	K	L	Country	Y	h	K	L
Angola	5E+09	1.51	3E+09	4.E+06	Iran	2E+11	1.55	4E+11	2.E+07	Sweden	1E+11	2.83	3.E+11	4.E+06
Argentina	2E+11	2.24	4E+11	1.E+07	Iceland	3E+09	2.53	9E+09	1.E+05	Swaziland	2E+09	1.66	2.E+09	3.E+05
Australia	2E+11	2.98	7E+11	8.E+06	Israel	4E+10	2.82	9E+10	2.E+06	Seychelles	2E+08	1.35	4.E+08	3.E+04
Austria	9E+10	2.23	3E+11	4.E+06	Italy	7E+11	2.15	2E+12	2.E+07	Syria	4E+10	1.71	7.E+10	3.E+06
Burundi	3E+09	1.31	2E+09	3.E+06	Jamaica	5E+09	1.74	1E+10	1.E+06	Chad	2E+09	1.42	7.E+08	2.E+06
Belgium	1E+11	2.77	3E+11	4.E+06	Jordan	1E+10	1.76	2E+10	7.E+05	Togo	2E+09	1.33	4.E+09	1.E+06
Benin	4E+09	1.10	4E+09	2.E+06	Japan	2E+12	2.64	5E+12	8.E+07	Thailand	2E+11	1.91	2.E+11	3.E+07
Burkina Faso	4E+09	1.66	4E+09	4.E+06	Kenya	2E+10	1.51	3E+10	1.E+07	Trinidad&Tob	8E+09	2.20	2.E+10	5.E+05
Bangladesh	1E+11	1.30	5E+10	3.E+07	Korea, rep.	2E+11	2.52	4E+11	2.E+07	Tunisia	2E+10	1.39	3.E+10	3.E+06
Bolivia	1E+10	1.76	2E+10	2.E+06	Sri Lanka	3E+10	1.96	4E+10	6.E+06	Turkey	2E+11	1.55	4.E+11	2.E+07
Brazil	6E+11	1.60	1E+12	5.E+07	Lesotho	2E+09	1.60	2E+09	8.E+05	Tanzania	1E+10	1.36	1.E+10	1.E+07
Barbados	2E+09	2.43	2E+09	1.E+05	Luxembourg	6E+09	2.67	2E+10	2.E+05	Uganda	8E+09	1.29	3.E+09	7.E+06
Botswana	1E+09	1.64	4E+09	4.E+05	Morocco	5E+10	1.90	5E+10	7.E+06	Uruguay	1E+10	2.19	3.E+10	1.E+06
Central Afr.R.	2E+09	1.18	1E+09	1.E+06	Madagascar	7E+09	1.70	2E+09	5.E+06	U.S.A.	4E+12	3.31	1.E+13	1.E+08
Canada	4E+11	3.01	1E+12	1.E+07	Mexico	4E+11	1.78	8E+11	3.E+07	Venezuela	1E+11	1.96	3.E+11	6.E+06
Switzerland	1E+11	2.76	4E+11	3.E+06	Mali	4E+09	1.12	3E+09	3.E+06	Yemen	2E+10	1.11	2.E+10	3.E+06
Chile	4E+10	2.19	1E+11	5.E+06	Malta	2E+09	2.29	4E+09	1.E+05	Yugoslavia	1E+11	2.35	4.E+11	1.E+07
China	1E+12	2.09	3E+12	7.E+08	Myanmar	2E+10	1.31	2E+10	2.E+07	South Africa	1E+11	1.88	2.E+11	1.E+07
Ivory Coast	2E+10	1.48	2E+10	4.E+06	Mozambique	1E+10	1.16	3E+09	8.E+06	Zaire	2E+10	1.35	1.E+10	1.E+07
Cameroon	1E+10	1.35	2E+10	5.E+06	Mauritania	1E+09	1.40	3E+09	8.E+05	Zambia	5E+09	1.77	2.E+10	3.E+06
Congo	4E+09	1.52	5E+09	1.E+06	Mauritius	6E+09	1.81	5E+09	6.E+05	Zimbabwe	9E+09	1.42	2.E+10	4.E+06
Colombia	9E+10	1.80	2E+11	1.E+07	Malawi	4E+09	1.41	4E+09	3.E+06					
Comoros	2E+08	1.50	5E+08	2.E+05	Malaysia	6E+10	1.96	2E+11	7.E+06					
Cape Verde Is.	4E+08	1.56	9E+08	1.E+05	Namibia	3E+09	1.58	1E+10	4.E+05					
Costa Rica	9E+09	1.95	2E+10	1.E+06	Niger	4E+09	1.08	4E+09	4.E+06					
Czechoslovakia	6E+10	2.53	2E+11	8.E+06	Nigeria	7E+10	1.22	1E+11	4.E+07					
Cyprus	5E+09	2.34	1E+10	3.E+05	Nicaragua	5E+09	1.66	9E+09	1.E+06					
Germany, West	8E+11	2.66	3E+12	3.E+07	Netherlands	2E+11	2.66	5E+11	6.E+06					
Denmark	7E+10	3.00	2E+11	3.E+06	Norway	6E+10	3.01	2E+11	2.E+06					
Dominican rep.	2E+10	1.74	3E+10	2.E+06	New Zealand	4E+10	3.37	1E+11	1.E+06					
Algeria	6E+10	1.38	2E+11	5.E+06	Taiwan	1E+11	2.31	2E+11	9.E+06					
Ecuador	3E+10	2.00	6E+10	3.E+06	Oman	6E+09	1.87	2E+10	4.E+05					
Egypt	9E+10	1.91	5E+10	1.E+07	Pakistan	1E+11	1.29	1E+11	3.E+07					
Spain	3E+11	2.00	9E+11	1.E+07	Panama	7E+09	2.16	2E+10	8.E+05					
Finland	7E+10	2.83	2E+11	3.E+06	Peru	6E+10	2.05	1E+11	7.E+06					
Fiji	2E+09	2.26	5E+09	2.E+05	Philippines	1E+11	2.20	2E+11	2.E+07					
France	7E+11	2.20	2E+12	3.E+07	P. N.Guinea	5E+09	1.25	1E+10	2.E+06					
Gabon	3E+09	1.35	1E+10	5.E+05	Poland	2E+11	2.63	7E+11	2.E+07					
U.K.	7E+11	2.68	1E+12	3.E+07	Puerto Rico	3E+10	1.82	5E+10	1.E+06					
Ghana	1E+10	1.54	7E+09	6.E+06	Portugal	6E+10	1.67	1E+11	5.E+06					
Guinea	4E+09	1.37	3E+09	3.E+06	Paraguay	8E+09	1.83	1E+10	1.E+06					
Gambia	7E+08	1.12	5E+08	4.E+05	Reunion	2E+09	1.69	3E+09	2.E+05					
Guinea-Bissau	6E+08	1.08	1E+09	4.E+05	Romania	5E+10	2.01	1E+11	1.E+07					
Greece	6E+10	2.25	2E+11	4.E+06	Rwanda	5E+09	1.12	2E+09	3.E+06					
Guatemala	2E+10	1.41	2E+10	2.E+06	Saudi Arabia	8E+10	1.85	2E+11	4.E+06					
Guyana	1E+09	1.91	4E+09	3.E+05	Sudan	2E+10	1.13	3E+10	8.E+06					
Hong Kong	8E+10	2.44	1E+11	4.E+06	Senegal	8E+09	1.38	5E+09	3.E+06					
Honduras	7E+09	1.61	9E+09	1.E+06	Singapore	3E+10	1.81	7E+10	1.E+06					
Haiti	5E+09	1.24	4E+09	3.E+06	Sierra Leone	3E+09	1.26	7E+08	1.E+06					
Hungary	6E+10	3.09	2E+11	5.E+06	El Salvador	9E+09	1.61	9E+09	2.E+06					
Indonesia	3E+11	1.65	5E+11	7.E+07	Somalia	6E+09	1.36	7E+09	3.E+06					
India	1E+12	1.50	1E+12	3.E+08	U.S.S.R.	2E+12	2.40	8E+12	1.E+08					
Ireland	3E+10	2.56	8E+10	1.E+06	Suriname	1E+09	1.33	3E+09	1.E+05					

Table A.46: Productivity Ratios ($\alpha = .1$).

	Alpha=.1			Ratio to US		
Country	Y/L	X	A	Y/L	X	TFP TO US
Angola	1167.222	1.55E-08	5.68E+21	0.032999	70.09265	2.22E-07
Argentina	14864.86	2.88E-09	2.66E+25	0.420245	13.05443	0.0010363
Australia	29919.53	3.56E-09	7.05E+25	0.845856	16.1361	0.0027479
Austria	25128.95	7.40E-09	1.15E+25	0.710421	33.50509	0.0004496
Burundi	1055.371	2.40E-08	1.93E+21	0.029836	108.6327	7.54E-08
Belgium	29659.17	6.51E-09	2.07E+25	0.838495	29.48933	0.0008085
Benin	2088.864	2.28E-08	8.41E+21	0.059054	103.1458	3.28E-07
Burkina faso	1044.883	1.75E-08	3.57E+21	0.02954	79.15661	1.39E-07
Bangladesh	4515.05	1.16E-09	1.52E+25	0.127645	5.238905	0.0005937
Bolivia	4973.95	2.07E-08	5.78E+22	0.140619	93.69808	2.25E-06
Brazil	11311.79	5.83E-10	3.77E+26	0.319796	2.637426	0.0147023
Barbados	14305.55	2.41E-07	3.53E+21	0.404432	1090.333	1.38E-07
Botswana	3316.999	1.31E-07	6.39E+20	0.093775	594.0291	2.49E-08
Central Afr.R.	1176.661	4.48E-08	6.91E+20	0.033265	202.6849	2.69E-08
Canada	33230.77	2.03E-09	2.68E+26	0.939468	9.181535	0.0104697
Switzerland	30992.45	8.23E-09	1.42E+25	0.876188	37.26009	0.000553
Chile	9327.717	8.35E-09	1.25E+24	0.263704	37.82216	4.86E-05
China	2115.677	1.02E-10	4.29E+26	0.059812	0.462307	0.0167387
Ivory Coast	3443.181	1.05E-08	1.08E+23	0.097342	47.45655	4.21E-06
Cameroon	2710.431	9.92E-09	7.47E+22	0.076627	44.90903	2.91E-06
Congo	4311.284	4.36E-08	9.77E+21	0.121884	197.4449	3.81E-07
Colombia	9366.337	3.39E-09	7.63E+24	0.264796	15.34966	0.0002976
Comoros	1250.706	3.63E-07	1.19E+19	0.035359	1641.533	4.64E-10
Cape Verde Is.	2675.961	4.15E-07	4.16E+19	0.075652	1877.399	1.62E-09
Costa rica	9114.44	3.64E-08	6.29E+22	0.257675	164.577	2.45E-06
Czechoslovakia	7475.214	5.57E-09	1.80E+24	0.211332	25.21206	7.03E-05
Cyprus	15794.74	1.00E-07	2.49E+22	0.446533	453.4219	9.70E-07
Germany, West	28978.87	9.54E-10	9.23E+26	0.819263	4.317561	0.0360055
Denmark	24455.88	1.07E-08	5.24E+24	0.691393	48.37756	0.0002043
Dominican rep.	7337.939	1.78E-08	1.71E+23	0.207451	80.4024	6.66E-06
Algeria	11616.1	5.50E-09	4.46E+24	0.328399	24.90198	0.0001739
Ecuador	8376.941	1.28E-08	4.31E+23	0.236825	57.7658	1.68E-05
Egypt	6644.928	2.59E-09	6.58E+24	0.187859	11.72907	0.0002565
Spain	24142.86	1.82E-09	1.75E+26	0.682543	8.26099	0.0068265
Finland	26046.29	1.16E-08	5.07E+24	0.736355	52.36429	0.0001977
Fiji	9659.981	1.56E-07	3.81E+21	0.273098	708.4589	1.49E-07
France	29015.75	9.84E-10	8.69E+26	0.820305	4.455508	0.0338966
Gabon	5555.996	8.28E-08	4.50E+21	0.157074	374.8869	1.76E-07
U.K.	25765.12	9.68E-10	7.08E+26	0.728407	4.384707	0.0275973
Ghana	1861.504	9.30E-09	4.01E+22	0.052627	42.11163	1.56E-06
Guinea	1525.596	2.28E-08	4.47E+21	0.04313	103.2732	1.74E-07
Gambia	1718.807	1.33E-07	1.67E+20	0.048592	602.0284	6.51E-09
Guinea-biss	1389.759	1.37E-07	1.03E+20	0.03929	619.1296	4.03E-09
Greece	16607.1	8.14E-09	4.16E+24	0.4695	36.85126	0.0001623
Guatemala	7431.974	1.32E-08	3.19E+23	0.21011	59.55831	1.24E-05
Guyana	3745.935	1.91E-07	3.86E+20	0.105901	863.7239	1.50E-08
Hong Kong	21524.65	7.44E-09	8.37E+24	0.608524	33.69085	0.0003262
Honduras	4596.596	2.91E-08	2.49E+22	0.12995	131.8645	9.71E-07

	Alpha=.1			Ratio to US		
Country	Y/L	X	A	Y/L	X	TFP TO US
Haiti	2009.57	1.94E-08	1.07E+22	0.056813	87.88841	4.18E-07
Hungary	10875.3	8.18E-09	1.77E+24	0.307456	37.01587	6.90E-05
Indonesia	3907.186	7.19E-10	2.96E+25	0.11046	3.253246	0.001153
India	3047.319	1.53E-10	3.96E+26	0.086151	0.693156	0.015447
Ireland	20446.92	2.24E-08	8.35E+23	0.578056	101.315	3.26E-05
Iran	10457.52	2.09E-09	2.50E+25	0.295645	9.466524	0.000975
Iceland	25839.15	2.06E-07	1.58E+22	0.730499	931.9662	6.14E-07
Israel	23385.74	1.70E-08	1.88E+24	0.661139	77.18601	7.34E-05
Italy	29567.1	1.06E-09	7.81E+26	0.835892	4.790421	0.030448
Jamaica	4591.961	4.21E-08	1.19E+22	0.129819	190.5324	4.64E-07
Jordan	14732.43	4.15E-08	1.26E+23	0.416501	187.8116	4.92E-06
Japan	20827.94	3.99E-10	2.73E+27	0.588827	1.806184	0.10628
Kenya	1990.196	5.71E-09	1.21E+23	0.056265	25.86155	4.73E-06
Korea, rep.	13526.01	1.97E-09	4.70E+25	0.382394	8.936538	0.001831
Sri lanka	5480.63	6.95E-09	6.22E+23	0.154943	31.45762	2.43E-05
Lesotho	2230.844	7.04E-08	1.00E+21	0.063068	318.7301	3.92E-08
Luxembourg	34939.55	1.57E-07	4.94E+22	0.987777	711.9966	1.92E-06
Morocco	6642.414	5.08E-09	1.71E+24	0.187788	22.97918	6.68E-05
Madagascar	1442.449	1.20E-08	1.44E+22	0.04078	54.47393	5.60E-07
Mexico	15338.35	1.06E-09	2.08E+26	0.433631	4.819907	0.008094
Mali	1228.426	1.76E-08	4.87E+21	0.034729	79.6889	1.90E-07
Malta	16386.22	2.46E-07	4.45E+21	0.463255	1111.993	1.74E-07
Myanmar	1016.76	3.93E-09	6.68E+22	0.028745	17.81326	2.60E-06
Mozambique	1385.216	6.92E-09	4.01E+22	0.039161	31.33056	1.56E-06
Mauritania	1786.149	8.09E-08	4.88E+20	0.050496	366.1687	1.90E-08
Mauritius	9269.678	5.44E-08	2.91E+22	0.262063	246.1135	1.13E-06
Malawi	1047.77	2.09E-08	2.51E+21	0.029622	94.70994	9.78E-08
Malaysia	9467.414	5.37E-09	3.11E+24	0.267654	24.2964	0.000121
Namibia	6881.095	9.76E-08	4.97E+21	0.194536	441.9615	1.94E-07
Niger	1010.721	1.85E-08	3.00E+21	0.028574	83.61223	1.17E-07
Nigeria	1711.392	1.50E-09	1.30E+24	0.048383	6.801553	5.06E-05
Nicaragua	4449.227	4.23E-08	1.11E+22	0.125784	191.3873	4.32E-07
Netherlands	28627.44	4.43E-09	4.17E+25	0.809327	20.06749	0.001627
Norway	26903.76	1.41E-08	3.66E+24	0.760597	63.64615	0.000143
New zealand	25392.68	2.11E-08	1.44E+24	0.717877	95.74687	5.62E-05
Taiwan	15844.64	3.55E-09	1.99E+25	0.447944	16.06101	0.000778
Oman	15037.67	7.63E-08	3.89E+22	0.42513	345.3814	1.52E-06
Pakistan	4556.962	1.18E-09	1.49E+25	0.12883	5.353546	0.000579
Panama	7899.483	4.97E-08	2.53E+22	0.223326	224.9117	9.86E-07
Peru	8385.669	5.90E-09	2.02E+24	0.237071	26.71204	7.88E-05
Philippines	4462.963	2.33E-09	3.68E+24	0.126173	10.53707	0.000143
Papua n.guinea	2752.131	2.82E-08	9.49E+21	0.077806	127.8762	3.70E-07
Poland	8453.608	2.34E-09	1.31E+25	0.238992	10.58913	0.000509
Puerto rico	25164.57	2.01E-08	1.56E+24	0.711428	91.14901	6.09E-05
Portugal	12961.15	6.53E-09	3.94E+24	0.366425	29.55037	0.000154
Paraguay	6015.375	3.05E-08	3.88E+22	0.170061	138.2184	1.51E-06
Reunion	7988.712	1.53E-07	2.72E+21	0.225849	693.5916	1.06E-07
Romania	4026.316	4.61E-09	7.62E+23	0.113828	20.87848	2.97E-05

	Alpha=.1			Ratio to US		
Country	Y/L	X	A	Y/L	X	TFP TO US
Rwanda	1514.97	1.60E-08	8.94E+21	0.04283	72.55712	3.48E-07
Saudi arabia	18686.76	6.52E-09	8.21E+24	0.528294	29.52342	0.00032
Sudan	2360.851	6.42E-09	1.35E+23	0.066744	29.08308	5.27E-06
Senegal	2540.603	1.45E-08	3.05E+22	0.071825	65.83072	1.19E-06
Singapore	21486.01	2.06E-08	1.08E+24	0.607432	93.42442	4.23E-05
Sierra leone	2274.882	2.94E-08	5.99E+21	0.064313	133.057	2.34E-07
El salvador	5546.329	2.34E-08	5.63E+22	0.1568	105.8298	2.20E-06
Somalia	1723.252	1.73E-08	9.94E+21	0.048718	78.24045	3.88E-07
U.S.S.R.	14758.62	2.39E-10	3.80E+27	0.417241	1.083684	0.148241
Suriname	9045.726	2.28E-07	1.57E+21	0.255732	1033.685	6.12E-08
Sweden	27852.45	6.39E-09	1.90E+25	0.787418	28.90987	0.000742
Swaziland	5824.276	1.30E-07	2.00E+21	0.164658	590.3088	7.78E-08
Seychelles	7606.596	1.12E-06	4.64E+19	0.215046	5057.456	1.81E-09
Syria	15554.49	9.79E-09	2.53E+24	0.439741	44.30273	9.85E-05
Chad	1139.785	3.23E-08	1.24E+21	0.032223	146.2939	4.85E-08
Togo	1405.974	4.74E-08	8.81E+20	0.039748	214.5095	3.43E-08
Thailand	5540.07	1.48E-09	1.41E+25	0.156623	6.678345	0.00055
Trinidad&tobago	17643.03	6.37E-08	7.67E+22	0.498787	288.4796	2.99E-06
Tunisia	7696.728	1.31E-08	3.44E+23	0.217594	59.37733	1.34E-05
Turkey	7725.322	1.53E-09	2.54E+25	0.218403	6.940741	0.00099
Tanzania	1128.44	6.25E-09	3.26E+22	0.031902	28.2988	1.27E-06
Uganda	1122.692	8.32E-09	1.82E+22	0.03174	37.65563	7.10E-07
Uruguay	12018.53	2.86E-08	1.76E+23	0.339776	129.5494	6.88E-06
U.S.A.	35371.9	2.21E-10	2.56E+28	1	1	1
Venezuela	17510.68	4.52E-09	1.50E+25	0.495045	20.48287	0.000584
Yemen	7511.125	1.12E-08	4.47E+23	0.212347	50.86623	1.74E-05
Yugoslavia	10654.21	3.67E-09	8.42E+24	0.301205	16.62507	0.000328
South africa	8852.459	3.01E-09	8.62E+24	0.250268	13.64772	0.000336
Zaire	1165.414	4.78E-09	5.93E+22	0.032947	21.65895	2.31E-06
Zambia	1800.73	2.83E-08	4.06E+21	0.050908	127.9481	1.58E-07
Zimbabwe	2316.543	1.36E-08	2.89E+22	0.065491	61.67158	1.13E-06

Table A.47: Productivity Ratios ($\alpha = .2$).

	Alpha=.2			Ratio to US		
Country	Y/L	X	A	Y/L	X	TFP TO US
Angola	1167.222	1.88E-08	3.85E+21	0.032999	61.64356	2.87E-07
Argentina	14864.86	3.91E-09	1.44E+25	0.420245	12.81705	0.001075
Australia	29919.53	4.94E-09	3.67E+25	0.845856	16.19308	0.002729
Austria	25128.95	1.03E-08	5.96E+24	0.710421	33.71259	0.000444
Burundi	1055.371	2.92E-08	1.31E+21	0.029836	95.68874	9.72E-08
Belgium	29659.17	9.01E-09	1.08E+25	0.838495	29.52854	0.000806
Benin	2088.864	2.89E-08	5.24E+21	0.059054	94.56707	3.90E-07
Burkina Faso	1044.883	2.13E-08	2.40E+21	0.02954	69.8842	1.79E-07
Bangladesh	4515.05	1.45E-09	9.68E+24	0.127645	4.755442	0.000721
Bolivia	4973.95	2.71E-08	3.36E+22	0.140619	88.9551	2.50E-06
Brazil	11311.79	7.88E-10	2.06E+26	0.319796	2.580728	0.015355
Barbados	14305.55	3.20E-07	2.00E+21	0.404433	1048.427	1.49E-07
Botswana	3316.999	1.73E-07	3.68E+20	0.093775	566.7455	2.74E-08
Central Afr.R.	1176.661	5.54E-08	4.51E+20	0.033265	181.5826	3.36E-08
Canada	33230.77	2.81E-09	1.40E+26	0.939468	9.191513	0.010447
Switzerland	30992.45	1.15E-08	7.25E+24	0.876189	37.72638	0.000539
Chile	9327.717	1.12E-08	6.93E+23	0.263704	36.70716	5.16E-05
China	2115.677	1.30E-10	2.65E+26	0.059812	0.425817	0.01973
Ivory Coast	3443.181	1.35E-08	6.47E+22	0.097342	44.34328	4.82E-06
Cameroon	2710.431	1.27E-08	4.56E+22	0.076627	41.56655	3.40E-06
Congo	4311.284	5.64E-08	5.85E+21	0.121884	184.6841	4.36E-07
Colombia	9366.337	4.52E-09	4.29E+24	0.264796	14.80993	0.00032
Comoros	1250.706	4.58E-07	7.45E+18	0.035359	1500.971	5.55E-10
Cape Verde Is.	2675.961	5.40E-07	2.45E+19	0.075652	1770.219	1.83E-09
Costa Rica	9114.44	4.85E-08	3.54E+22	0.257675	158.7763	2.63E-06
Czechoslovakia	7475.214	7.45E-09	1.01E+24	0.211332	24.40954	7.50E-05
Cyprus	15794.74	1.36E-07	1.35E+22	0.446534	446.041	1.00E-06
Germany, West	28978.87	1.33E-09	4.76E+26	0.819263	4.350827	0.035457
Denmark	24455.88	1.47E-08	2.76E+24	0.691393	48.20068	0.000206
Dominican rep.	7337.939	2.35E-08	9.73E+22	0.207451	77.09198	7.24E-06
Algeria	11616.1	7.55E-09	2.36E+24	0.328399	24.74942	0.000176
Ecuador	8376.941	1.71E-08	2.39E+23	0.236825	56.10895	1.78E-05
Egypt	6644.928	3.29E-09	4.09E+24	0.187859	10.7644	0.000305
Spain	24142.86	2.53E-09	9.08E+25	0.682543	8.300304	0.006762
Finland	26046.29	1.61E-08	2.63E+24	0.736355	52.65497	0.000196
Fiji	9659.981	2.09E-07	2.14E+21	0.273098	684.5145	1.59E-07
France	29015.75	1.38E-09	4.45E+26	0.820305	4.509237	0.033094
Gabon	5555.996	1.13E-07	2.42E+21	0.157074	369.8008	1.80E-07
U.K.	25765.12	1.32E-09	3.79E+26	0.728407	4.338084	0.028194
Ghana	1861.504	1.15E-08	2.62E+22	0.052627	37.67123	1.95E-06
Guinea	1525.596	2.81E-08	2.94E+21	0.04313	92.13527	2.19E-07
Gambia	1718.807	1.66E-07	1.07E+20	0.048592	543.8737	7.98E-09
Guinea-biss	1389.759	1.75E-07	6.31E+19	0.03929	573.337	4.70E-09
Greece	16607.1	1.11E-08	2.23E+24	0.4695	36.46925	0.000166
Guatemala	7431.974	1.73E-08	1.85E+23	0.21011	56.65509	1.38E-05
Guyana	3745.935	2.53E-07	2.19E+20	0.105901	829.7529	1.63E-08
Hong Kong	21524.65	1.00E-08	4.61E+24	0.608524	32.84989	0.000343
Honduras	4596.596	3.79E-08	1.47E+22	0.129951	124.0191	1.10E-06

Country	Alpha=.2 Y/L	X	A	Ratio to US Y/L	X	TFP TO US
Haiti	2009.57	2.44E-08	6.79E+21	0.056813	79.90252	5.06E-07
Hungary	10875.3	1.10E-08	9.80E+23	0.307456	35.99902	7.29E-05
Indonesia	3907.186	9.41E-10	1.72E+25	0.11046	3.083489	0.001283
India	3047.319	1.96E-10	2.41E+26	0.086151	0.643261	0.017937
Ireland	20446.92	3.07E-08	4.43E+23	0.578056	100.6888	3.30E-05
Iran	10457.52	2.84E-09	1.35E+25	0.295645	9.315953	0.001007
Iceland	25839.15	2.84E-07	8.25E+21	0.730499	931.8407	6.15E-07
Israel	23385.74	2.33E-08	1.01E+24	0.661139	76.29939	7.51E-05
Italy	29567.1	1.48E-09	4.00E+26	0.835892	4.846788	0.029744
Jamaica	4591.961	5.58E-08	6.76E+21	0.129819	182.9629	5.03E-07
Jordan	14732.43	5.60E-08	6.92E+22	0.416501	183.4659	5.15E-06
Japan	20827.94	5.50E-10	1.44E+27	0.588827	1.801321	0.106855
Kenya	1990.196	7.25E-09	7.54E+22	0.056265	23.74958	5.61E-06
Korea, rep.	13526.01	2.64E-09	2.62E+25	0.382394	8.658915	0.00195
Sri lanka	5480.63	8.96E-09	3.74E+23	0.154943	29.36296	2.78E-05
Lesotho	2230.844	8.90E-08	6.29E+20	0.063068	291.4679	4.68E-08
Luxembourg	34939.55	2.20E-07	2.52E+22	0.987777	721.6	1.87E-06
Morocco	6642.414	6.56E-09	1.02E+24	0.187788	21.50649	7.62E-05
Madagascar	1442.449	1.42E-08	1.03E+22	0.04078	46.54632	7.68E-07
Mexico	15338.35	1.45E-09	1.12E+26	0.433631	4.743422	0.008357
Mali	1228.426	2.17E-08	3.20E+21	0.034729	71.15387	2.38E-07
Malta	16386.22	3.33E-07	2.42E+21	0.463255	1090.678	1.80E-07
Myanmar	1016.76	4.88E-09	4.35E+22	0.028745	15.97512	3.24E-06
Mozambique	1385.216	8.34E-09	2.76E+22	0.039162	27.33367	2.05E-06
Mauritania	1786.149	1.04E-07	2.94E+20	0.050496	341.3244	2.19E-08
Mauritius	9269.678	7.11E-08	1.70E+22	0.262063	233.0415	1.27E-06
Malawi	1047.77	2.59E-08	1.64E+21	0.029622	84.87872	1.22E-07
Malaysia	9467.414	7.23E-09	1.71E+24	0.267654	23.69412	0.000128
Namibia	6881.095	1.33E-07	2.68E+21	0.194536	435.6662	1.99E-07
Niger	1010.721	2.30E-08	1.92E+21	0.028574	75.51914	1.43E-07
Nigeria	1711.392	1.94E-09	7.80E+23	0.048383	6.349883	5.81E-05
Nicaragua	4449.227	5.55E-08	6.43E+21	0.125784	181.8399	4.79E-07
Netherlands	28627.44	6.15E-09	2.17E+25	0.809327	20.14238	0.001615
Norway	26903.76	1.95E-08	1.90E+24	0.760597	64.00556	0.000141
New zealand	25392.68	2.91E-08	7.61E+23	0.717877	95.34812	5.67E-05
Taiwan	15844.64	4.77E-09	1.10E+25	0.447944	15.63515	0.000821
Oman	15037.67	1.05E-07	2.04E+22	0.425131	344.9161	1.52E-06
Pakistan	4556.962	1.52E-09	8.94E+24	0.12883	4.992633	0.000666
Panama	7899.483	6.64E-08	1.42E+22	0.223327	217.497	1.05E-06
Peru	8385.669	7.87E-09	1.13E+24	0.237072	25.80039	8.44E-05
Philippines	4462.963	3.02E-09	2.18E+24	0.126173	9.894674	0.000163
Papua n.guinea	2752.131	3.70E-08	5.54E+21	0.077806	121.1929	4.12E-07
Poland	8453.608	3.16E-09	7.16E+24	0.238992	10.35109	0.000533
Puerto rico	25164.57	2.77E-08	8.25E+23	0.711428	90.78994	6.14E-05
Portugal	12961.15	8.90E-09	2.12E+24	0.366425	29.17305	0.000158
Paraguay	6015.375	4.01E-08	2.25E+22	0.170061	131.3167	1.68E-06
Reunion	7988.712	2.04E-07	1.53E+21	0.225849	669.0298	1.14E-07
Romania	4026.316	6.05E-09	4.42E+23	0.113828	19.83644	3.29E-05

	Alpha=.2			Ratio to US		
Country	Y/L	X	A	Y/L	X	TFP TO US
Rwanda	1514.97	1.97E-08	5.92E+21	0.04283	64.491	4.41E-07
Saudi arabia	18686.76	8.94E-09	4.37E+24	0.528294	29.27822	0.000326
Sudan	2360.851	8.33E-09	8.03E+22	0.066744	27.29991	5.98E-06
Senegal	2540.603	1.81E-08	1.96E+22	0.071826	59.38831	1.46E-06
Singapore	21486.01	2.87E-08	5.62E+23	0.607432	93.90706	4.18E-05
Sierra leone	2274.882	3.55E-08	4.11E+21	0.064313	116.2435	3.06E-07
El salvador	5546.329	3.03E-08	3.35E+22	0.1568	99.23186	2.50E-06
Somalia	1723.252	2.18E-08	6.26E+21	0.048718	71.35636	4.66E-07
U.S.S.R.	14758.62	3.29E-10	2.01E+27	0.417241	1.078874	0.149566
Suriname	9045.726	3.11E-07	8.49E+20	0.255732	1017.386	6.32E-08
Sweden	27852.45	8.82E-09	9.98E+24	0.787418	28.88526	0.000743
Swaziland	5824.276	1.71E-07	1.16E+21	0.164658	559.6552	8.66E-08
Seychelles	7606.596	1.49E-06	2.60E+19	0.215046	4888.671	1.94E-09
Syria	15554.49	1.33E-08	1.37E+24	0.439741	43.49391	0.000102
Chad	1139.785	3.85E-08	8.76E+20	0.032223	126.2114	6.52E-08
Togo	1405.974	6.03E-08	5.43E+20	0.039748	197.6749	4.04E-08
Thailand	5540.07	1.92E-09	8.34E+24	0.156624	6.285127	0.000621
Trinidad&tobago	17643.03	8.70E-08	4.11E+22	0.498787	285.001	3.06E-06
Tunisia	7696.728	1.74E-08	1.95E+23	0.217594	57.10803	1.45E-05
Turkey	7725.322	2.06E-09	1.41E+25	0.218403	6.740005	0.00105
Tanzania	1128.44	7.75E-09	2.12E+22	0.031902	25.38559	1.58E-06
Uganda	1122.692	9.95E-09	1.27E+22	0.03174	32.59454	9.48E-07
Uruguay	12018.53	3.84E-08	9.79E+22	0.339776	125.8702	7.29E-06
U.S.A.	35371.9	3.05E-10	1.34E+28	1	1	1
Venezuela	17510.68	6.21E-09	7.94E+24	0.495045	20.35703	0.000591
Yemen	7511.125	1.48E-08	2.56E+23	0.212347	48.60699	1.91E-05
Yugoslavia	10654.21	5.00E-09	4.53E+24	0.301205	16.39732	0.000337
South africa	8852.459	4.05E-09	4.78E+24	0.250268	13.26017	0.000356
Zaire	1165.414	5.84E-09	3.98E+22	0.032947	19.12904	2.97E-06
Zambia	1800.73	3.67E-08	2.41E+21	0.050909	120.1598	1.80E-07
Zimbabwe	2316.543	1.76E-08	1.73E+22	0.065491	57.69596	1.29E-06

Table A.48: Productivity Ratios ($\alpha = .3$).

	Alpha=.3			Ratio to US		
Country	Y/L	X	A	Y/L	X	TFP TO US
Angola	1167.222	2.22E-08	2.77E+21	0.032999	55.32417	3.56E-07
Argentina	14864.86	5.06E-09	8.64E+24	0.420245	12.62052	0.001109
Australia	29919.53	6.51E-09	2.11E+25	0.845856	16.24122	0.002712
Austria	25128.95	1.36E-08	3.42E+24	0.710421	33.88831	0.00044
Burundi	1055.371	3.45E-08	9.38E+20	0.029836	85.99339	1.20E-07
Belgium	29659.17	1.18E-08	6.27E+24	0.838495	29.5616	0.000805
Benin	2088.864	3.52E-08	3.52E+21	0.059054	87.89931	4.51E-07
Burkina faso	1044.883	2.52E-08	1.72E+21	0.02954	62.92425	2.20E-07
Bangladesh	4515.05	1.76E-09	6.61E+24	0.127645	4.383122	0.000848
Bolivia	4973.95	3.41E-08	2.13E+22	0.140619	85.14804	2.73E-06
Brazil	11311.79	1.02E-09	1.24E+26	0.319796	2.533933	0.015928
Barbados	14305.55	4.06E-07	1.24E+21	0.404433	1014.391	1.59E-07
Botswana	3316.999	2.18E-07	2.31E+20	0.093775	544.7459	2.96E-08
Central Afr.R.	1176.661	6.63E-08	3.15E+20	0.033265	165.5272	4.04E-08
Canada	33230.77	3.69E-09	8.13E+25	0.939468	9.199923	0.010428
Switzerland	30992.45	1.53E-08	4.12E+24	0.876189	38.12354	0.000528
Chile	9327.717	1.43E-08	4.23E+23	0.263704	35.79382	5.43E-05
China	2115.677	1.59E-10	1.77E+26	0.059812	0.397335	0.022661
Ivory Coast	3443.181	1.68E-08	4.21E+22	0.097342	41.88075	5.40E-06
Cameroon	2710.431	1.56E-08	3.02E+22	0.076627	38.94577	3.87E-06
Congo	4311.284	7.00E-08	3.80E+21	0.121884	174.5809	4.87E-07
Colombia	9366.337	5.76E-09	2.65E+24	0.264796	14.37019	0.00034
Comoros	1250.706	5.58E-07	5.03E+18	0.035359	1391.99	6.45E-10
Cape Verde Is.	2675.961	6.75E-07	1.57E+19	0.075652	1684.729	2.02E-09
Costa rica	9114.44	6.17E-08	2.18E+22	0.257675	154.0507	2.80E-06
Czechoslovakia	7475.214	9.52E-09	6.17E+23	0.211332	23.75365	7.92E-05
Cyprus	15794.74	1.76E-07	8.03E+21	0.446534	439.9193	1.03E-06
Germany, West	28978.87	1.75E-09	2.73E+26	0.819263	4.379036	0.035002
Denmark	24455.88	1.93E-08	1.61E+24	0.691393	48.05225	0.000207
Dominican rep.	7337.939	2.98E-08	6.06E+22	0.207451	74.41043	7.77E-06
Algeria	11616.1	9.87E-09	1.39E+24	0.328399	24.62169	0.000178
Ecuador	8376.941	2.19E-08	1.46E+23	0.236825	54.75073	1.87E-05
Egypt	6644.928	4.01E-09	2.74E+24	0.187859	10.01392	0.000352
Spain	24142.86	3.34E-09	5.23E+25	0.682543	8.333554	0.006708
Finland	26046.29	2.12E-08	1.51E+24	0.736355	52.90099	0.000194
Fiji	9659.981	2.66E-07	1.31E+21	0.273098	664.9812	1.69E-07
France	29015.75	1.83E-09	2.53E+26	0.820305	4.554981	0.032432
Gabon	5555.996	1.46E-07	1.44E+21	0.157074	365.5717	1.85E-07
U.K.	25765.12	1.72E-09	2.24E+26	0.728407	4.29921	0.028706
Ghana	1861.504	1.37E-08	1.83E+22	0.052627	34.29745	2.35E-06
Guinea	1525.596	3.35E-08	2.07E+21	0.04313	83.69378	2.66E-07
Gambia	1718.807	2.00E-07	7.38E+19	0.048592	499.2848	9.47E-09
Guinea-biss	1389.759	2.15E-07	4.16E+19	0.03929	537.4152	5.35E-09
Greece	16607.1	1.45E-08	1.31E+24	0.4695	36.15064	0.000169
Guatemala	7431.974	2.18E-08	1.17E+23	0.21011	54.32052	1.50E-05
Guyana	3745.935	3.21E-07	1.36E+20	0.105901	802.1865	1.74E-08
Hong Kong	21524.65	1.29E-08	2.79E+24	0.608524	32.15807	0.000358
Honduras	4596.596	4.72E-08	9.49E+21	0.129951	117.7761	1.22E-06

Country	Alpha=.3 Y/L	X	A	Ratio to US Y/L	X	TFP TO US
Haiti	2009.57	2.95E-08	4.62E+21	0.0568126	73.74363	5.935E-07
Hungary	10875.3	1.41E-08	5.96E+23	0.307456	35.16449	7.645E-05
Indonesia	3907.186	1.18E-09	1.09E+25	0.1104602	2.947437	0.0014045
India	3047.319	2.42E-10	1.59E+26	0.0861508	0.604044	0.0203414
Ireland	20446.92	4.01E-08	2.6E+23	0.5780556	100.1646	3.331E-05
Iran	10457.52	3.68E-09	8.06E+24	0.2956447	9.191026	0.0010347
Iceland	25839.15	3.73E-07	4.79E+21	0.7304994	931.7351	6.147E-07
Israel	23385.74	3.03E-08	5.97E+23	0.661139	75.56073	7.656E-05
Italy	29567.1	1.96E-09	2.27E+26	0.8358923	4.894766	0.0291633
Jamaica	4591.961	7.09E-08	4.2E+21	0.1298194	176.8229	5.39E-07
Jordan	14732.43	7.21E-08	4.18E+22	0.4165008	179.8849	5.361E-06
Japan	20827.94	7.2E-10	8.36E+26	0.5888274	1.797236	0.107341
Kenya	1990.196	8.86E-09	5.05E+22	0.0562649	22.10558	6.478E-06
Korea, rep.	13526.01	3.38E-09	1.6E+25	0.3823943	8.431846	0.0020567
Sri lanka	5480.63	1.11E-08	2.44E+23	0.154943	27.70774	3.127E-05
Lesotho	2230.844	1.08E-07	4.24E+20	0.0630682	270.3289	5.443E-08
Luxembourg	34939.55	2.92E-07	1.43E+22	0.9877771	729.7868	1.832E-06
Morocco	6642.414	8.15E-09	6.64E+23	0.1877879	20.33989	8.524E-05
Madagascar	1442.449	1.63E-08	7.79E+21	0.0407795	40.7729	1E-06
Mexico	15338.35	1.88E-09	6.69E+25	0.4336308	4.679962	0.0085853
Mali	1228.426	2.59E-08	2.25E+21	0.0347289	64.68014	2.883E-07
Malta	16386.22	4.3E-07	1.45E+21	0.4632554	1073.046	1.864E-07
Myanmar	1016.76	5.84E-09	3.03E+22	0.0287448	14.57528	3.889E-06
Mozambique	1385.216	9.76E-09	2.01E+22	0.0391615	24.36635	2.583E-06
Mauritania	1786.149	1.29E-07	1.92E+20	0.0504963	321.7168	2.464E-08
Mauritius	9269.678	8.92E-08	1.08E+22	0.2620633	222.5745	1.386E-06
Malawi	1047.77	3.1E-08	1.14E+21	0.0296215	77.39639	1.465E-07
Malaysia	9467.414	9.3E-09	1.04E+24	0.2676535	23.19857	0.0001331
Namibia	6881.095	1.72E-07	1.59E+21	0.1945356	430.4349	2.043E-07
Niger	1010.721	2.78E-08	1.32E+21	0.0285741	69.31517	1.699E-07
Nigeria	1711.392	2.4E-09	5.08E+23	0.0483828	5.992904	6.518E-05
Nicaragua	4449.227	6.98E-08	4.06E+21	0.1257842	174.171	5.216E-07
Netherlands	28627.44	8.1E-09	1.25E+25	0.8093271	20.20567	0.0016044
Norway	26903.76	2.58E-08	1.09E+24	0.760597	64.30977	0.0001399
New zealand	25392.68	3.81E-08	4.45E+23	0.7178771	95.01365	5.709E-05
Taiwan	15844.64	6.12E-09	6.69E+24	0.4479443	15.28533	0.0008588
Oman	15037.67	1.38E-07	1.19E+22	0.4251305	344.5247	1.523E-06
Pakistan	4556.962	1.89E-09	5.84E+24	0.12883	4.70767	0.0007489
Panama	7899.483	8.47E-08	8.69E+21	0.2233265	211.4434	1.116E-06
Peru	8385.669	1E-08	6.98E+23	0.2370715	25.05692	8.952E-05
Philippines	4462.963	3.76E-09	1.41E+24	0.1261726	9.384224	0.0001808
Papua n.guinea	2752.131	4.64E-08	3.52E+21	0.0778056	115.837	4.512E-07
Poland	8453.608	4.07E-09	4.32E+24	0.2389922	10.15481	0.0005539
Puerto rico	25164.57	3.63E-08	4.82E+23	0.7114282	90.48868	6.181E-05
Portugal	12961.15	1.16E-08	1.26E+24	0.366425	28.85907	0.0001612
Paraguay	6015.375	5.04E-08	1.42E+22	0.1700608	125.7731	1.828E-06
Reunion	7988.712	2.6E-07	9.44E+20	0.2258491	649.0237	1.211E-07
Romania	4026.316	7.61E-09	2.8E+23	0.1138281	18.99944	3.589E-05

Country	Alpha=.3 Y/L	X	A	Ratio to US Y/L	X	TFP TO US
Rwanda	1514.97	2.34E-08	4.19E+21	0.04283	58.39868	5.38E-07
Saudi arabia	18686.76	1.16E-08	2.57E+24	0.528294	29.07333	0.00033
Sudan	2360.851	1.04E-08	5.18E+22	0.066744	25.88349	6.65E-06
Senegal	2540.603	2.18E-08	1.36E+22	0.071826	54.45513	1.74E-06
Singapore	21486.01	3.78E-08	3.23E+23	0.607432	94.31539	4.15E-05
Sierra leone	2274.882	4.16E-08	2.99E+21	0.064313	103.7451	3.84E-07
El salvador	5546.329	3.77E-08	2.17E+22	0.1568	93.9962	2.78E-06
Somalia	1723.252	2.65E-08	4.24E+21	0.048718	66.03169	5.44E-07
U.S.S.R.	14758.62	4.31E-10	1.17E+27	0.417241	1.074841	0.150691
Suriname	9045.726	4.02E-07	5.06E+20	0.255732	1003.861	6.49E-08
Sweden	27852.45	1.16E-08	5.80E+24	0.787418	28.86455	0.000744
Swaziland	5824.276	2.14E-07	7.38E+20	0.164658	535.0817	9.47E-08
Seychelles	7606.596	1.90E-06	1.60E+19	0.215046	4750.924	2.05E-09
Syria	15554.49	1.72E-08	8.22E+23	0.439741	42.82433	0.000105
Chad	1139.785	4.47E-08	6.51E+20	0.032223	111.4553	8.36E-08
Togo	1405.974	7.39E-08	3.62E+20	0.039748	184.5285	4.64E-08
Thailand	5540.07	2.39E-09	5.36E+24	0.156624	5.972036	0.000688
Trinidad&tobago	17643.03	1.13E-07	2.44E+22	0.498787	282.1044	3.13E-06
Tunisia	7696.728	2.21E-08	1.21E+23	0.217594	55.2646	1.55E-05
Turkey	7725.322	2.63E-09	8.60E+24	0.218403	6.575487	0.001103
Tanzania	1128.44	9.28E-09	1.48E+22	0.031902	23.16645	1.90E-06
Uganda	1122.692	1.16E-08	9.42E+21	0.03174	28.86435	1.21E-06
Uruguay	12018.53	4.92E-08	5.96E+22	0.339776	122.8534	7.65E-06
U.S.A.	35371.9	4.01E-10	7.79E+27	1	1	1
Venezuela	17510.68	8.11E-09	4.66E+24	0.495045	20.25167	0.000598
Yemen	7511.125	1.87E-08	1.61E+23	0.212347	46.78263	2.06E-05
Yugoslavia	10654.21	6.49E-09	2.69E+24	0.301205	16.20797	0.000345
South africa	8852.459	5.19E-09	2.91E+24	0.250268	12.94239	0.000374
Zaire	1165.414	6.90E-09	2.85E+22	0.032947	17.2294	3.66E-06
Zambia	1800.73	4.57E-08	1.55E+21	0.050909	113.9706	2.00E-07
Zimbabwe	2316.543	2.19E-08	1.12E+22	0.065491	54.54779	1.44E-06

Table A.49: Productivity Ratios ($\alpha = .4$).

	Alpha=.4			Ratio to US		
Country	Y/L	X	A	Y/L	X	TFP TO US
Angola	1167.222	2.58E-08	2.04E+21	0.032999	50.03018	4.35E-07
Argentina	14864.86	6.42E-09	5.36E+24	0.420245	12.44046	0.001141
Australia	29919.53	8.41E-09	1.27E+25	0.845856	16.28611	0.002698
Austria	25128.95	1.76E-08	2.04E+24	0.710421	34.05255	0.000435
Burundi	1055.371	4.02E-08	6.90E+20	0.029836	77.86079	1.47E-07
Belgium	29659.17	1.53E-08	3.77E+24	0.838495	29.59237	0.000803
Benin	2088.864	4.24E-08	2.43E+21	0.059054	82.12116	5.17E-07
Burkina faso	1044.883	2.95E-08	1.26E+21	0.02954	57.07529	2.68E-07
Bangladesh	4515.05	2.10E-09	4.63E+24	0.127645	4.063086	0.000987
Bolivia	4973.95	4.22E-08	1.39E+22	0.140619	81.75398	2.96E-06
Brazil	11311.79	1.29E-09	7.74E+25	0.319796	2.491177	0.016479
Barbados	14305.55	5.08E-07	7.94E+20	0.404433	983.7318	1.69E-07
Botswana	3316.999	2.71E-07	1.50E+20	0.093775	525.0543	3.19E-08
Central Afr.R.	1176.661	7.84E-08	2.25E+20	0.033265	151.873	4.80E-08
Canada	33230.77	4.75E-09	4.89E+25	0.939468	9.207752	0.01041
Switzerland	30992.45	1.99E-08	2.43E+24	0.876189	38.49664	0.000518
Chile	9327.717	1.80E-08	2.67E+23	0.263704	34.96485	5.69E-05
China	2115.677	1.92E-10	1.21E+26	0.059812	0.37256	0.025775
Ivory Coast	3443.181	2.05E-08	2.82E+22	0.097342	39.71358	6.01E-06
Cameroon	2710.431	1.89E-08	2.05E+22	0.076627	36.65705	4.37E-06
Congo	4311.284	8.55E-08	2.54E+21	0.121884	165.6819	5.41E-07
Colombia	9366.337	7.21E-09	1.69E+24	0.264796	13.97298	0.000359
Comoros	1250.706	6.70E-07	3.49E+18	0.035359	1297.755	7.42E-10
Cape Verde Is.	2675.961	8.30E-07	1.04E+19	0.075652	1608.936	2.21E-09
Costa rica	9114.44	7.73E-08	1.39E+22	0.257675	149.7824	2.96E-06
Czechoslovakia	7475.214	1.20E-08	3.91E+23	0.211332	23.15951	8.33E-05
Cyprus	15794.74	2.24E-07	4.96E+21	0.446534	434.3018	1.06E-06
Germany, West	28978.87	2.27E-09	1.62E+26	0.819263	4.405434	0.034584
Denmark	24455.88	2.47E-08	9.78E+23	0.691393	47.91463	0.000208
Dominican rep.	7337.939	3.72E-08	3.90E+22	0.207451	72.00046	8.30E-06
Algeria	11616.1	1.26E-08	8.44E+23	0.328399	24.5035	0.00018
Ecuador	8376.941	2.76E-08	9.20E+22	0.236825	53.51717	1.96E-05
Egypt	6644.928	4.83E-09	1.89E+24	0.187859	9.363035	0.000403
Spain	24142.86	4.32E-09	3.13E+25	0.682543	8.364594	0.006658
Finland	26046.29	2.74E-08	9.02E+23	0.736355	53.1308	0.000192
Fiji	9659.981	3.34E-07	8.36E+20	0.273098	647.3166	1.78E-07
France	29015.75	2.37E-09	1.49E+26	0.820305	4.597937	0.031829
Gabon	5555.996	1.87E-07	8.86E+20	0.157074	361.6822	1.89E-07
U.K.	25765.12	2.20E-09	1.37E+26	0.728407	4.263372	0.029191
Ghana	1861.504	1.62E-08	1.32E+22	0.052627	31.43169	2.80E-06
Guinea	1525.596	3.95E-08	1.49E+21	0.04313	76.53909	3.18E-07
Gambia	1718.807	2.38E-07	5.22E+19	0.048592	461.1058	1.11E-08
Guinea-biss	1389.759	2.61E-07	2.83E+19	0.03929	506.0319	6.03E-09
Greece	16607.1	1.85E-08	8.05E+23	0.4695	35.85686	0.000171
Guatemala	7431.974	2.70E-08	7.60E+22	0.21011	52.23587	1.62E-05
Guyana	3745.935	4.01E-07	8.72E+19	0.105901	777.3733	1.86E-08
Hong Kong	21524.65	1.63E-08	1.75E+24	0.608524	31.52779	0.000373
Honduras	4596.596	5.79E-08	6.29E+21	0.129951	112.2527	1.34E-06

Country	Alpha=.4			Ratio to US		
	Y/L	X	A	Y/L	X	TFP TO US
Haiti	2009.57	3.53E-08	3.24E+21	0.056813	68.44289	6.89E-07
Hungary	10875.3	1.78E-08	3.75E+23	0.307456	34.40578	7.99E-05
Indonesia	3907.186	1.46E-09	7.17E+24	0.11046	2.826306	0.001528
India	3047.319	2.94E-10	1.07E+26	0.086151	0.569723	0.022866
Ireland	20446.92	5.15E-08	1.58E+23	0.578056	99.67948	3.36E-05
Iran	10457.52	4.68E-09	4.98E+24	0.295645	9.076353	0.001061
Iceland	25839.15	4.81E-07	2.89E+21	0.730499	931.6368	6.15E-07
Israel	23385.74	3.87E-08	3.66E+23	0.661139	74.88022	7.80E-05
Italy	29567.1	2.55E-09	1.34E+26	0.835892	4.939809	0.028634
Jamaica	4591.961	8.84E-08	2.70E+21	0.129819	171.298	5.74E-07
Jordan	14732.43	9.12E-08	2.61E+22	0.416501	176.6173	5.56E-06
Japan	20827.94	9.26E-10	5.06E+26	0.588827	1.793446	0.107795
Kenya	1990.196	1.07E-08	3.48E+22	0.056265	20.67902	7.40E-06
Korea, rep.	13526.01	4.25E-09	1.01E+25	0.382394	8.226027	0.002161
Sri lanka	5480.63	1.36E-08	1.64E+23	0.154943	26.2523	3.48E-05
Lesotho	2230.844	1.30E-07	2.94E+20	0.063068	252.0487	6.26E-08
Luxembourg	34939.55	3.81E-07	8.42E+21	0.987777	737.4835	1.79E-06
Morocco	6642.414	9.97E-09	4.44E+23	0.187788	19.31185	9.46E-05
Madagascar	1442.449	1.86E-08	6.01E+21	0.04078	36.04839	1.28E-06
Mexico	15338.35	2.39E-09	4.13E+25	0.433631	4.621708	0.008803
Mali	1228.426	3.06E-08	1.62E+21	0.034729	59.18952	3.44E-07
Malta	16386.22	5.46E-07	9.02E+20	0.463255	1056.905	1.92E-07
Myanmar	1016.76	6.91E-09	2.17E+22	0.028745	13.38378	4.61E-06
Mozambique	1385.216	1.13E-08	1.50E+22	0.039162	21.89668	3.20E-06
Mauritania	1786.149	1.57E-07	1.29E+20	0.050496	304.4946	2.75E-08
Mauritius	9269.678	1.10E-07	7.09E+21	0.262063	213.2628	1.51E-06
Malawi	1047.77	3.67E-08	8.17E+20	0.029622	71.03127	1.74E-07
Malaysia	9467.414	1.17E-08	6.50E+23	0.267654	22.74704	0.000139
Namibia	6881.095	2.20E-07	9.81E+20	0.194536	425.6264	2.09E-07
Niger	1010.721	3.30E-08	9.36E+20	0.028574	64.00399	1.99E-07
Nigeria	1711.392	2.93E-09	3.41E+23	0.048383	5.678962	7.26E-05
Nicaragua	4449.227	8.64E-08	2.65E+21	0.125784	167.3297	5.65E-07
Netherlands	28627.44	1.05E-08	7.49E+24	0.809327	20.2647	0.001595
Norway	26903.76	3.33E-08	6.51E+23	0.760597	64.59396	0.000139
New zealand	25392.68	4.89E-08	2.70E+23	0.717877	94.70366	5.75E-05
Taiwan	15844.64	7.73E-09	4.21E+24	0.447944	14.96704	0.000896
Oman	15037.67	1.78E-07	7.17E+21	0.425131	344.1612	1.53E-06
Pakistan	4556.962	2.30E-09	3.92E+24	0.12883	4.457281	0.000835
Panama	7899.483	1.06E-07	5.52E+21	0.223327	205.9651	1.18E-06
Peru	8385.669	1.26E-08	4.44E+23	0.237072	24.38476	9.45E-05
Philippines	4462.963	4.61E-09	9.37E+23	0.126173	8.933185	0.0002
Papua n.guinea	2752.131	5.73E-08	2.30E+21	0.077806	111.0688	4.91E-07
Poland	8453.608	5.15E-09	2.70E+24	0.238992	9.975616	0.000574
Puerto rico	25164.57	4.66E-08	2.92E+23	0.711428	90.20942	6.22E-05
Portugal	12961.15	1.47E-08	7.72E+23	0.366425	28.57011	0.000165
Paraguay	6015.375	6.24E-08	9.30E+21	0.170061	120.8281	1.98E-06
Reunion	7988.712	3.26E-07	6.02E+20	0.225849	630.956	1.28E-07
Romania	4026.316	9.42E-09	1.83E+23	0.113828	18.25279	3.89E-05

	Alpha=.4			Ratio to US		
Country	Y/L	X	A	Y/L	X	TFP TO US
Rwanda	1514.97	2.75E-08	3.04E+21	0.04283	53.2507	6.47E-07
Saudi arab	18686.76	1.49E-08	1.57E+24	0.528294	28.88407	0.000335
Sudan	2360.851	1.27E-08	3.45E+22	0.066744	24.6323	7.34E-06
Senegal	2540.603	2.59E-08	9.60E+21	0.071826	50.23592	2.04E-06
Singapore	21486.01	4.89E-08	1.93E+23	0.607432	94.69671	4.12E-05
Sierra leon	2274.882	4.82E-08	2.23E+21	0.064313	93.33107	4.75E-07
El salvador	5546.329	4.61E-08	1.45E+22	0.1568	89.37546	3.08E-06
Somalia	1723.252	3.17E-08	2.95E+21	0.048718	61.43714	6.29E-07
U.S.S.R.	14758.62	5.53E-10	7.13E+26	0.417241	1.071103	0.151744
Suriname	9045.726	5.12E-07	3.12E+20	0.255732	991.4454	6.65E-08
Sweden	27852.45	1.49E-08	3.50E+24	0.787418	28.8453	0.000745
Swaziland	5824.276	2.65E-07	4.83E+20	0.164658	513.1985	1.03E-07
Seychelles	7606.596	2.39E-06	1.01E+19	0.215046	4626.31	2.16E-09
Syria	15554.49	2.18E-08	5.10E+23	0.439741	42.21089	0.000109
Chad	1139.785	5.12E-08	4.95E+20	0.032223	99.2853	1.05E-07
Togo	1405.974	8.93E-08	2.48E+20	0.039748	173.0887	5.27E-08
Thailand	5540.07	2.94E-09	3.55E+24	0.156624	5.694886	0.000756
Trinidad&tc	17643.03	1.44E-07	1.50E+22	0.498787	279.4372	3.19E-06
Tunisia	7696.728	2.77E-08	7.74E+22	0.217594	53.60372	1.65E-05
Turkey	7725.322	3.32E-09	5.42E+24	0.218403	6.426098	0.001155
Tanzania	1128.44	1.10E-08	1.06E+22	0.031902	21.27718	2.25E-06
Uganda	1122.692	1.33E-08	7.12E+21	0.03174	25.77956	1.52E-06
Uruguay	12018.53	6.20E-08	3.76E+22	0.339776	120.1128	8.00E-06
U.S.A.	35371.9	5.16E-10	4.70E+27	1	1	1
Venezuela	17510.68	1.04E-08	2.83E+24	0.495045	20.15418	0.000603
Yemen	7511.125	2.33E-08	1.04E+23	0.212347	45.14755	2.21E-05
Yugoslavia	10654.21	8.28E-09	1.66E+24	0.301205	16.03385	0.000353
South afric	8852.459	6.53E-09	1.84E+24	0.250268	12.6537	0.000391
Zaire	1165.414	8.07E-09	2.09E+22	0.032947	15.6325	4.44E-06
Zambia	1800.73	5.60E-08	1.03E+21	0.050909	108.5013	2.20E-07
Zimbabwe	2316.543	2.67E-08	7.51E+21	0.065491	51.77447	1.60E-06

Table A.50: Productivity Ratios ($\alpha = .5$).

	Alpha=.5			Ratio to US		
Country	Y/L	X	A	Y/L	X	TFP TO US
Angola	1167.222	3.00E-08	1.51E+21	0.032999	45.32811	5.30E-07
Argentina	14864.86	8.12E-09	3.35E+24	0.420245	12.26627	0.001174
Australia	29919.53	1.08E-08	7.67E+24	0.845856	16.33028	0.002683
Austria	25128.95	2.26E-08	1.23E+24	0.710421	34.21448	0.000431
Burundi	1055.371	4.67E-08	5.10E+20	0.029836	70.62865	1.79E-07
Belgium	29659.17	1.96E-08	2.29E+24	0.838495	29.6226	0.000801
Benin	2088.864	5.08E-08	1.69E+21	0.059054	76.82064	5.91E-07
Burkina faso	1044.883	3.43E-08	9.27E+20	0.02954	51.86472	3.24E-07
Bangladesh	4515.05	2.50E-09	3.27E+24	0.127645	3.771773	0.001145
Bolivia	4973.95	5.20E-08	9.16E+21	0.140619	78.55506	3.20E-06
Brazil	11311.79	1.62E-09	4.87E+25	0.319796	2.449923	0.017039
Barbados	14305.55	6.32E-07	5.13E+20	0.404433	954.5479	1.80E-07
Botswana	3316.999	3.35E-07	9.80E+19	0.093775	506.4236	3.43E-08
Central Afr.R.	1176.661	9.24E-08	1.62E+20	0.033265	139.57	5.68E-08
Canada	33230.77	6.10E-09	2.97E+25	0.939468	9.215439	0.010393
Switzerland	30992.45	2.57E-08	1.45E+24	0.876189	38.86629	0.000508
Chile	9327.717	2.26E-08	1.70E+23	0.263704	34.17008	5.96E-05
China	2115.677	2.31E-10	8.36E+25	0.059812	0.349751	0.029246
Ivory Coast	3443.181	2.49E-08	1.91E+22	0.097342	37.69606	6.67E-06
Cameroon	2710.431	2.29E-08	1.41E+22	0.076627	34.54201	4.92E-06
Congo	4311.284	1.04E-07	1.71E+21	0.121884	157.3908	6.00E-07
Colombia	9366.337	9.00E-09	1.08E+24	0.264796	13.59389	0.000379
Comoros	1250.706	8.02E-07	2.43E+18	0.035359	1211.49	8.52E-10
Cape Verde Is.	2675.961	1.02E-06	6.91E+18	0.075652	1537.879	2.42E-09
Costa rica	9114.44	9.64E-08	8.94E+21	0.257675	145.709	3.13E-06
Czechoslovakia	7475.214	1.49E-08	2.50E+23	0.211332	22.59096	8.75E-05
Cyprus	15794.74	2.84E-07	3.10E+21	0.446534	428.8593	1.08E-06
Germany, West	28978.87	2.93E-09	9.77E+25	0.819263	4.431492	0.034178
Denmark	24455.88	3.16E-08	5.98E+23	0.691393	47.77996	0.000209
Dominican rep.	7337.939	4.61E-08	2.53E+22	0.207451	69.71154	8.86E-06
Algeria	11616.1	1.61E-08	5.18E+23	0.328399	24.38807	0.000181
Ecuador	8376.941	3.46E-08	5.85E+22	0.236825	52.33374	2.05E-05
Egypt	6644.928	5.80E-09	1.31E+24	0.187859	8.765486	0.000459
Spain	24142.86	5.56E-09	1.89E+25	0.682543	8.395164	0.00661
Finland	26046.29	3.53E-08	5.44E+23	0.736355	53.35728	0.000191
Fiji	9659.981	4.17E-07	5.36E+20	0.273098	630.4391	1.88E-07
France	29015.75	3.07E-09	8.93E+25	0.820305	4.640482	0.031248
Gabon	5555.996	2.37E-07	5.50E+20	0.157074	357.9058	1.93E-07
U.K.	25765.12	2.80E-09	8.48E+25	0.728407	4.228496	0.029674
Ghana	1861.504	1.91E-08	9.51E+21	0.052627	28.85251	3.33E-06
Guinea	1525.596	4.64E-08	1.08E+21	0.04313	70.11333	3.78E-07
Gambia	1718.807	2.82E-07	3.71E+19	0.048592	426.4814	1.30E-08
Guinea-biss	1389.759	3.16E-07	1.94E+19	0.03929	477.0189	6.78E-09
Greece	16607.1	2.35E-08	4.98E+23	0.4695	35.5709	0.000174
Guatemala	7431.974	3.33E-08	4.99E+22	0.21011	50.26807	1.75E-05
Guyana	3745.935	4.99E-07	5.64E+19	0.105901	753.7713	1.97E-08
Hong Kong	21524.65	2.05E-08	1.11E+24	0.608524	30.92132	0.000387
Honduras	4596.596	7.09E-08	4.21E+21	0.129951	107.0847	1.47E-06

Country	Alpha=.5 Y/L	X	A	Ratio to US Y/L	X	TFP TO US
Haiti	2009.57	4.21E-08	2.28E+21	0.056813	63.61203	7.98E-07
Hungary	10875.3	2.23E-08	2.38E+23	0.307456	33.6772	8.34E-05
Indonesia	3907.186	1.79E-09	4.74E+24	0.11046	2.712285	0.001659
India	3047.319	3.56E-10	7.33E+25	0.086151	0.537941	0.025648
Ireland	20446.92	6.56E-08	9.70E+22	0.578056	99.20575	3.40E-05
Iran	10457.52	5.93E-09	3.11E+24	0.295645	8.965219	0.001088
Iceland	25839.15	6.16E-07	1.76E+21	0.730499	931.5404	6.15E-07
Israel	23385.74	4.91E-08	2.27E+23	0.661139	74.21842	7.94E-05
Italy	29567.1	3.30E-09	8.04E+25	0.835892	4.98441	0.028124
Jamaica	4591.961	1.10E-07	1.75E+21	0.129819	166.0444	6.11E-07
Jordan	14732.43	1.15E-07	1.65E+22	0.416501	173.4687	5.77E-06
Japan	20827.94	1.18E-09	3.09E+26	0.588827	1.789734	0.108243
Kenya	1990.196	1.28E-08	2.41E+22	0.056265	19.36871	8.44E-06
Korea, rep.	13526.01	5.31E-09	6.48E+24	0.382394	8.028949	0.002268
Sri lanka	5480.63	1.65E-08	1.11E+23	0.154943	24.89846	3.87E-05
Lesotho	2230.844	1.56E-07	2.05E+20	0.063068	235.3131	7.18E-08
Luxembourg	34939.55	4.93E-07	5.02E+21	0.987777	745.1149	1.76E-06
Morocco	6642.414	1.21E-08	2.99E+23	0.187788	18.3536	0.000105
Madagascar	1442.449	2.11E-08	4.66E+21	0.04078	31.94496	1.63E-06
Mexico	15338.35	3.02E-09	2.58E+25	0.433631	4.56525	0.009022
Mali	1228.426	3.59E-08	1.17E+21	0.034729	54.25511	4.10E-07
Malta	16386.22	6.89E-07	5.65E+20	0.463255	1041.303	1.98E-07
Myanmar	1016.76	8.15E-09	1.56E+22	0.028745	12.30934	5.45E-06
Mozambique	1385.216	1.30E-08	1.13E+22	0.039162	19.71677	3.95E-06
Mauritania	1786.149	1.91E-07	8.75E+19	0.050496	288.4916	3.06E-08
Mauritius	9269.678	1.35E-07	4.69E+21	0.262063	204.5045	1.64E-06
Malawi	1047.77	4.32E-08	5.88E+20	0.029622	65.29453	2.06E-07
Malaysia	9467.414	1.48E-08	4.11E+23	0.267654	22.31251	0.000144
Namibia	6881.095	2.79E-07	6.10E+20	0.194536	420.9603	2.14E-07
Niger	1010.721	3.92E-08	6.66E+20	0.028574	59.1881	2.33E-07
Nigeria	1711.392	3.56E-09	2.30E+23	0.048383	5.386893	8.07E-05
Nicaragua	4449.227	1.06E-07	1.75E+21	0.125784	160.8779	6.11E-07
Netherlands	28627.44	1.34E-08	4.53E+24	0.809327	20.32279	0.001586
Norway	26903.76	4.29E-08	3.93E+23	0.760597	64.87406	0.000138
New zealand	25392.68	6.25E-08	1.65E+23	0.717877	94.40046	5.78E-05
Taiwan	15844.64	9.70E-09	2.67E+24	0.447944	14.66115	0.000934
Oman	15037.67	2.28E-07	4.37E+21	0.425131	343.8048	1.53E-06
Pakistan	4556.962	2.80E-09	2.66E+24	0.12883	4.224533	0.00093
Panama	7899.483	1.33E-07	3.54E+21	0.223327	200.7274	1.24E-06
Peru	8385.669	1.57E-08	2.85E+23	0.237072	23.74272	9.97E-05
Philippines	4462.963	5.63E-09	6.28E+23	0.126173	8.511677	0.00022
Papua n.guinea	2752.131	7.05E-08	1.52E+21	0.077806	106.5808	5.33E-07
Poland	8453.608	6.49E-09	1.70E+24	0.238992	9.802856	0.000594
Puerto rico	25164.57	5.95E-08	1.79E+23	0.711428	89.93624	6.26E-05
Portugal	12961.15	1.87E-08	4.79E+23	0.366425	28.28938	0.000168
Paraguay	6015.375	7.69E-08	6.12E+21	0.170061	116.1647	2.14E-06
Reunion	7988.712	4.06E-07	3.87E+20	0.225849	613.7159	1.35E-07
Romania	4026.316	1.16E-08	1.20E+23	0.113828	17.54866	4.21E-05

Country	Alpha=.5			Ratio to US		
	Y/L	X	A	Y/L	X	TFP TO US
Rwanda	1514.97	3.22E-08	2.22E+21	0.04283	48.64055	7.75E-07
Saudi arabia	18686.76	1.90E-08	9.68E+23	0.528294	28.69956	0.000339
Sudan	2360.851	1.55E-08	2.31E+22	0.066744	23.46337	8.09E-06
Senegal	2540.603	3.07E-08	6.84E+21	0.071826	46.4137	2.40E-06
Singapore	21486.01	6.29E-08	1.17E+23	0.607432	95.07239	4.08E-05
Sierra leone	2274.882	5.57E-08	1.67E+21	0.064313	84.12901	5.84E-07
El salvador	5546.329	5.63E-08	9.71E+21	0.1568	85.06216	3.40E-06
Somalia	1723.252	3.79E-08	2.07E+21	0.048718	57.23959	7.24E-07
U.S.S.R.	14758.62	7.06E-10	4.37E+26	0.417241	1.067449	0.152785
Suriname	9045.726	6.48E-07	1.95E+20	0.255732	979.4114	6.82E-08
Sweden	27852.45	1.91E-08	2.13E+24	0.787418	28.82642	0.000746
Swaziland	5824.276	3.26E-07	3.19E+20	0.164658	492.5955	1.12E-07
Seychelles	7606.596	2.98E-06	6.50E+18	0.215046	4507.208	2.28E-09
Syria	15554.49	2.75E-08	3.19E+23	0.439741	41.6175	0.000112
Chad	1139.785	5.87E-08	3.78E+20	0.032223	88.63598	1.32E-07
Togo	1405.974	1.08E-07	1.71E+20	0.039748	162.553	5.98E-08
Thailand	5540.07	3.60E-09	2.37E+24	0.156624	5.435435	0.00083
Trinidad&tobago	17643.03	1.83E-07	9.27E+21	0.498787	276.8444	3.25E-06
Tunisia	7696.728	3.44E-08	5.00E+22	0.217594	52.02249	1.75E-05
Turkey	7725.322	4.16E-09	3.45E+24	0.218403	6.282808	0.001208
Tanzania	1128.44	1.30E-08	7.59E+21	0.031902	19.57316	2.66E-06
Uganda	1122.692	1.53E-08	5.41E+21	0.03174	23.07327	1.89E-06
Uruguay	12018.53	7.77E-08	2.39E+22	0.339776	117.483	8.36E-06
U.S.A.	35371.9	6.62E-10	2.86E+27	1	1	1
Venezuela	17510.68	1.33E-08	1.74E+24	0.495045	20.05898	0.000609
Yemen	7511.125	2.89E-08	6.78E+22	0.212347	43.59867	2.37E-05
Yugoslavia	10654.21	1.05E-08	1.03E+24	0.301205	15.86481	0.000361
South africa	8852.459	8.19E-09	1.17E+24	0.250268	12.37668	0.000409
Zaire	1165.414	9.40E-09	1.54E+22	0.032947	14.20949	5.38E-06
Zambia	1800.73	6.84E-08	6.93E+20	0.050909	103.3897	2.43E-07
Zimbabwe	2316.543	3.26E-08	5.06E+21	0.065491	49.19022	1.77E-06

Table A.51: Productivity Ratios ($\alpha = .6$).

	Alpha=.6			Ratio to US		
Country	Y/L	X	A	Y/L	X	TFP TO US
Angola	1167.222	3.50E-08	1.11E+21	0.032999	40.97356	6.49E-07
Argentina	14864.86	1.03E-08	2.08E+24	0.420245	12.09054	0.001208
Australia	29919.53	1.40E-08	4.58E+24	0.845856	16.37561	0.002668
Austria	25128.95	2.93E-08	7.34E+23	0.710421	34.38099	0.000427
Burundi	1055.371	5.45E-08	3.74E+20	0.029836	63.9228	2.18E-07
Belgium	29659.17	2.53E-08	1.37E+24	0.838495	29.65357	0.0008
Benin	2088.864	6.12E-08	1.16E+21	0.059054	71.75053	6.77E-07
Burkina faso	1044.883	4.01E-08	6.78E+20	0.02954	47.02474	3.95E-07
Bangladesh	4515.05	2.98E-09	2.29E+24	0.127645	3.495277	0.001334
Bolivia	4973.95	6.43E-08	5.97E+21	0.140619	75.41109	3.48E-06
Brazil	11311.79	2.06E-09	3.03E+25	0.319796	2.408415	0.017631
Barbados	14305.55	7.90E-07	3.28E+20	0.404433	925.5795	1.91E-07
Botswana	3316.999	4.16E-07	6.34E+19	0.093775	488.0427	3.69E-08
Central Afr.R.	1176.661	1.09E-07	1.16E+20	0.033265	128.0113	6.75E-08
Canada	33230.77	7.87E-09	1.78E+25	0.939468	9.223313	0.010375
Switzerland	30992.45	3.35E-08	8.56E+23	0.876189	39.24823	0.000498
Chile	9327.717	2.85E-08	1.07E+23	0.263704	33.37548	6.24E-05
China	2115.677	2.80E-10	5.72E+25	0.059812	0.327856	0.033283
Ivory Coast	3443.181	3.05E-08	1.27E+22	0.097342	35.73755	7.42E-06
Cameroon	2710.431	2.77E-08	9.55E+21	0.076627	32.50393	5.56E-06
Congo	4311.284	1.27E-07	1.14E+21	0.121884	149.3357	6.66E-07
Colombia	9366.337	1.13E-08	6.90E+23	0.264796	13.2166	0.000401
Comoros	1250.706	9.64E-07	1.68E+18	0.035359	1129.147	9.81E-10
Cape Verde Is.	2675.961	1.25E-06	4.56E+18	0.075652	1468.413	2.65E-09
Costa rica	9114.44	1.21E-07	5.69E+21	0.257675	141.6553	3.31E-06
Czechoslovakia	7475.214	1.88E-08	1.58E+23	0.211332	22.02359	9.21E-05
Cyprus	15794.74	3.61E-07	1.91E+21	0.446534	423.3605	1.11E-06
Germany, West	28978.87	3.80E-09	5.80E+25	0.819263	4.458317	0.033768
Denmark	24455.88	4.07E-08	3.62E+23	0.691393	47.64255	0.000211
Dominican rep.	7337.939	5.76E-08	1.63E+22	0.207451	67.44455	9.46E-06
Algeria	11616.1	2.07E-08	3.15E+23	0.328399	24.27051	0.000183
Ecuador	8376.941	4.36E-08	3.68E+22	0.236825	51.14979	2.14E-05
Egypt	6644.928	6.99E-09	9.03E+23	0.187859	8.193463	0.000526
Spain	24142.86	7.19E-09	1.13E+25	0.682543	8.426564	0.006561
Finland	26046.29	4.57E-08	3.24E+23	0.736355	53.59005	0.000189
Fiji	9659.981	5.24E-07	3.40E+20	0.273098	613.6236	1.98E-07
France	29015.75	4.00E-09	5.27E+25	0.820305	4.684427	0.030665
Gabon	5555.996	3.02E-07	3.38E+20	0.157074	354.0822	1.97E-07
U.K.	25765.12	3.58E-09	5.19E+25	0.728407	4.193102	0.030177
Ghana	1861.504	2.26E-08	6.81E+21	0.052627	26.43215	3.96E-06
Guinea	1525.596	5.47E-08	7.78E+20	0.04313	64.09584	4.53E-07
Gambia	1718.807	3.36E-07	2.62E+19	0.048592	393.7395	1.52E-08
Guinea-biss	1389.759	3.83E-07	1.32E+19	0.03929	449.0506	7.66E-09
Greece	16607.1	3.01E-08	3.04E+23	0.4695	35.28063	0.000177
Guatemala	7431.974	4.12E-08	3.25E+22	0.21011	48.33109	1.89E-05
Guyana	3745.935	6.23E-07	3.61E+19	0.105901	730.3605	2.10E-08
Hong Kong	21524.65	2.59E-08	6.92E+23	0.608524	30.31279	0.000403
Honduras	4596.596	8.71E-08	2.79E+21	0.129951	102.0424	1.62E-06

Country	Alpha=.6 Y/L	X	A	Ratio to US Y/L	X	TFP TO US
Haiti	2009.57	5.04E-08	1.59E+21	0.056813	59.02131	9.27E-07
Hungary	10875.3	2.81E-08	1.50E+23	0.307456	32.9476	8.71E-05
Indonesia	3907.186	2.22E-09	3.10E+24	0.11046	2.600366	0.001804
India	3047.319	4.33E-10	4.96E+25	0.086151	0.507252	0.028845
Ireland	20446.92	8.42E-08	5.89E+22	0.578056	98.72331	3.43E-05
Iran	10457.52	7.55E-09	1.92E+24	0.295645	8.852902	0.001115
Iceland	25839.15	7.95E-07	1.06E+21	0.730499	931.4418	6.15E-07
Israel	23385.74	6.28E-08	1.39E+23	0.661139	73.54724	8.08E-05
Italy	29567.1	4.29E-09	4.74E+25	0.835892	5.030469	0.027611
Jamaica	4591.961	1.37E-07	1.12E+21	0.129819	160.8351	6.52E-07
Jordan	14732.43	1.45E-07	1.03E+22	0.416501	170.3048	5.98E-06
Japan	20827.94	1.52E-09	1.87E+26	0.588827	1.785943	0.108703
Kenya	1990.196	1.55E-08	1.66E+22	0.056265	18.11376	9.65E-06
Korea, rep.	13526.01	6.68E-09	4.10E+24	0.382394	7.832163	0.002384
Sri lanka	5480.63	2.01E-08	7.42E+22	0.154943	23.58531	4.32E-05
Lesotho	2230.844	1.87E-07	1.42E+20	0.063068	219.337	8.27E-08
Luxembourg	34939.55	6.43E-07	2.96E+21	0.987777	753.006	1.72E-06
Morocco	6642.414	1.49E-08	2.00E+23	0.187788	17.42221	0.000116
Madagascar	1442.449	2.41E-08	3.59E+21	0.04078	28.22897	2.09E-06
Mexico	15338.35	3.85E-09	1.59E+25	0.433631	4.50819	0.009252
Mali	1228.426	4.24E-08	8.41E+20	0.034729	49.63121	4.90E-07
Malta	16386.22	8.75E-07	3.51E+20	0.463255	1025.575	2.04E-07
Myanmar	1016.76	9.64E-09	1.11E+22	0.028745	11.29908	6.47E-06
Mozambique	1385.216	1.51E-08	8.40E+21	0.039162	17.71052	4.89E-06
Mauritania	1786.149	2.33E-07	5.88E+19	0.050496	272.9858	3.42E-08
Mauritius	9269.678	1.67E-07	3.07E+21	0.262063	195.9141	1.79E-06
Malawi	1047.77	5.11E-08	4.20E+20	0.029622	59.90336	2.45E-07
Malaysia	9467.414	1.87E-08	2.57E+23	0.267654	21.87643	0.00015
Namibia	6881.095	3.55E-07	3.75E+20	0.194536	416.2382	2.18E-07
Niger	1010.721	4.66E-08	4.70E+20	0.028574	54.63483	2.74E-07
Nigeria	1711.392	4.35E-09	1.54E+23	0.048383	5.103558	8.99E-05
Nicaragua	4449.227	1.32E-07	1.14E+21	0.125784	154.5331	6.63E-07
Netherlands	28627.44	1.74E-08	2.71E+24	0.809327	20.3824	0.001577
Norway	26903.76	5.56E-08	2.34E+23	0.760597	65.16194	0.000136
New zealand	25392.68	8.03E-08	1.00E+23	0.717877	94.09119	5.82E-05
Taiwan	15844.64	1.22E-08	1.67E+24	0.447944	14.35461	0.000974
Oman	15037.67	2.93E-07	2.63E+21	0.425131	343.4405	1.53E-06
Pakistan	4556.962	3.41E-09	1.78E+24	0.12883	3.998935	0.001038
Panama	7899.483	1.67E-07	2.24E+21	0.223327	195.5055	1.31E-06
Peru	8385.669	1.97E-08	1.81E+23	0.237072	23.10321	0.000105
Philippines	4462.963	6.91E-09	4.17E+23	0.126173	8.100922	0.000243
Papua n.guinea	2752.131	8.72E-08	9.96E+20	0.077806	102.1758	5.80E-07
Poland	8453.608	8.22E-09	1.06E+24	0.238992	9.629163	0.000616
Puerto rico	25164.57	7.65E-08	1.08E+23	0.711428	89.65753	6.30E-05
Portugal	12961.15	2.39E-08	2.94E+23	0.366425	28.00496	0.000171
Paraguay	6015.375	9.52E-08	3.99E+21	0.170061	111.5789	2.32E-06
Reunion	7988.712	5.09E-07	2.46E+20	0.225849	596.5613	1.43E-07
Romania	4026.316	1.44E-08	7.84E+22	0.113828	16.85623	4.56E-05

Country	Alpha=.6 Y/L	X	A	Ratio to US Y/L	X	TFP TO US
Rwanda	1514.97	3.78E-08	1.60E+21	0.04283	44.33581	9.33E-07
Saudi arabia	18686.76	2.43E-08	5.90E+23	0.528294	28.51197	0.000343
Sudan	2360.851	1.90E-08	1.54E+22	0.066744	22.32458	8.94E-06
Senegal	2540.603	3.65E-08	4.84E+21	0.071826	42.80324	2.82E-06
Singapore	21486.01	8.15E-08	6.96E+22	0.607432	95.45838	4.05E-05
Sierra leone	2274.882	6.46E-08	1.24E+21	0.064313	75.65088	7.23E-07
El salvador	5546.329	6.90E-08	6.46E+21	0.1568	80.8637	3.76E-06
Somalia	1723.252	4.54E-08	1.44E+21	0.048718	53.24089	8.37E-07
U.S.S.R.	14758.62	9.08E-10	2.64E+26	0.417241	1.063722	0.153858
Suriname	9045.726	8.25E-07	1.20E+20	0.255732	967.2479	6.99E-08
Sweden	27852.45	2.46E-08	1.28E+24	0.787418	28.80712	0.000747
Swaziland	5824.276	4.03E-07	2.09E+20	0.164658	472.3682	1.22E-07
Seychelles	7606.596	3.74E-06	4.13E+18	0.215046	4388.503	2.40E-09
Syria	15554.49	3.50E-08	1.97E+23	0.439741	41.0189	0.000115
Chad	1139.785	6.73E-08	2.86E+20	0.032223	78.91981	1.67E-07
Togo	1405.974	1.30E-07	1.17E+20	0.039748	152.4351	6.80E-08
Thailand	5540.07	4.42E-09	1.57E+24	0.156624	5.182167	0.000914
Trinidad&tobago	17643.03	2.34E-07	5.69E+21	0.498787	274.2161	3.31E-06
Tunisia	7696.728	4.31E-08	3.20E+22	0.217594	50.45266	1.86E-05
Turkey	7725.322	5.24E-09	2.17E+24	0.218403	6.139483	0.001266
Tanzania	1128.44	1.53E-08	5.42E+21	0.031902	17.9706	3.15E-06
Uganda	1122.692	1.76E-08	4.08E+21	0.03174	20.59773	2.37E-06
Uruguay	12018.53	9.80E-08	1.50E+22	0.339776	114.8514	8.75E-06
U.S.A.	35371.9	8.53E-10	1.72E+27	1	1	1
Venezuela	17510.68	1.70E-08	1.06E+24	0.495045	19.96202	0.000615
Yemen	7511.125	3.59E-08	4.38E+22	0.212347	42.06867	2.55E-05
Yugoslavia	10654.21	1.34E-08	6.33E+23	0.301205	15.69367	0.000368
South africa	8852.459	1.03E-08	7.35E+23	0.250268	12.09948	0.000428
Zaire	1165.414	1.10E-08	1.12E+22	0.032947	12.88729	6.54E-06
Zambia	1800.73	8.40E-08	4.60E+20	0.050909	98.40811	2.68E-07
Zimbabwe	2316.543	3.98E-08	3.38E+21	0.065491	46.67919	1.97E-06

Table A.52: Productivity Ratios ($\alpha = .7$).

	Alpha=.7			Ratio to US		
Country	Y/L	X	A	Y/L	X	TFP TO US
Angola	1167.222	4.12E-08	8.03E+20	0.032999	36.77962	8.05E-07
Argentina	14864.86	1.33E-08	1.24E+24	0.420245	11.90545	0.001246
Australia	29919.53	1.84E-08	2.65E+24	0.845856	16.42421	0.002652
Austria	25128.95	3.87E-08	4.22E+23	0.710421	34.5599	0.000423
Burundi	1055.371	6.43E-08	2.69E+20	0.029836	57.45601	2.70E-07
Belgium	29659.17	3.32E-08	7.96E+23	0.838495	29.68671	0.000798
Benin	2088.864	7.47E-08	7.82E+20	0.059054	66.69946	7.84E-07
Burkina faso	1044.883	4.74E-08	4.85E+20	0.02954	42.34865	4.87E-07
Bangladesh	4515.05	3.61E-09	1.57E+24	0.127645	3.222046	0.001569
Bolivia	4973.95	8.08E-08	3.79E+21	0.140619	72.18881	3.79E-06
Brazil	11311.79	2.65E-09	1.82E+25	0.319796	2.364815	0.018287
Barbados	14305.55	1.00E-06	2.03E+20	0.404433	895.5802	2.04E-07
Botswana	3316.999	5.25E-07	3.99E+19	0.093775	469.1285	4.00E-08
Central Afr.R.	1176.661	1.31E-07	8.11E+19	0.033265	116.7102	8.12E-08
Canada	33230.77	1.03E-08	1.03E+25	0.939468	9.231739	0.010356
Switzerland	30992.45	4.44E-08	4.87E+23	0.876189	39.66074	0.000488
Chile	9327.717	3.64E-08	6.55E+22	0.263704	32.54637	6.57E-05
China	2115.677	3.43E-10	3.81E+25	0.059812	0.30596	0.038217
Ivory Coast	3443.181	3.78E-08	8.30E+21	0.097342	33.75607	8.32E-06
Cameroon	2710.431	3.41E-08	6.31E+21	0.076627	30.45777	6.33E-06
Congo	4311.284	1.58E-07	7.44E+20	0.121884	141.1791	7.45E-07
Colombia	9366.337	1.44E-08	4.25E+23	0.264796	12.82481	0.000426
Comoros	1250.706	1.17E-06	1.14E+18	0.035359	1047.291	1.14E-09
Cape Verde Is.	2675.961	1.57E-06	2.92E+18	0.075652	1397.611	2.93E-09
Costa rica	9114.44	1.54E-07	3.51E+21	0.257675	137.4461	3.52E-06
Czechoslovakia	7475.214	2.40E-08	9.70E+22	0.211332	21.43276	9.72E-05
Cyprus	15794.74	4.68E-07	1.14E+21	0.446534	417.5594	1.14E-06
Germany, West	28978.87	5.02E-09	3.33E+25	0.819263	4.487177	0.033335
Denmark	24455.88	5.32E-08	2.11E+23	0.691393	47.49607	0.000212
Dominican rep.	7337.939	7.29E-08	1.01E+22	0.207451	65.10232	1.02E-05
Algeria	11616.1	2.70E-08	1.85E+23	0.328399	24.14546	0.000185
Ecuador	8376.941	5.59E-08	2.25E+22	0.236825	49.91361	2.25E-05
Egypt	6644.928	8.54E-09	6.06E+23	0.187859	7.623121	0.000607
Spain	24142.86	9.47E-09	6.49E+24	0.682543	8.460264	0.006509
Finland	26046.29	6.03E-08	1.87E+23	0.736355	53.84002	0.000187
Fiji	9659.981	6.68E-07	2.09E+20	0.273098	596.1413	2.10E-07
France	29015.75	5.30E-09	3.00E+25	0.820305	4.73187	0.030053
Gabon	5555.996	3.92E-07	2.01E+20	0.157074	350.0394	2.01E-07
U.K.	25765.12	4.65E-09	3.07E+25	0.728407	4.155588	0.030724
Ghana	1861.504	2.70E-08	4.77E+21	0.052627	24.0686	4.78E-06
Guinea	1525.596	6.52E-08	5.47E+20	0.04313	58.23244	5.49E-07
Gambia	1718.807	4.05E-07	1.80E+19	0.048592	361.5095	1.81E-08
Guinea-biss	1389.759	4.71E-07	8.69E+18	0.03929	420.9601	8.71E-09
Greece	16607.1	3.92E-08	1.80E+23	0.4695	34.97291	0.00018
Guatemala	7431.974	5.19E-08	2.05E+22	0.21011	46.3427	2.06E-05
Guyana	3745.935	7.91E-07	2.24E+19	0.105901	706.135	2.25E-08
Hong Kong	21524.65	3.32E-08	4.20E+23	0.608524	29.67543	0.000421
Honduras	4596.596	1.09E-07	1.79E+21	0.129951	96.91386	1.80E-06

Country	Alpha=.7			Ratio to US		
	Y/L	X	A	Y/L	X	TFP TO US
Haiti	2009.57	6.10E-08	1.09E+21	0.056813	54.47905	1.09E-06
Hungary	10875.3	3.60E-08	9.10E+22	0.307456	32.18504	9.13E-05
Indonesia	3907.186	2.78E-09	1.97E+24	0.11046	2.485813	0.001975
India	3047.319	5.33E-10	3.26E+25	0.086151	0.476376	0.032705
Ireland	20446.92	1.10E-07	3.46E+22	0.578056	98.21011	3.46E-05
Iran	10457.52	9.78E-09	1.14E+24	0.295645	8.734376	0.001146
Iceland	25839.15	1.04E-06	6.14E+20	0.730499	931.3363	6.15E-07
Israel	23385.74	8.16E-08	8.22E+22	0.661139	72.83638	8.24E-05
Italy	29567.1	5.69E-09	2.70E+25	0.835892	5.080183	0.027073
Jamaica	4591.961	1.74E-07	6.96E+20	0.129819	155.4463	6.98E-07
Jordan	14732.43	1.87E-07	6.21E+21	0.416501	166.986	6.22E-06
Japan	20827.94	2.00E-09	1.09E+26	0.588827	1.7819	0.109197
Kenya	1990.196	1.89E-08	1.11E+22	0.056265	16.86185	1.11E-05
Korea, rep.	13526.01	8.54E-09	2.51E+24	0.382394	7.627104	0.002514
Sri lanka	5480.63	2.49E-08	4.83E+22	0.154943	22.25788	4.85E-05
Lesotho	2230.844	2.28E-07	9.59E+19	0.063068	203.4543	9.61E-08
Luxembourg	34939.55	8.53E-07	1.68E+21	0.987777	761.5351	1.68E-06
Morocco	6642.414	1.85E-08	1.30E+23	0.187788	16.47865	0.00013
Madagascar	1442.449	2.77E-08	2.71E+21	0.04078	24.73288	2.72E-06
Mexico	15338.35	4.98E-09	9.48E+24	0.433631	4.447974	0.009504
Mali	1228.426	5.05E-08	5.91E+20	0.034729	45.12266	5.92E-07
Malta	16386.22	1.13E-06	2.10E+20	0.463255	1009.023	2.11E-07
Myanmar	1016.76	1.15E-08	7.75E+21	0.028745	10.31052	7.77E-06
Mozambique	1385.216	1.77E-08	6.14E+21	0.039162	15.79083	6.15E-06
Mauritania	1786.149	2.88E-07	3.84E+19	0.050496	257.3286	3.85E-08
Mauritius	9269.678	2.10E-07	1.96E+21	0.262063	187.1286	1.96E-06
Malawi	1047.77	6.12E-08	2.93E+20	0.029622	54.63089	2.94E-07
Malaysia	9467.414	2.40E-08	1.56E+23	0.267654	21.41964	0.000156
Namibia	6881.095	4.61E-07	2.23E+20	0.194536	411.2483	2.24E-07
Niger	1010.721	5.62E-08	3.24E+20	0.028574	50.15352	3.25E-07
Nigeria	1711.392	5.39E-09	1.01E+23	0.048383	4.817099	0.000101
Nicaragua	4449.227	1.66E-07	7.20E+20	0.125784	148.0262	7.22E-07
Netherlands	28627.44	2.29E-08	1.56E+24	0.809327	20.44634	0.001567
Norway	26903.76	7.33E-08	1.35E+23	0.760597	65.47114	0.000135
New zealand	25392.68	1.05E-07	5.85E+22	0.717877	93.76167	5.86E-05
Taiwan	15844.64	1.57E-08	1.02E+24	0.447944	14.03396	0.001019
Oman	15037.67	3.84E-07	1.53E+21	0.425131	343.0515	1.54E-06
Pakistan	4556.962	4.22E-09	1.16E+24	0.12883	3.771049	0.001167
Panama	7899.483	2.13E-07	1.38E+21	0.223327	190.0727	1.38E-06
Peru	8385.669	2.51E-08	1.11E+23	0.237072	22.43853	0.000112
Philippines	4462.963	8.60E-09	2.69E+23	0.126173	7.683671	0.00027
Papua n.guinea	2752.131	1.09E-07	6.33E+20	0.077806	97.66749	6.35E-07
Poland	8453.608	1.06E-08	6.39E+23	0.238992	9.446866	0.00064
Puerto rico	25164.57	1.00E-07	6.32E+22	0.711428	89.36052	6.34E-05
Portugal	12961.15	3.10E-08	1.75E+23	0.366425	27.70404	0.000175
Paraguay	6015.375	1.20E-07	2.53E+21	0.170061	106.8761	2.53E-06
Reunion	7988.712	6.48E-07	1.52E+20	0.225849	578.7509	1.52E-07
Romania	4026.316	1.81E-08	4.96E+22	0.113828	16.14611	4.97E-05

	Alpha=.7			Ratio to US		
Country	Y/L	X	A	Y/L	X	TFP TO US
Rwanda	1514.97	4.50E-08	1.14E+21	0.04283	40.15398	1.14E-06
Saudi arabia	18686.76	3.17E-08	3.47E+23	0.528294	28.31276	0.000348
Sudan	2360.851	2.37E-08	9.92E+21	0.066744	21.16814	9.94E-06
Senegal	2540.603	4.40E-08	3.34E+21	0.071826	39.25325	3.35E-06
Singapore	21486.01	1.07E-07	4.01E+22	0.607432	95.87278	4.01E-05
Sierra leone	2274.882	7.56E-08	9.05E+20	0.064313	67.52943	9.07E-07
El salvador	5546.329	8.58E-08	4.18E+21	0.1568	76.60394	4.19E-06
Somalia	1723.252	5.52E-08	9.75E+20	0.048718	49.27422	9.78E-07
U.S.S.R.	14758.62	1.19E-09	1.55E+26	0.417241	1.059751	0.155013
Suriname	9045.726	1.07E-06	7.16E+19	0.255732	954.4106	7.18E-08
Sweden	27852.45	3.22E-08	7.47E+23	0.787418	28.7865	0.000748
Swaziland	5824.276	5.06E-07	1.33E+20	0.164658	451.6602	1.33E-07
Seychelles	7606.596	4.78E-06	2.54E+18	0.215046	4265.047	2.54E-09
Syria	15554.49	4.52E-08	1.18E+23	0.439741	40.38843	0.000119
Chad	1139.785	7.81E-08	2.13E+20	0.032223	69.70697	2.14E-07
Togo	1405.974	1.59E-07	7.78E+19	0.039748	142.3133	7.80E-08
Thailand	5540.07	5.51E-09	1.01E+24	0.156624	4.924428	0.001012
Trinidad&tobago	17643.03	3.04E-07	3.37E+21	0.498787	271.4337	3.38E-06
Tunisia	7696.728	5.47E-08	1.98E+22	0.217594	48.82667	1.99E-05
Turkey	7725.322	6.71E-09	1.33E+24	0.218403	5.989864	0.00133
Tanzania	1128.44	1.84E-08	3.77E+21	0.031902	16.4021	3.78E-06
Uganda	1122.692	2.04E-08	3.02E+21	0.03174	18.24409	3.03E-06
Uruguay	12018.53	1.26E-07	9.17E+21	0.339776	112.1031	9.19E-06
U.S.A.	35371.9	1.12E-09	9.98E+26	1	1	1
Venezuela	17510.68	2.22E-08	6.20E+23	0.495045	19.85887	0.000621
Yemen	7511.125	4.53E-08	2.74E+22	0.212347	40.49224	2.75E-05
Yugoslavia	10654.21	1.74E-08	3.76E+23	0.301205	15.51274	0.000377
South africa	8852.459	1.32E-08	4.48E+23	0.250268	11.80998	0.000449
Zaire	1165.414	1.30E-08	8.04E+21	0.032947	11.60948	8.05E-06
Zambia	1800.73	1.05E-07	2.97E+20	0.050909	93.34734	2.97E-07
Zimbabwe	2316.543	4.94E-08	2.20E+21	0.065491	44.13617	2.20E-06

Table A.53: Productivity Ratios ($\alpha = .8$).

	Alpha=.8			Ratio to US		
Country	Y/L	X	A	Y/L	X	TFP TO US
Angola	1167.222	4.96E-08	5.54E+20	0.032999	32.53512	1.03E-06
Argentina	14864.86	1.78E-08	6.94E+23	0.420245	11.6987	0.00129
Australia	29919.53	2.51E-08	1.42E+24	0.845856	16.47957	0.002635
Austria	25128.95	5.30E-08	2.25E+23	0.710421	34.7642	0.000418
Burundi	1055.371	7.76E-08	1.85E+20	0.029836	50.902	3.44E-07
Belgium	29659.17	4.53E-08	4.28E+23	0.838495	29.72439	0.000796
Benin	2088.864	9.36E-08	4.98E+20	0.059054	61.39332	9.25E-07
Burkina faso	1044.883	5.73E-08	3.32E+20	0.02954	37.59979	6.17E-07
Bangladesh	4515.05	4.48E-09	1.02E+24	0.127645	2.937576	0.001888
Bolivia	4973.95	1.05E-07	2.25E+21	0.140619	68.69627	4.19E-06
Brazil	11311.79	3.53E-09	1.03E+25	0.319796	2.316259	0.019062
Barbados	14305.55	1.32E-06	1.18E+20	0.404433	862.6907	2.20E-07
Botswana	3316.999	6.84E-07	2.35E+19	0.093775	448.5369	4.37E-08
Central Afr.R.	1176.661	1.60E-07	5.39E+19	0.033265	105.0817	1.00E-07
Canada	33230.77	1.41E-08	5.56E+24	0.939468	9.241316	0.010335
Switzerland	30992.45	6.12E-08	2.56E+23	0.876189	40.13443	0.000477
Chile	9327.717	4.82E-08	3.74E+22	0.263704	31.62979	6.95E-05
China	2115.677	4.31E-10	2.41E+25	0.059812	0.282864	0.044712
Ivory Coast	3443.181	4.82E-08	5.09E+21	0.097342	31.6388	9.47E-06
Cameroon	2710.431	4.31E-08	3.95E+21	0.076627	28.28993	7.34E-06
Congo	4311.284	2.02E-07	4.56E+20	0.121884	132.4555	8.47E-07
Colombia	9366.337	1.89E-08	2.46E+23	0.264796	12.39395	0.000457
Comoros	1250.706	1.47E-06	7.28E+17	0.035359	961.5089	1.35E-09
Cape Verde Is.	2675.961	2.01E-06	1.76E+18	0.075652	1321.34	3.28E-09
Costa rica	9114.44	2.03E-07	2.03E+21	0.257675	132.8176	3.76E-06
Czechoslovakia	7475.214	3.17E-08	5.57E+22	0.211332	20.78101	0.000103
Cyprus	15794.74	6.27E-07	6.35E+20	0.446534	411.0682	1.18E-06
Germany, West	28978.87	6.89E-09	1.77E+25	0.819263	4.520175	0.03285
Denmark	24455.88	7.22E-08	1.15E+23	0.691393	47.33028	0.000213
Dominican rep.	7337.939	9.54E-08	5.92E+21	0.207451	62.541	1.10E-05
Algeria	11616.1	3.66E-08	1.01E+23	0.328399	24.00422	0.000187
Ecuador	8376.941	7.40E-08	1.28E+22	0.236825	48.54601	2.38E-05
Egypt	6644.928	1.07E-08	3.85E+23	0.187859	7.023436	0.000715
Spain	24142.86	1.30E-08	3.47E+24	0.682543	8.498696	0.00645
Finland	26046.29	8.25E-08	9.96E+22	0.736355	54.12531	0.000185
Fiji	9659.981	8.80E-07	1.21E+20	0.273098	576.8919	2.24E-07
France	29015.75	7.30E-09	1.58E+25	0.820305	4.786329	0.029373
Gabon	5555.996	5.27E-07	1.11E+20	0.157074	345.5044	2.07E-07
U.K.	25765.12	6.27E-09	1.69E+25	0.728407	4.113396	0.031358
Ghana	1861.504	3.30E-08	3.18E+21	0.052627	21.6398	5.91E-06
Guinea	1525.596	7.96E-08	3.67E+20	0.04313	52.22169	6.82E-07
Gambia	1718.807	5.00E-07	1.18E+19	0.048592	328.0966	2.19E-08
Guinea-biss	1389.759	5.96E-07	5.43E+18	0.03929	391.1855	1.01E-08
Greece	16607.1	5.28E-08	9.89E+22	0.4695	34.62672	0.000184
Guatemala	7431.974	6.74E-08	1.22E+22	0.21011	44.18372	2.26E-05
Guyana	3745.935	1.04E-06	1.31E+19	0.105901	679.5977	2.43E-08
Hong Kong	21524.65	4.42E-08	2.37E+23	0.608524	28.96788	0.000441
Honduras	4596.596	1.39E-07	1.09E+21	0.129951	91.40178	2.02E-06

	Alpha=.8			Ratio to US		
Country	Y/L	X	A	Y/L	X	TFP TO US
Haiti	2009.57	7.58E-08	7.02E+20	0.056813	49.74331	1.30E-06
Hungary	10875.3	4.78E-08	5.18E+22	0.307456	31.34046	9.62E-05
Indonesia	3907.186	3.60E-09	1.18E+24	0.11046	2.361835	0.002187
India	3047.319	6.76E-10	2.03E+25	0.086151	0.443586	0.037719
Ireland	20446.92	1.49E-07	1.89E+22	0.578056	97.63057	3.51E-05
Iran	10457.52	1.31E-08	6.36E+23	0.295645	8.601703	0.001181
Iceland	25839.15	1.42E-06	3.31E+20	0.730499	931.2166	6.15E-07
Israel	23385.74	1.10E-07	4.53E+22	0.661139	72.03746	8.42E-05
Italy	29567.1	7.83E-09	1.42E+25	0.835892	5.137234	0.026475
Jamaica	4591.961	2.28E-07	4.06E+20	0.129819	149.5455	7.54E-07
Jordan	14732.43	2.49E-07	3.50E+21	0.416501	163.2955	6.51E-06
Japan	20827.94	2.71E-09	5.91E+25	0.588827	1.777319	0.10976
Kenya	1990.196	2.37E-08	7.05E+21	0.056265	15.54479	1.31E-05
Korea, rep.	13526.01	1.13E-08	1.44E+24	0.382394	7.400744	0.00267
Sri lanka	5480.63	3.18E-08	2.97E+22	0.154943	20.84083	5.53E-05
Lesotho	2230.844	2.85E-07	6.13E+19	0.063068	186.8081	1.14E-07
Luxembourg	34939.55	1.18E-06	8.83E+20	0.987777	771.3378	1.64E-06
Morocco	6642.414	2.36E-08	7.93E+22	0.187788	15.46897	0.000147
Madagascar	1442.449	3.25E-08	1.98E+21	0.04078	21.28478	3.67E-06
Mexico	15338.35	6.68E-09	5.27E+24	0.433631	4.380568	0.009799
Mali	1228.426	6.18E-08	3.96E+20	0.034729	40.49735	7.35E-07
Malta	16386.22	1.51E-06	1.18E+20	0.463255	990.55	2.19E-07
Myanmar	1016.76	1.42E-08	5.15E+21	0.028745	9.29237	9.57E-06
Mozambique	1385.216	2.11E-08	4.29E+21	0.039162	13.8619	7.98E-06
Mauritania	1786.149	3.67E-07	2.37E+19	0.050496	240.6347	4.40E-08
Mauritius	9269.678	2.71E-07	1.17E+21	0.262063	177.6286	2.18E-06
Malawi	1047.77	7.50E-08	1.95E+20	0.029622	49.20397	3.62E-07
Malaysia	9467.414	3.19E-08	8.82E+22	0.267654	20.91246	0.000164
Namibia	6881.095	6.19E-07	1.24E+20	0.194536	405.6544	2.30E-07
Niger	1010.721	6.94E-08	2.12E+20	0.028574	45.50864	3.94E-07
Nigeria	1711.392	6.88E-09	6.19E+22	0.048383	4.511247	0.000115
Nicaragua	4449.227	2.15E-07	4.28E+20	0.125784	140.9687	7.96E-07
Netherlands	28627.44	3.13E-08	8.37E+23	0.809327	20.51918	0.001556
Norway	26903.76	1.00E-07	7.19E+22	0.760597	65.82404	0.000134
New zealand	25392.68	1.42E-07	3.18E+22	0.717877	93.38886	5.91E-05
Taiwan	15844.64	2.09E-08	5.77E+23	0.447944	13.67851	0.001072
Oman	15037.67	5.22E-07	8.29E+20	0.425131	342.6102	1.54E-06
Pakistan	4556.962	5.38E-09	7.18E+23	0.12883	3.527971	0.001334
Panama	7899.483	2.81E-07	7.92E+20	0.223327	184.0862	1.47E-06
Peru	8385.669	3.31E-08	6.42E+22	0.237072	21.70689	0.000119
Philippines	4462.963	1.10E-08	1.64E+23	0.126173	7.235845	0.000304
Papua n.guinea	2752.131	1.41E-07	3.78E+20	0.077806	92.78863	7.03E-07
Poland	8453.608	1.41E-08	3.60E+23	0.238992	9.244033	0.000668
Puerto rico	25164.57	1.36E-07	3.44E+22	0.711428	89.02443	6.39E-05
Portugal	12961.15	4.17E-08	9.65E+22	0.366425	27.36623	0.000179
Paraguay	6015.375	1.55E-07	1.50E+21	0.170061	101.7755	2.79E-06
Reunion	7988.712	8.53E-07	8.78E+19	0.225849	559.1694	1.63E-07
Romania	4026.316	2.34E-08	2.95E+22	0.113828	15.37592	5.48E-05

	Alpha=.8			Ratio to US		
Country	Y/L	X	A	Y/L	X	TFP TO US
Rwanda	1514.97	5.47E-08	7.67E+20	0.04283	35.88136	1.43E-06
Saudi arabia	18686.76	4.28E-08	1.90E+23	0.528294	28.08823	0.000354
Sudan	2360.851	3.04E-08	6.04E+21	0.066744	19.92736	1.12E-05
Senegal	2540.603	5.42E-08	2.19E+21	0.071826	35.57759	4.08E-06
Singapore	21486.01	1.47E-07	2.14E+22	0.607432	96.34555	3.98E-05
Sierra leone	2274.882	9.05E-08	6.32E+20	0.064313	59.35878	1.17E-06
El salvador	5546.329	1.10E-07	2.55E+21	0.1568	72.03806	4.74E-06
Somalia	1723.252	6.88E-08	6.27E+20	0.048718	45.12687	1.17E-06
U.S.S.R.	14758.62	1.61E-09	8.41E+25	0.417241	1.055261	0.156335
Suriname	9045.726	1.43E-06	3.98E+19	0.255732	940.0391	7.40E-08
Sweden	27852.45	4.39E-08	4.03E+23	0.787418	28.7631	0.000749
Swaziland	5824.276	6.55E-07	7.92E+19	0.164658	429.2432	1.47E-07
Seychelles	7606.596	6.30E-06	1.46E+18	0.215046	4129.058	2.71E-09
Syria	15554.49	6.05E-08	6.61E+22	0.439741	39.68423	0.000123
Chad	1139.785	9.23E-08	1.52E+20	0.032223	60.54202	2.83E-07
Togo	1405.974	2.01E-07	4.91E+19	0.039748	131.6317	9.12E-08
Thailand	5540.07	7.09E-09	6.11E+23	0.156624	4.647253	0.001136
Trinidad&tobago	17643.03	4.09E-07	1.86E+21	0.498787	268.3082	3.46E-06
Tunisia	7696.728	7.17E-08	1.15E+22	0.217594	47.04366	2.14E-05
Turkey	7725.322	8.88E-09	7.57E+23	0.218403	5.824376	0.001406
Tanzania	1128.44	2.25E-08	2.51E+21	0.031902	14.78626	4.66E-06
Uganda	1122.692	2.42E-08	2.15E+21	0.03174	15.89571	3.99E-06
Uruguay	12018.53	1.66E-07	5.22E+21	0.339776	109.0619	9.71E-06
U.S.A.	35371.9	1.52E-09	5.38E+26	1	1	1
Venezuela	17510.68	3.01E-08	3.38E+23	0.495045	19.74239	0.000629
Yemen	7511.125	5.91E-08	1.61E+22	0.212347	38.77357	3.00E-05
Yugoslavia	10654.21	2.33E-08	2.08E+23	0.301205	15.30981	0.000387
South africa	8852.459	1.75E-08	2.55E+23	0.250268	11.48962	0.000475
Zaire	1165.414	1.57E-08	5.49E+21	0.032947	10.31133	1.02E-05
Zambia	1800.73	1.34E-07	1.80E+20	0.050909	87.91523	3.35E-07
Zimbabwe	2316.543	6.32E-08	1.35E+21	0.065491	41.41594	2.50E-06

Table A.54: Productivity Ratios ($\alpha = .9$).

	Alpha=.9			Ratio to US		
Country	Y/L	X	A	Y/L	X	TFP TO US
Angola	1167.222	6.29E-08	3.44E+20	0.032999	27.82213	1.41E-06
Argentina	14864.86	2.59E-08	3.30E+23	0.420245	11.44005	0.001349
Australia	29919.53	3.74E-08	6.39E+23	0.845856	16.5505	0.002612
Austria	25128.95	7.92E-08	1.01E+23	0.710421	35.02668	0.000411
Burundi	1055.371	9.86E-08	1.15E+20	0.029836	43.61216	4.68E-07
Belgium	29659.17	6.73E-08	1.94E+23	0.838495	29.77254	0.000793
Benin	2088.864	1.25E-07	2.80E+20	0.059054	55.23032	1.14E-06
Burkina faso	1044.883	7.30E-08	2.05E+20	0.02954	32.30472	8.36E-07
Bangladesh	4515.05	5.90E-09	5.85E+23	0.127645	2.610721	0.002391
Bolivia	4973.95	1.46E-07	1.16E+21	0.140619	64.48352	4.76E-06
Brazil	11311.79	5.10E-09	4.92E+24	0.319796	2.255739	0.020099
Barbados	14305.55	1.86E-06	5.92E+19	0.404433	822.4665	2.42E-07
Botswana	3316.999	9.58E-07	1.20E+19	0.093775	423.5661	4.90E-08
Central Afr.R.	1176.661	2.08E-07	3.21E+19	0.033265	91.90884	1.31E-07
Canada	33230.77	2.09E-08	2.52E+24	0.939468	9.253553	0.010307
Switzerland	30992.45	9.21E-08	1.13E+23	0.876189	40.74717	0.000462
Chile	9327.717	6.90E-08	1.83E+22	0.263704	30.49747	7.48E-05
China	2115.677	5.79E-10	1.34E+25	0.059812	0.255903	0.05463
Ivory Coast	3443.181	6.59E-08	2.73E+21	0.097342	29.12856	1.12E-05
Cameroon	2710.431	5.82E-08	2.17E+21	0.076627	25.74601	8.86E-06
Congo	4311.284	2.76E-07	2.44E+20	0.121884	122.1012	9.97E-07
Colombia	9366.337	2.68E-08	1.22E+23	0.264796	11.86507	0.000498
Comoros	1250.706	1.95E-06	4.12E+17	0.035359	862.1632	1.68E-09
Cape Verde Is.	2675.961	2.78E-06	9.26E+17	0.075652	1230.02	3.78E-09
Costa rica	9114.44	2.87E-07	1.01E+21	0.257675	127.1365	4.11E-06
Czechoslovakia	7475.214	4.52E-08	2.74E+22	0.211332	19.97797	0.000112
Cyprus	15794.74	9.11E-07	3.01E+20	0.446534	402.9307	1.23E-06
Germany, West	28978.87	1.03E-08	7.89E+24	0.819263	4.56264	0.032241
Denmark	24455.88	1.07E-07	5.27E+22	0.691393	47.11955	0.000215
Dominican rep.	7337.939	1.34E-07	2.98E+21	0.207451	59.41814	1.22E-05
Algeria	11616.1	5.39E-08	4.65E+22	0.328399	23.82519	0.00019
Ecuador	8376.941	1.06E-07	6.25E+21	0.236825	46.85501	2.56E-05
Egypt	6644.928	1.43E-08	2.16E+23	0.187859	6.326151	0.000882
Spain	24142.86	1.93E-08	1.56E+24	0.682543	8.547996	0.006376
Finland	26046.29	1.23E-07	4.47E+22	0.736355	54.49158	0.000183
Fiji	9659.981	1.25E-06	5.96E+19	0.273098	553.2265	2.44E-07
France	29015.75	1.10E-08	6.98E+24	0.820305	4.856738	0.028527
Gabon	5555.996	7.68E-07	5.23E+19	0.157074	339.8022	2.14E-07
U.K.	25765.12	9.18E-09	7.88E+24	0.728407	4.060172	0.032185
Ghana	1861.504	4.27E-08	1.90E+21	0.052627	18.89285	7.76E-06
Guinea	1525.596	1.03E-07	2.20E+20	0.04313	45.44335	9.01E-07
Gambia	1718.807	6.55E-07	6.88E+18	0.048592	289.9026	2.81E-08
Guinea-biss	1389.759	8.05E-07	2.98E+18	0.03929	356.2267	1.22E-08
Greece	16607.1	7.73E-08	4.62E+22	0.4695	34.1899	0.000189
Guatemala	7431.974	9.40E-08	6.25E+21	0.21011	41.57394	2.55E-05
Guyana	3745.935	1.46E-06	6.55E+18	0.105901	647.1751	2.68E-08
Hong Kong	21524.65	6.35E-08	1.15E+23	0.608524	28.08939	0.000469
Honduras	4596.596	1.92E-07	5.74E+20	0.129951	84.82037	2.35E-06

Country	Alpha=.9 Y/L	X	A	Ratio to US Y/L	X	TFP TO US
Haiti	2009.57	1.00E-07	4.03E+20	0.056813	44.29275	1.65E-06
Hungary	10875.3	6.85E-08	2.52E+22	0.307456	30.29474	0.000103
Indonesia	3907.186	5.00E-09	6.10E+23	0.11046	2.212557	0.002492
India	3047.319	9.16E-10	1.11E+25	0.086151	0.404997	0.04525
Ireland	20446.92	2.19E-07	8.71E+21	0.578056	96.89593	3.56E-05
Iran	10457.52	1.91E-08	3.01E+23	0.295645	8.435313	0.001228
Iceland	25839.15	2.11E-06	1.51E+20	0.730499	931.0639	6.16E-07
Israel	23385.74	1.61E-07	2.12E+22	0.661139	71.03062	8.66E-05
Italy	29567.1	1.18E-08	6.30E+24	0.835892	5.210971	0.025731
Jamaica	4591.961	3.22E-07	2.04E+20	0.129819	142.3392	8.32E-07
Jordan	14732.43	3.59E-07	1.69E+21	0.416501	158.7041	6.89E-06
Japan	20827.94	4.01E-09	2.70E+25	0.588827	1.771491	0.110484
Kenya	1990.196	3.17E-08	3.95E+21	0.056265	14.01231	1.61E-05
Korea, rep.	13526.01	1.61E-08	7.06E+23	0.382394	7.121602	0.002883
Sri lanka	5480.63	4.33E-08	1.60E+22	0.154943	19.1627	6.54E-05
Lesotho	2230.844	3.79E-07	3.47E+19	0.063068	167.5277	1.42E-07
Luxembourg	34939.55	1.77E-06	3.88E+20	0.987777	784.0312	1.59E-06
Morocco	6642.414	3.23E-08	4.24E+22	0.187788	14.26979	0.000173
Madagascar	1442.449	3.97E-08	1.32E+21	0.04078	17.57341	5.39E-06
Mexico	15338.35	9.71E-09	2.49E+24	0.433631	4.296029	0.010188
Mali	1228.426	7.98E-08	2.37E+20	0.034729	35.27667	9.69E-07
Malta	16386.22	2.19E-06	5.61E+19	0.463255	967.4659	2.29E-07
Myanmar	1016.76	1.84E-08	3.05E+21	0.028745	8.137716	1.25E-05
Mozambique	1385.216	2.65E-08	2.72E+21	0.039162	11.73855	1.11E-05
Mauritania	1786.149	4.99E-07	1.28E+19	0.050496	220.8939	5.23E-08
Mauritius	9269.678	3.76E-07	6.09E+20	0.262063	166.2023	2.49E-06
Malawi	1047.77	9.73E-08	1.16E+20	0.029622	43.054	4.73E-07
Malaysia	9467.414	4.59E-08	4.26E+22	0.267654	20.28263	0.000174
Namibia	6881.095	9.01E-07	5.83E+19	0.194536	398.6259	2.38E-07
Niger	1010.721	9.09E-08	1.24E+20	0.028574	40.20035	5.05E-07
Nigeria	1711.392	9.38E-09	3.33E+22	0.048383	4.148966	0.000136
Nicaragua	4449.227	2.99E-07	2.21E+20	0.125784	132.4486	9.02E-07
Netherlands	28627.44	4.66E-08	3.77E+23	0.809327	20.61252	0.001542
Norway	26903.76	1.50E-07	3.22E+22	0.760597	66.27716	0.000132
New zealand	25392.68	2.10E-07	1.46E+22	0.717877	92.91525	5.97E-05
Taiwan	15844.64	2.99E-08	2.80E+23	0.447944	13.23794	0.001145
Oman	15037.67	7.73E-07	3.78E+20	0.425131	342.0479	1.55E-06
Pakistan	4556.962	7.33E-09	3.87E+23	0.12883	3.240384	0.001581
Panama	7899.483	4.00E-07	3.91E+20	0.223327	176.7194	1.60E-06
Peru	8385.669	4.70E-08	3.18E+22	0.237072	20.80774	0.00013
Philippines	4462.963	1.52E-08	8.67E+22	0.126173	6.702047	0.000354
Papua n.guinea	2752.131	1.97E-07	1.96E+20	0.077806	86.91472	8.01E-07
Poland	8453.608	2.03E-08	1.73E+23	0.238992	8.991497	0.000707
Puerto rico	25164.57	2.00E-07	1.58E+22	0.711428	88.59735	6.45E-05
Portugal	12961.15	6.09E-08	4.53E+22	0.366425	26.94111	0.000185
Paraguay	6015.375	2.16E-07	7.74E+20	0.170061	95.61834	3.16E-06
Reunion	7988.712	1.21E-06	4.36E+19	0.225849	535.1395	1.78E-07
Romania	4026.316	3.27E-08	1.52E+22	0.113828	14.44615	6.21E-05

	Alpha=.9			Ratio to US		
Country	Y/L	X	A	Y/L	X	TFP TO US
Rwanda	1514.97	7.03E-08	4.65E+20	0.04283	31.08249	1.90E-06
Saudi arabia	18686.76	6.29E-08	8.84E+22	0.528294	27.80428	0.000361
Sudan	2360.851	4.17E-08	3.20E+21	0.066744	18.44897	1.31E-05
Senegal	2540.603	7.10E-08	1.28E+21	0.071826	31.38235	5.24E-06
Singapore	21486.01	2.19E-07	9.61E+21	0.607432	96.95226	3.93E-05
Sierra leone	2274.882	1.14E-07	3.99E+20	0.064313	50.35114	1.63E-06
El salvador	5546.329	1.51E-07	1.36E+21	0.1568	66.6043	5.54E-06
Somalia	1723.252	9.12E-08	3.57E+20	0.048718	40.33715	1.46E-06
U.S.S.R.	14758.62	2.37E-09	3.87E+25	0.417241	1.049557	0.158038
Suriname	9045.726	2.08E-06	1.88E+19	0.255732	922.0127	7.69E-08
Sweden	27852.45	6.50E-08	1.84E+23	0.787418	28.73327	0.000751
Swaziland	5824.276	9.09E-07	4.10E+19	0.164658	402.2438	1.68E-07
Seychelles	7606.596	8.96E-06	7.21E+17	0.215046	3961.793	2.95E-09
Syria	15554.49	8.77E-08	3.14E+22	0.439741	38.80335	0.000128
Chad	1139.785	1.14E-07	9.94E+19	0.032223	50.57442	4.06E-07
Togo	1405.974	2.69E-07	2.72E+19	0.039748	119.1564	1.11E-07
Thailand	5540.07	9.76E-09	3.22E+23	0.156624	4.316071	0.001317
Trinidad&tobago	17643.03	5.98E-07	8.71E+20	0.498787	264.3718	3.56E-06
Tunisia	7696.728	1.01E-07	5.76E+21	0.217594	44.86249	2.35E-05
Turkey	7725.322	1.27E-08	3.70E+23	0.218403	5.619809	0.00151
Tanzania	1128.44	2.93E-08	1.48E+21	0.031902	12.95325	6.07E-06
Uganda	1122.692	3.01E-08	1.39E+21	0.03174	13.3325	5.67E-06
Uruguay	12018.53	2.38E-07	2.55E+21	0.339776	105.3002	1.04E-05
U.S.A.	35371.9	2.26E-09	2.45E+26	1	1	1
Venezuela	17510.68	4.43E-08	1.56E+23	0.495045	19.59473	0.000638
Yemen	7511.125	8.29E-08	8.20E+21	0.212347	36.6858	3.35E-05
Yugoslavia	10654.21	3.40E-08	9.80E+22	0.301205	15.05468	0.0004
South africa	8852.459	2.51E-08	1.25E+23	0.250268	11.09337	0.000509
Zaire	1165.414	2.00E-08	3.38E+21	0.032947	8.863294	1.38E-05
Zambia	1800.73	1.84E-07	9.56E+19	0.050909	81.43958	3.91E-07
Zimbabwe	2316.543	8.63E-08	7.20E+20	0.065491	38.18656	2.94E-06

Table A.55: Comparing Productivity Ratios with Hall and Jones and Klenow and Rodriguez-Clare.

Country	Hall and Jones	Klenow and Rodriguez-Clare	Ours(alpha=.6)
USA	1	1	1
Canada	1.034	1.05	0.01
Italy	1.207	1.04	0.02
Germany	0.912	0.79	0.03
France	1.126	1.04	0.03
UK	1.011	0.79	0.03
Hong Kong	1.115	0.88	0.004
Singapore	1.078	1.03	4.05E-05
Japan	0.658	0.63	0.1
Mexico	0.926	1.29	0.009
Argentina	0.648	0.64	0.001
U.S.S.R	0.468	NA	0.15
India	0.267	0.2	0.02
China	0.106	NA	0.03
Kenya	0.165	0.15	9.65E-06
Zaire	0.16	0.14	6.54E-06

Table A.56: TFP Decomposition.Complete Data (127 Countries).

Alpha	Variance (ln A)	Variance (ln X)	Covariance (X,A)	Variance [ln(Y/L)]
α=.1	19.678	3.027	-6.786	4.553
α=.3	18.937	2.999	-6.573	4.446
α=.6	18.067	2.981	-6.337	4.329
α=.9	17.063	2.987	-6.092	4.206

Alpha	*A1*	*X1*	*AX*
α=.1	1.080378	0.664763	-0.74514
α=.3	1.064654	0.674425	-0.73908
α=.6	1.043310	0.688572	-0.73188
α=.9	1.014025	0.710049	-0.72407

Note:

1) $Variance\left[\ln\left(\frac{Y}{L}\right)\right] = \frac{1}{4}Var(\ln A) + Var(\ln X) + \frac{1}{2}CoVar(\ln A, \ln X)$

2) $X = \frac{1}{L}\left[\alpha\left(\frac{K}{Y}\right)^{-\rho} + (1-\alpha)\left(\frac{hL}{Y}\right)^{-\rho}\right]^{-\frac{1}{2\rho}}$

3) $A1 = \frac{1}{4}\frac{Var(\ln A)}{Var[\ln(Y/L)]}$

4) $X1 = \frac{Var(\ln X)}{Var[\ln(Y/L)]}$

5) $AX = \frac{1}{2}\frac{CoVar(\ln A, \ln X)}{Var[\ln(Y/L)]}$

6) A1+X1+AX=1

Table A.57: TFP Decomposition. Sorted by K/hL ratio.

	Variance (ln A)	Variance (ln X)	Covariance (X,A)	Variance [ln(Y/L)]
α=.1	12.563	3.034	-5.8743	3.238
α=.3	12.546	3.034	-5.870	3.235
α=.6	12.527	3.034	-5.865	3.233
α=.9	12.504	3.035	-5.861	3.231

Alpha	A1	X1	AX
α=.1	0.96991898	0.93713658	-0.907056
α=.3	0.96929882	0.93774225	-0.907041
α=.6	0.96851002	0.9385153	-0.907025
α=.9	0.96749083	0.9395186	-0.907009

	Variance (ln A)	Variance (ln X)	Covariance (X,A)	Variance [ln(Y/L)]
α=.1	1.932	0.487	-0.866	0.537
α=.3	1.931	0.485	-0.864	0.535
α=.6	1.939	0.484	-0.865	0.536
α=.9	1.963	0.488	-0.874	0.541

Alpha	A1	X1	AX
α=.1	0.89980651	0.90686278	-0.806669
α=.3	0.90126799	0.90521489	-0.806483
α=.6	0.90331444	0.9032949	-0.806609
α=.9	0.90622077	0.90114289	-0.807364

Appendix B

Graphs

Figure B.1: U.S. Production Function. 1890-1992.

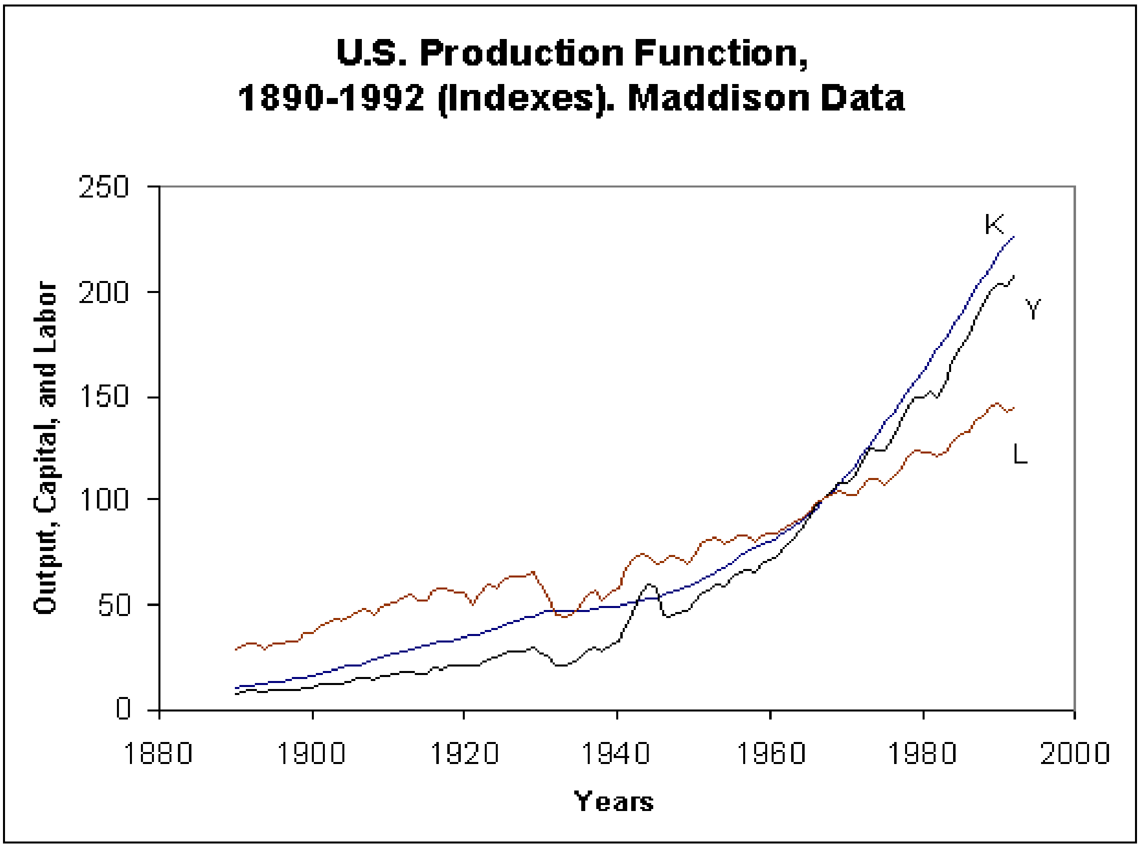

Figure B.2: U.S. Production Function. 1929-2000.

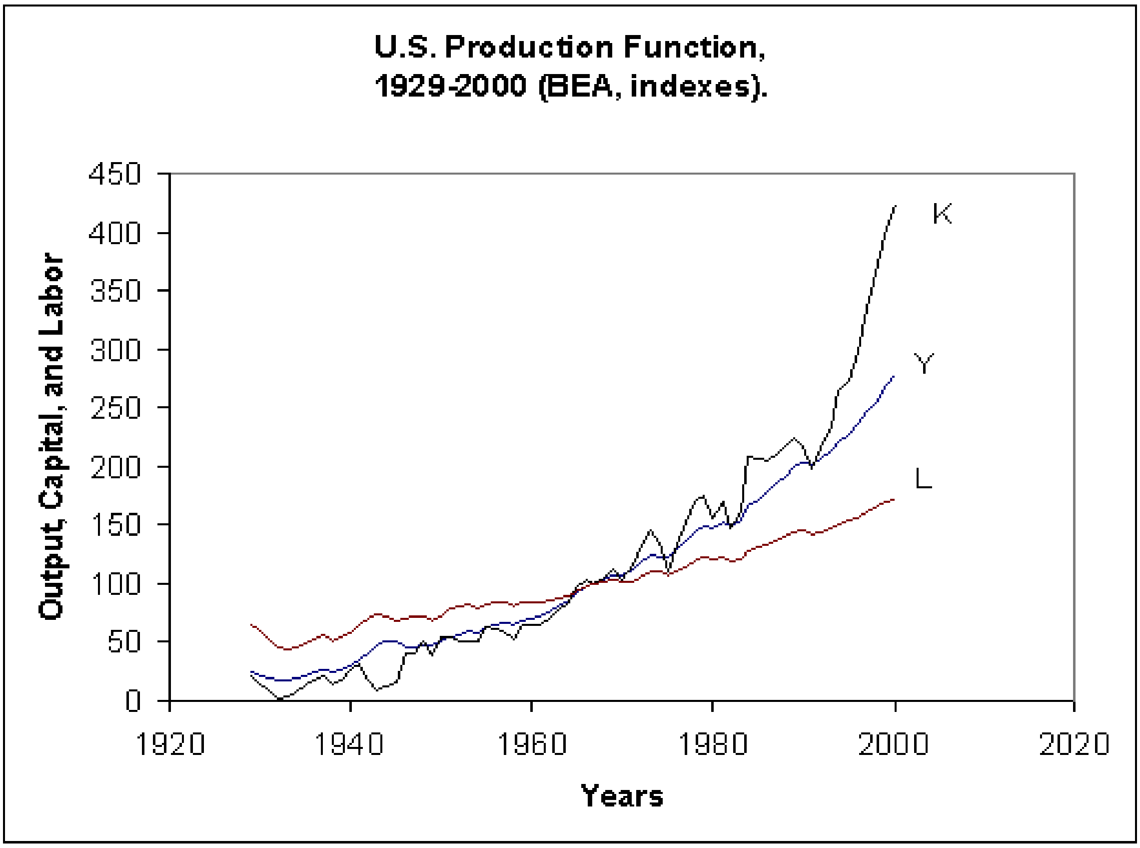

Figure B.3: U.K. Production Function. 1870-1991.

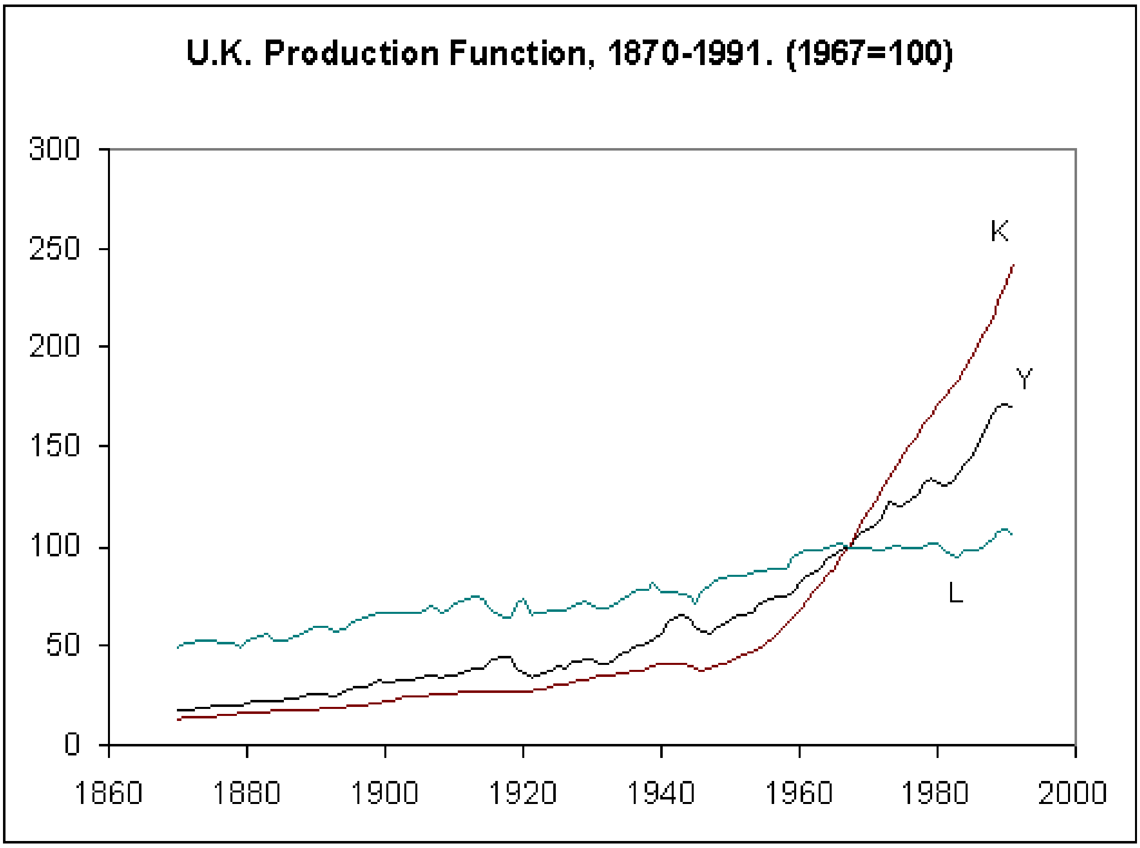

Figure B.4: Japan Production Function. 1890-1991.

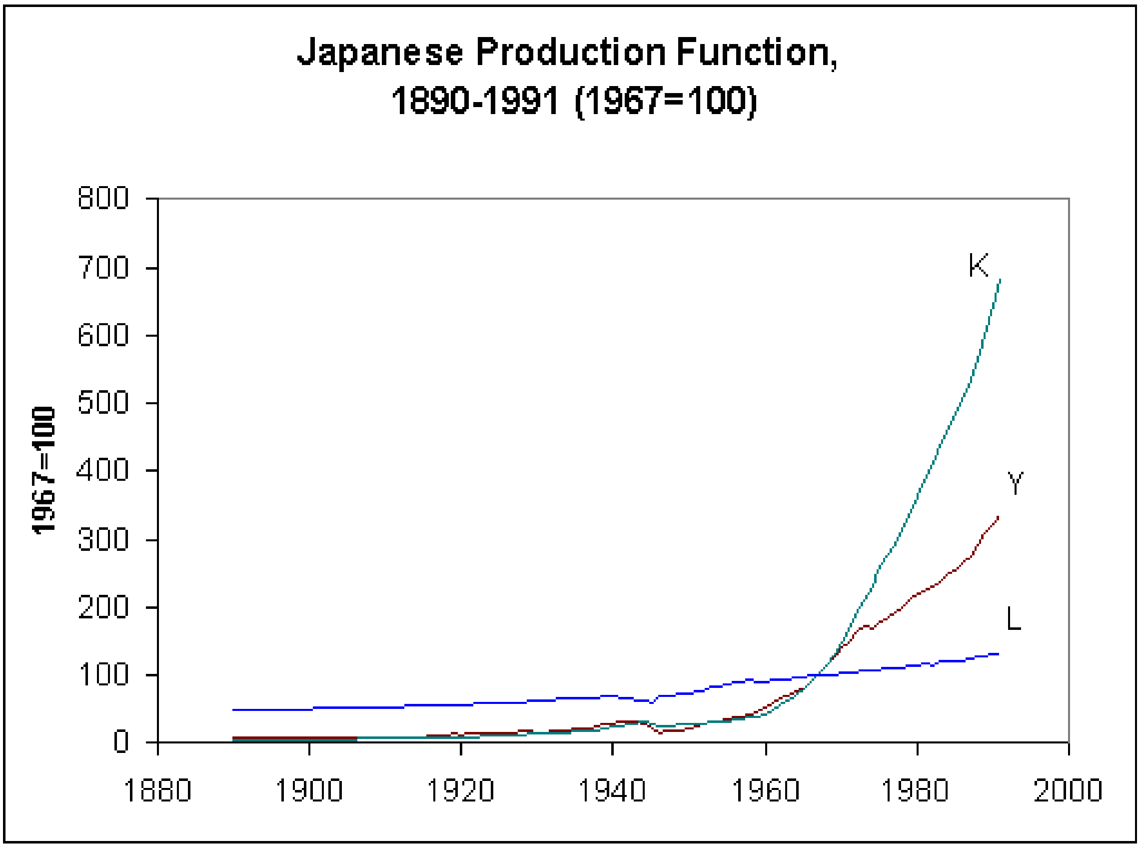

Figure B.5: Chow Test.Japan, Restricted Model.

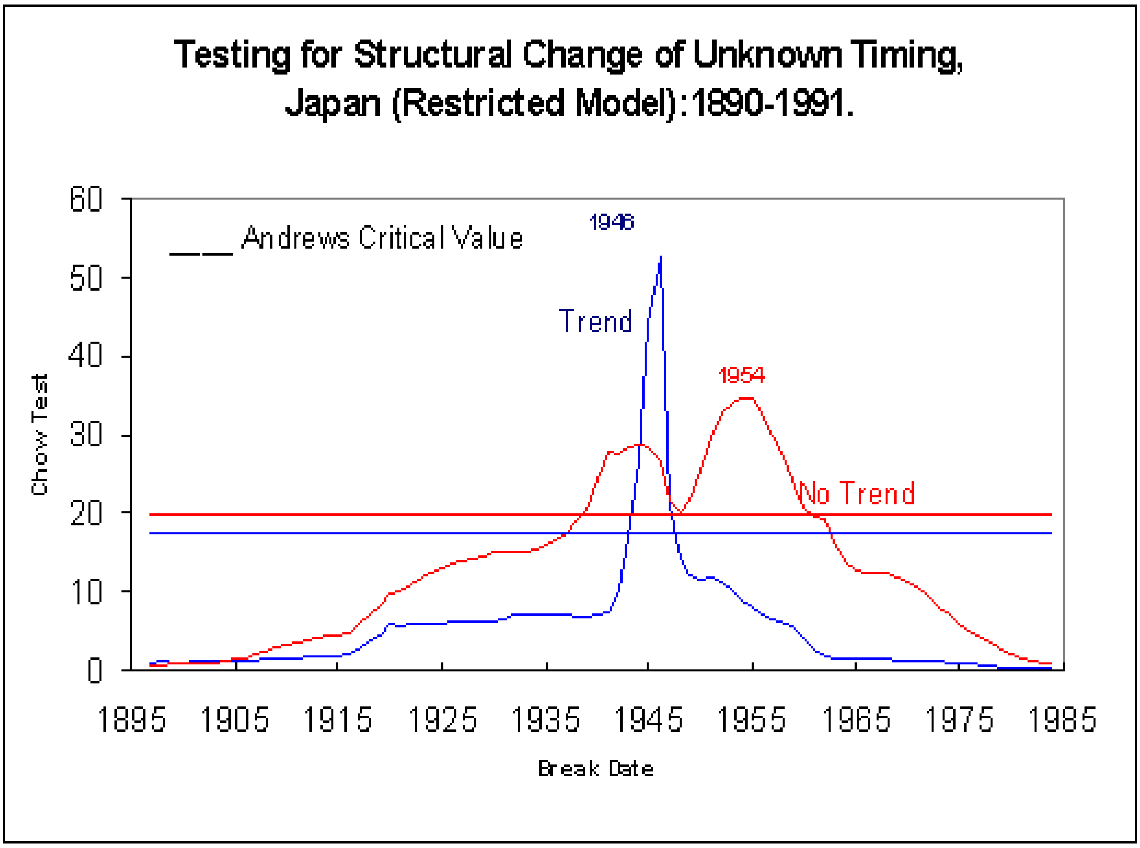

Figure B.6: Chow Test.USA, Restricted Model. 1890-1992.

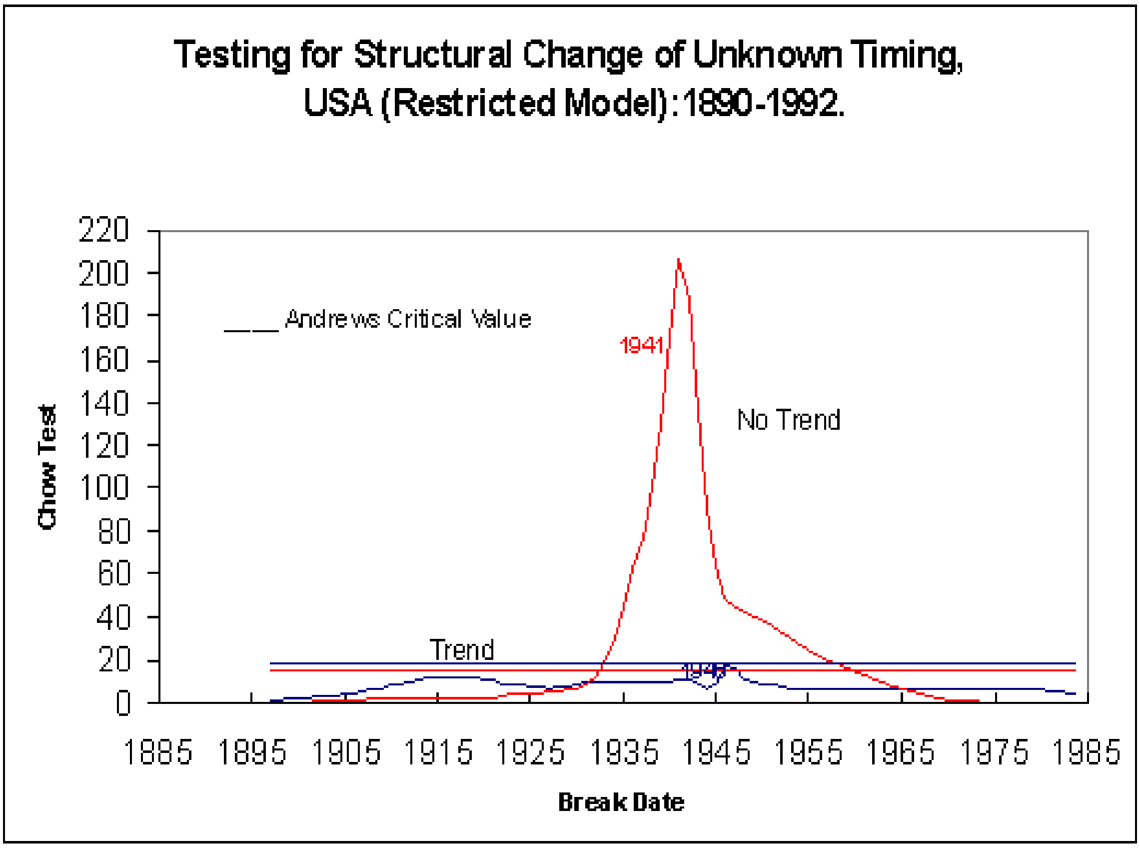

Figure B.7: Chow Test.USA, Restricted Model.1929-2000.

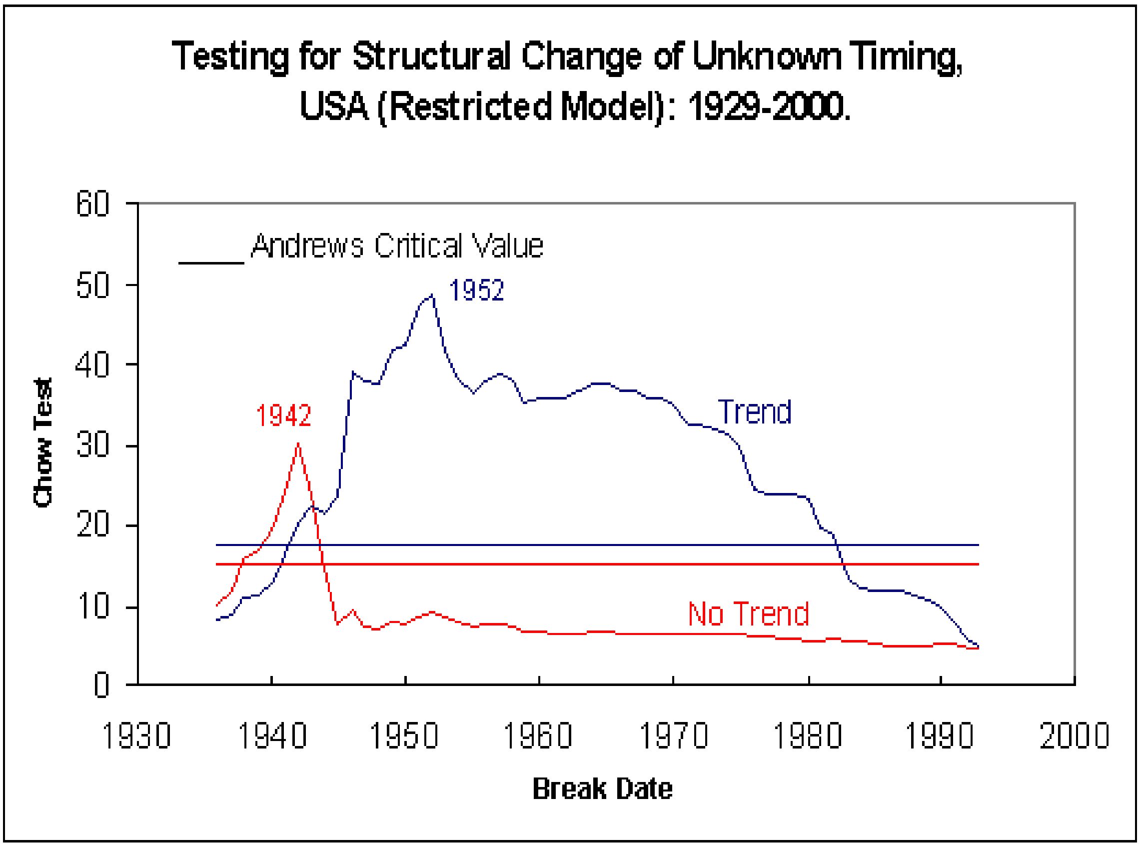

Figure B.8: Chow Test.UK, Restricted Model.

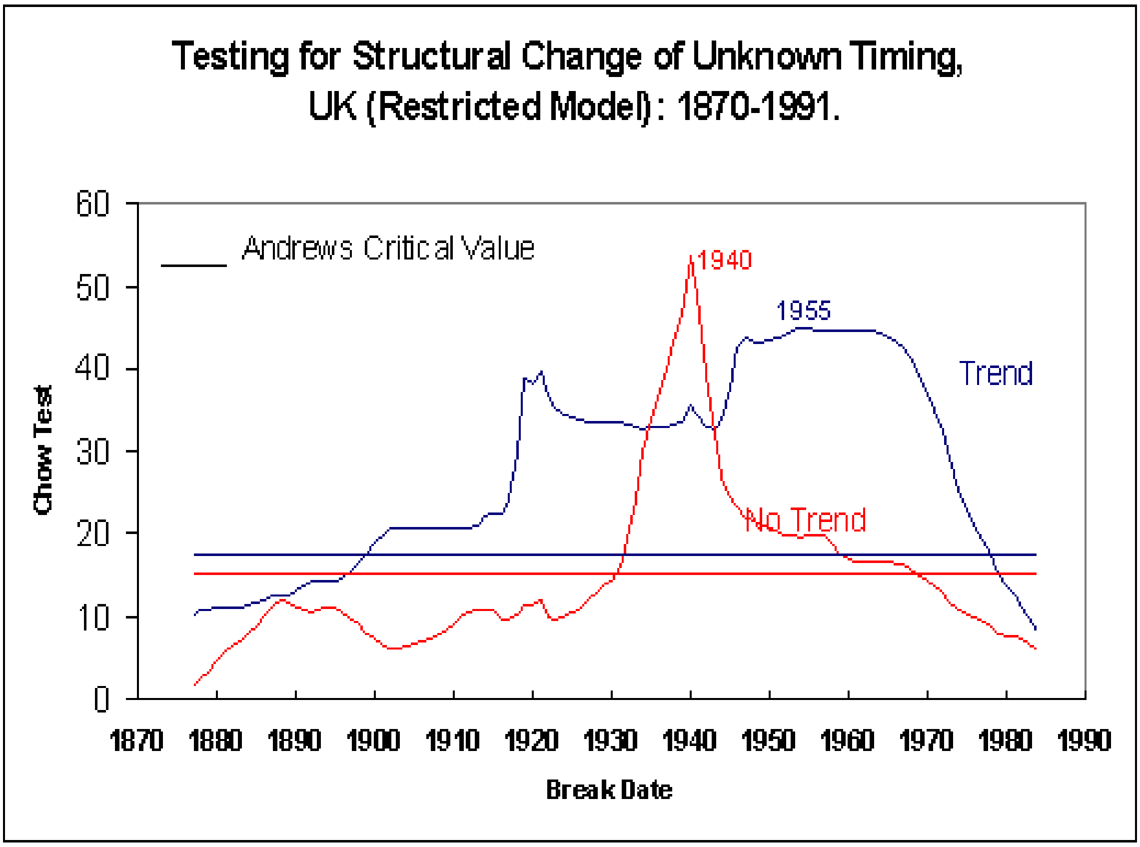

Figure B.9: Chow Test.Japan, Unrestricted Model.

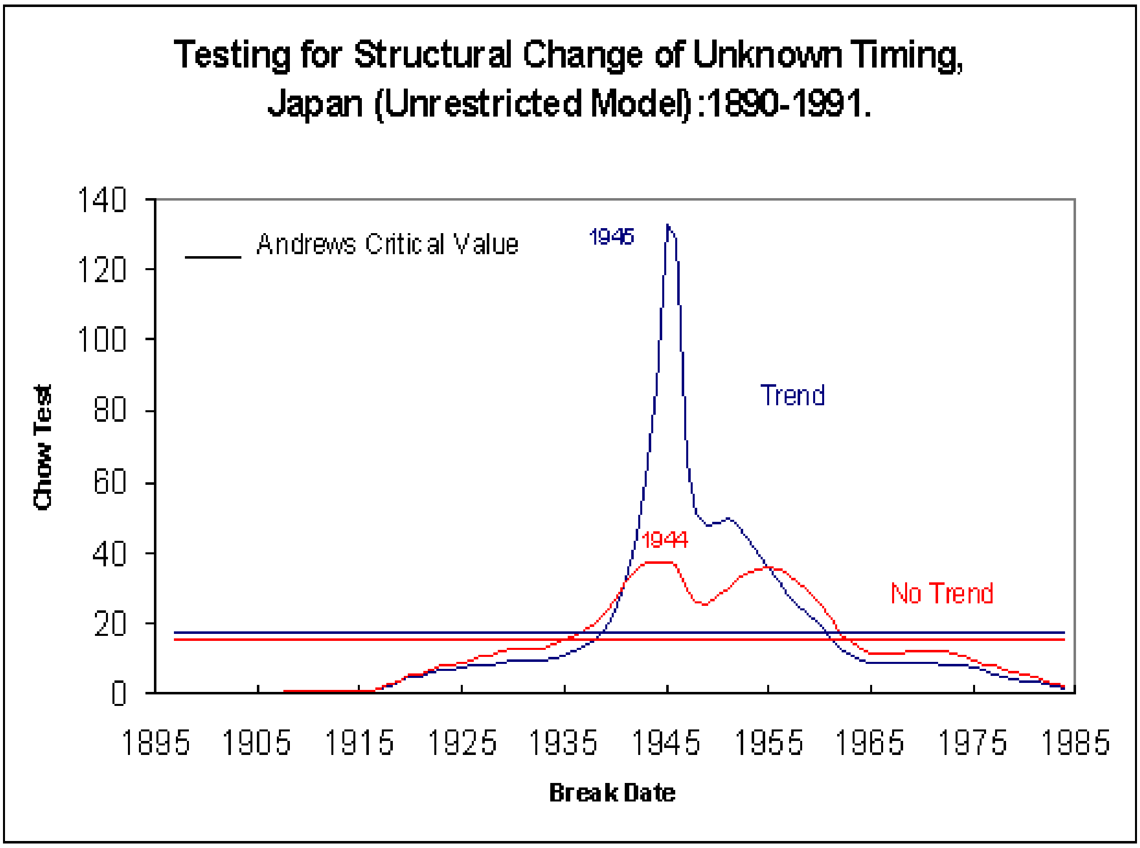

Figure B.10: Chow Test.USA, Unrestricted Model. 1890-1992.

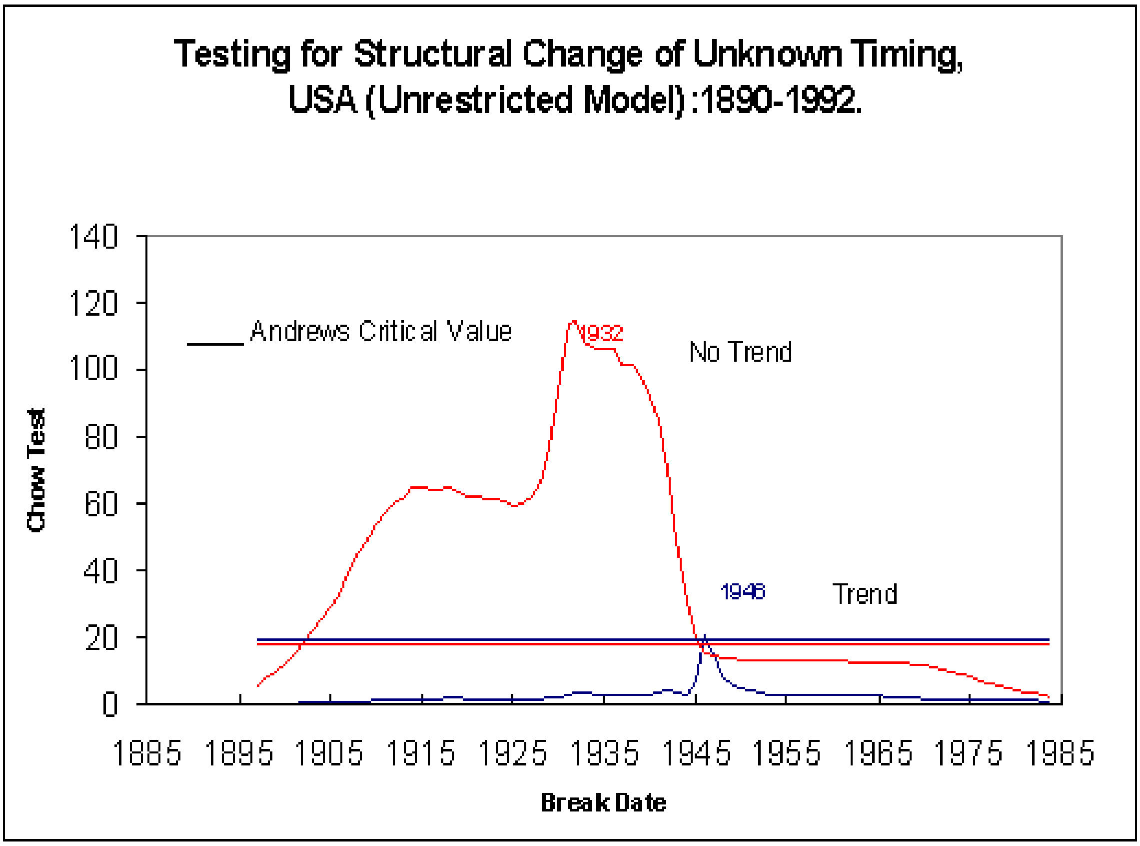

Figure B.11: Chow Test.USA, Unrestricted Model. 1929-2000.

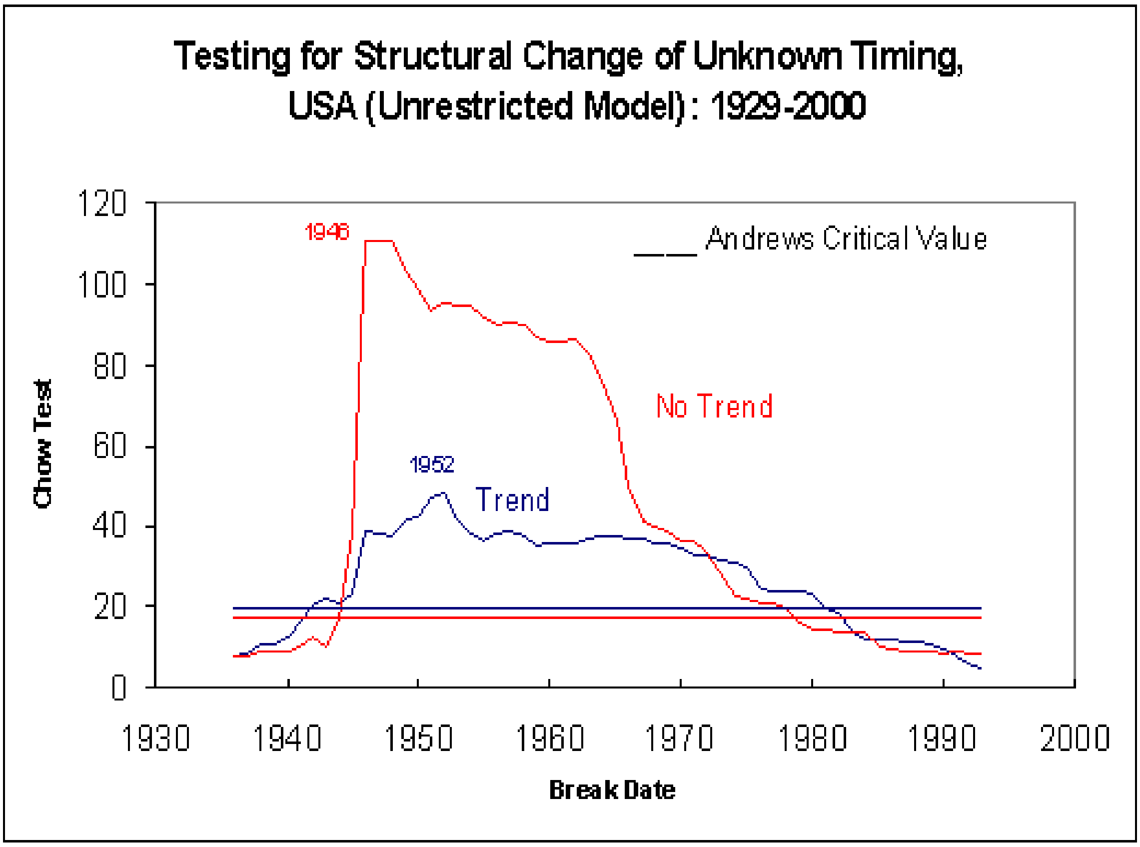

Figure B.12: Chow Test.UK, Unrestricted Model.

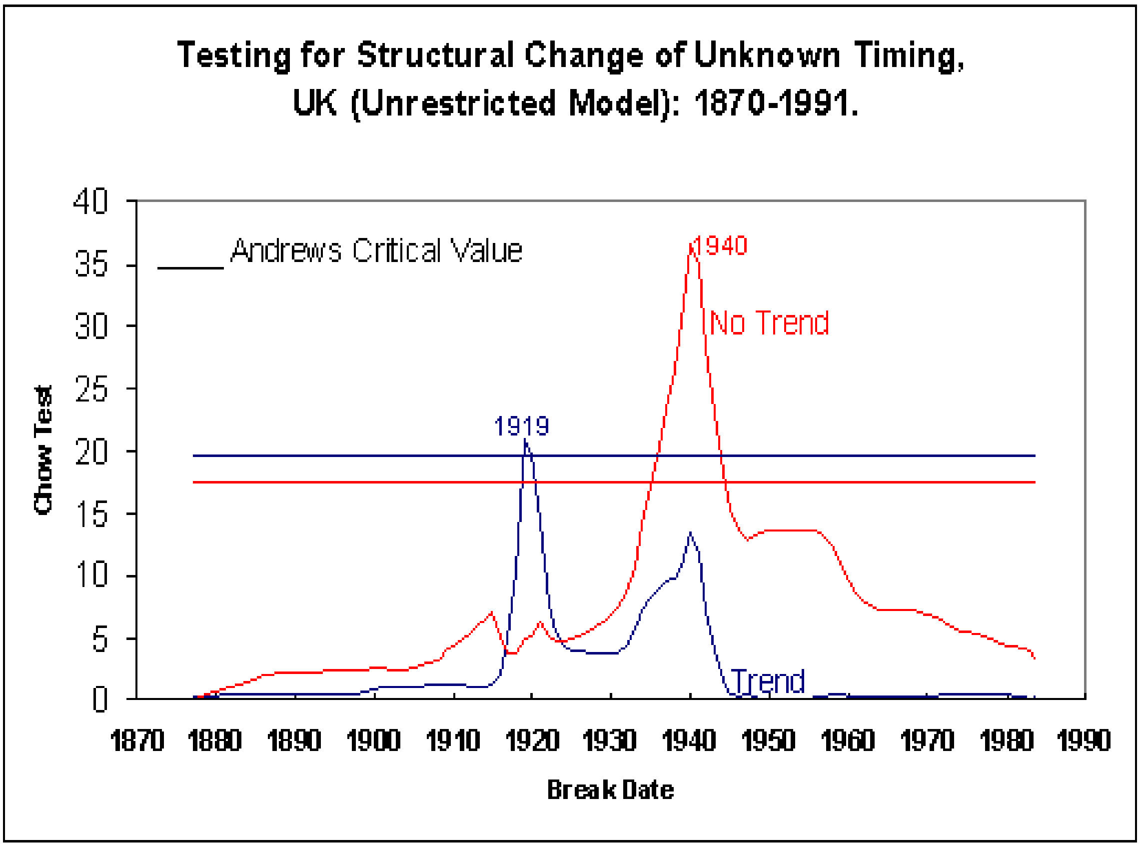

Figure B.13: Elasticity of Substitution (CES) with breaking points. USA, 1890-1992.

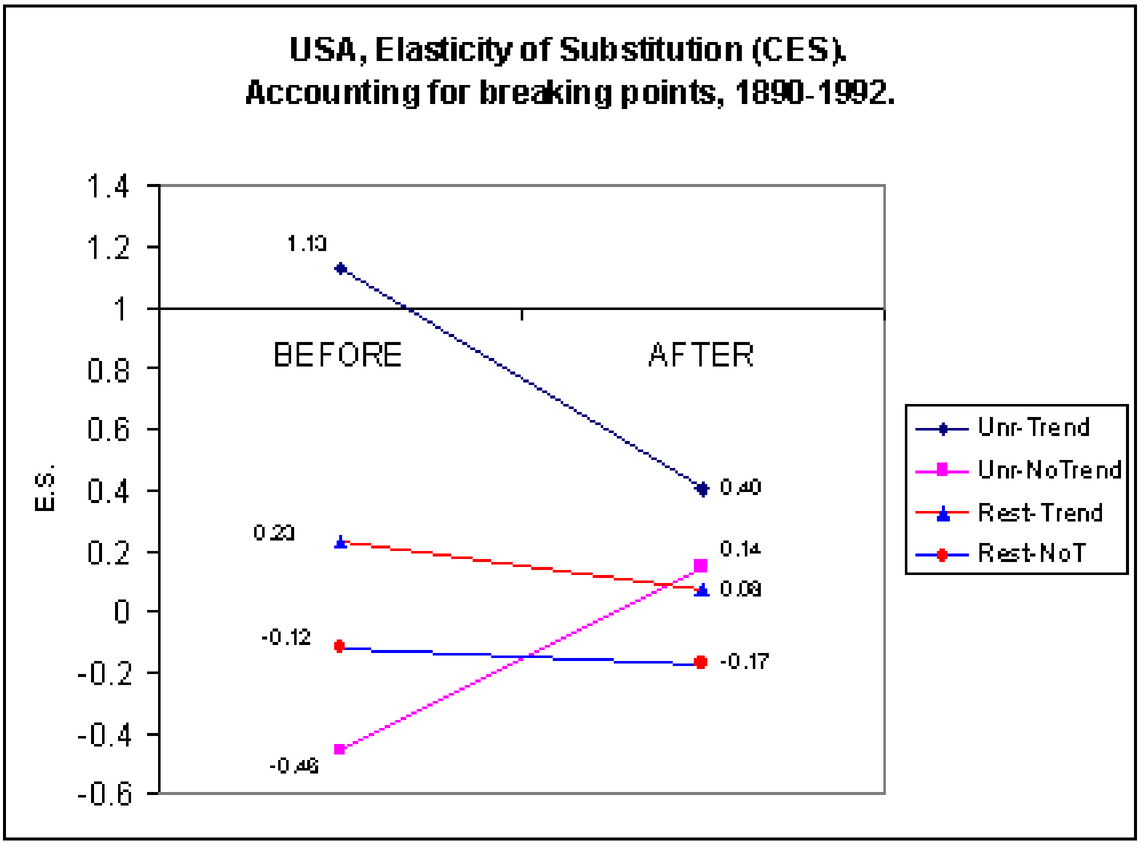

Figure B.14: Elasticity of Substitution (CES). Excluding WWII USA, 1890-1992.

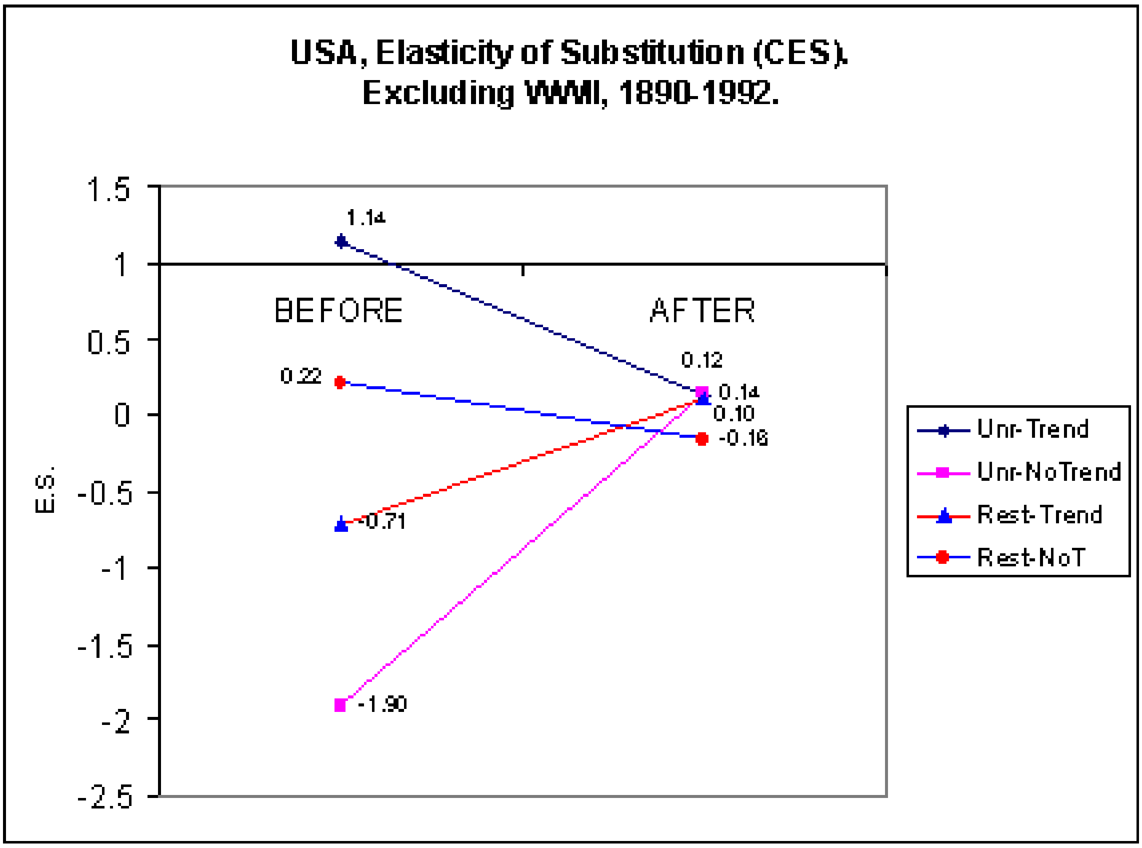

Figure B.15: Elasticity of Substitution (VES). Excluding WWII USA, 1890-1992.

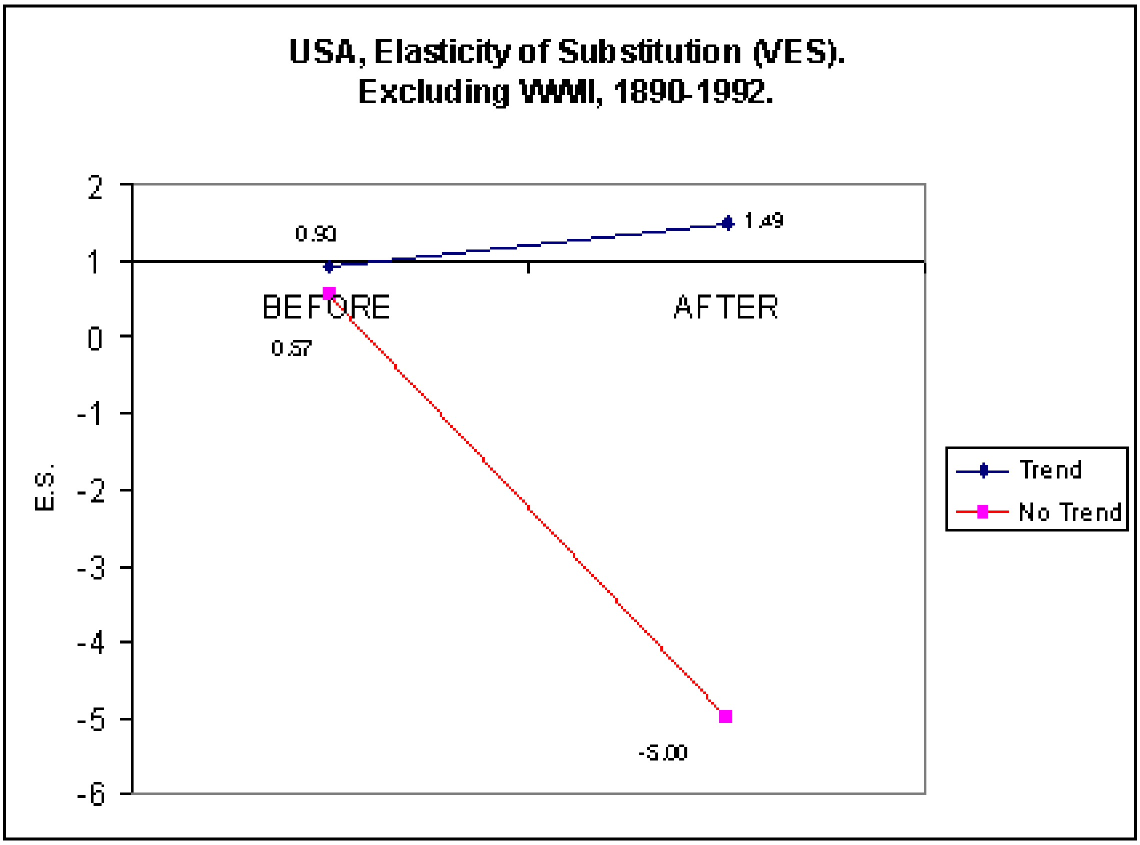

Figure B.16: Elasticity of Substitution (CES) with breaking points. USA, 1929-2000.

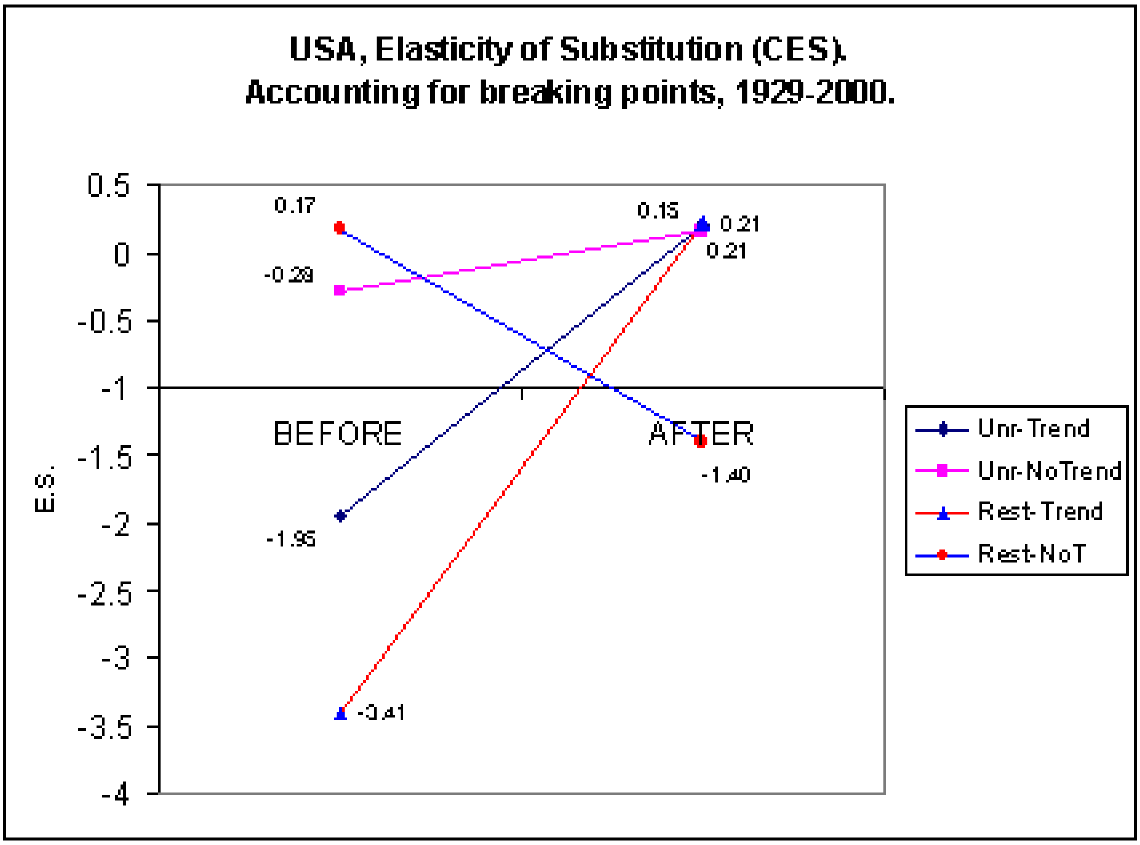

Figure B.17: Elasticity of Substitution (CES) with breaking points. UK, 1870-1991.

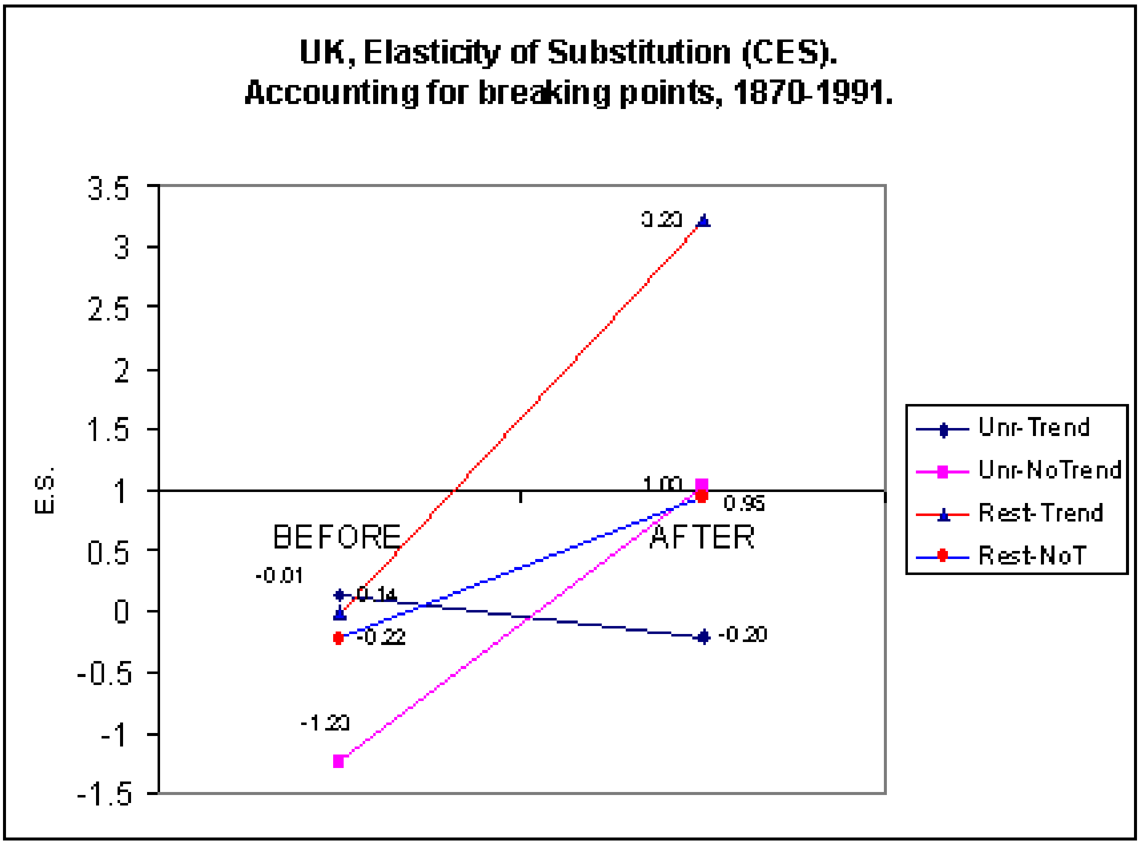

Figure B.18: Elasticity of Substitution (CES). Excluding WWII UK, 1870-1991.

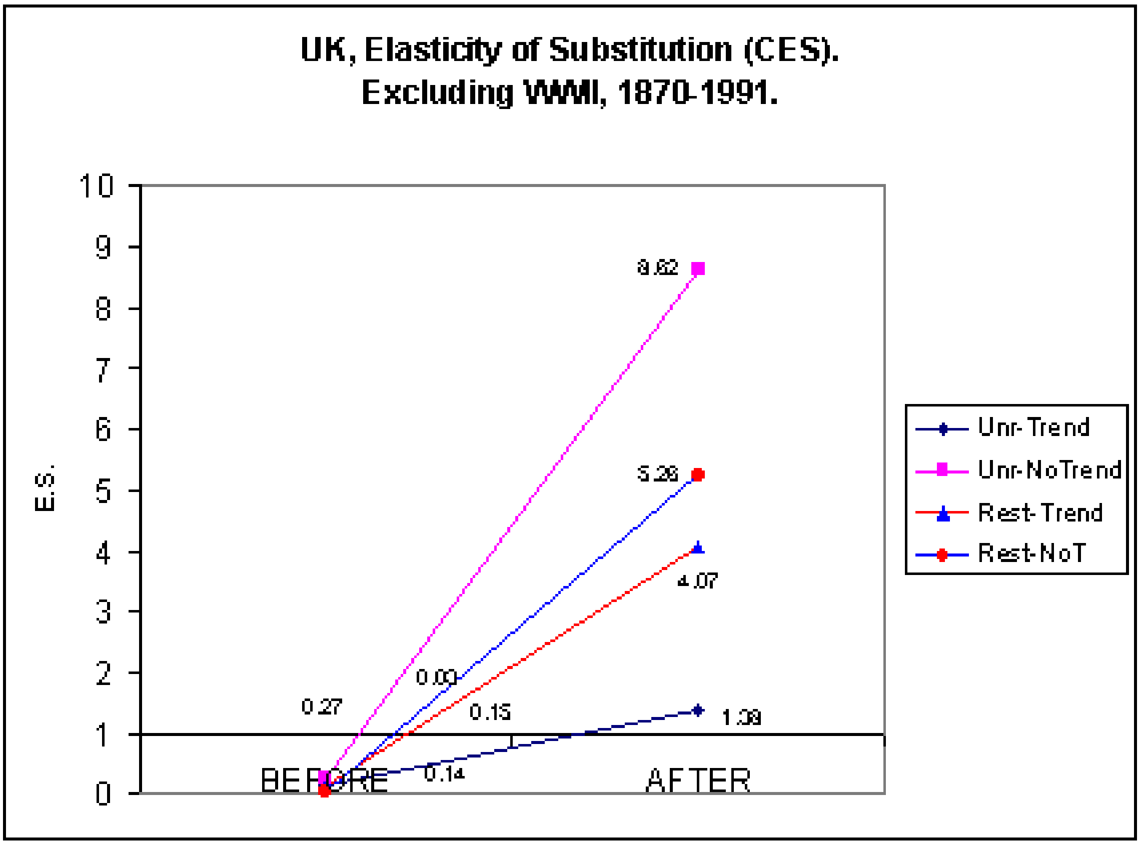

Figure B.19: Elasticity of Substitution (VES). Excluding WWII UK, 1870-1991.

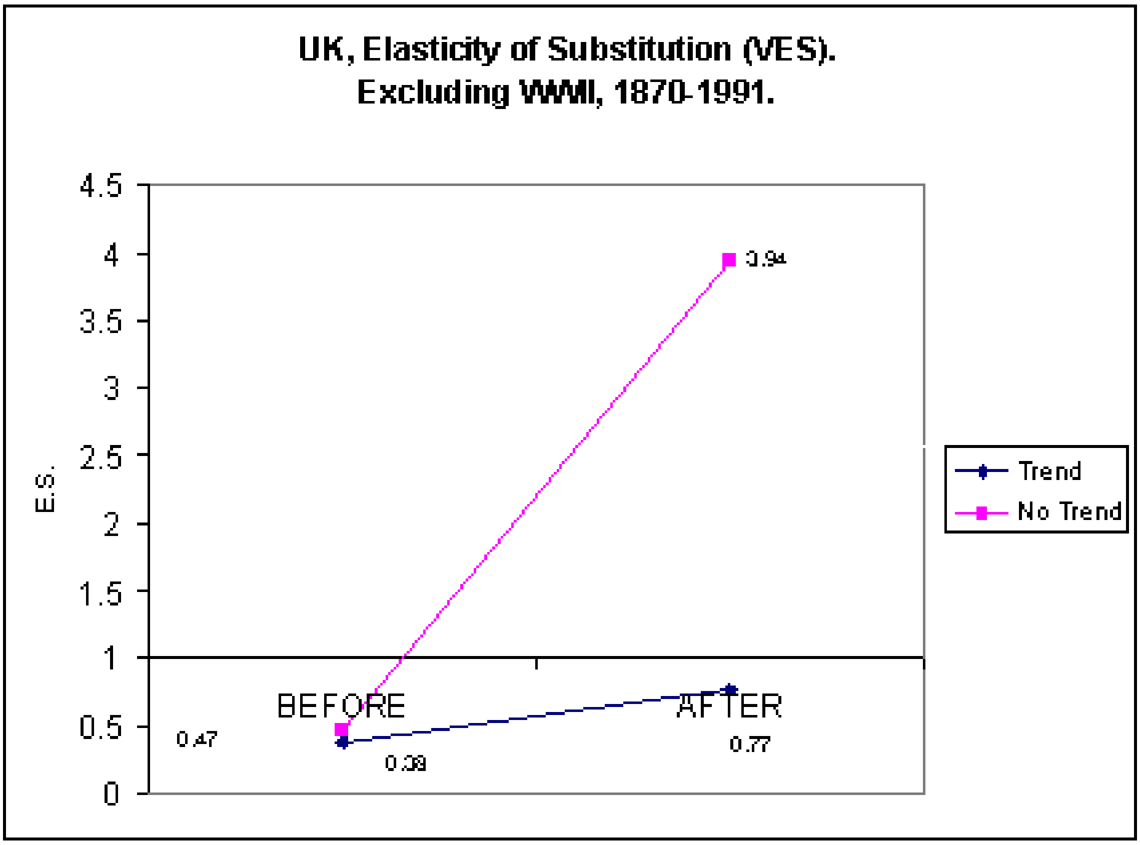

Figure B.20: Elasticity of Substitution (CES) with breaking points. Japan, 1890-1991.

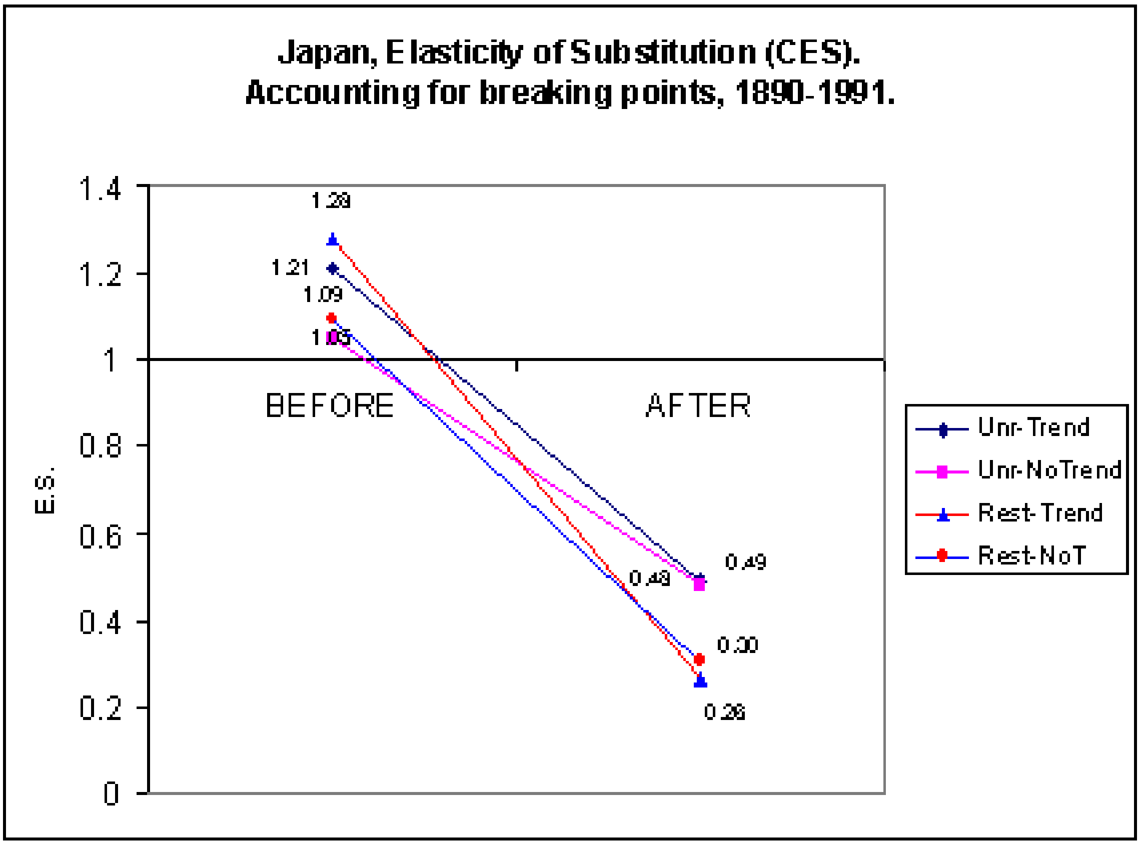

Figure B.21: Elasticity of Substitution (CES). Excluding WWII Japan, 1890-1991.

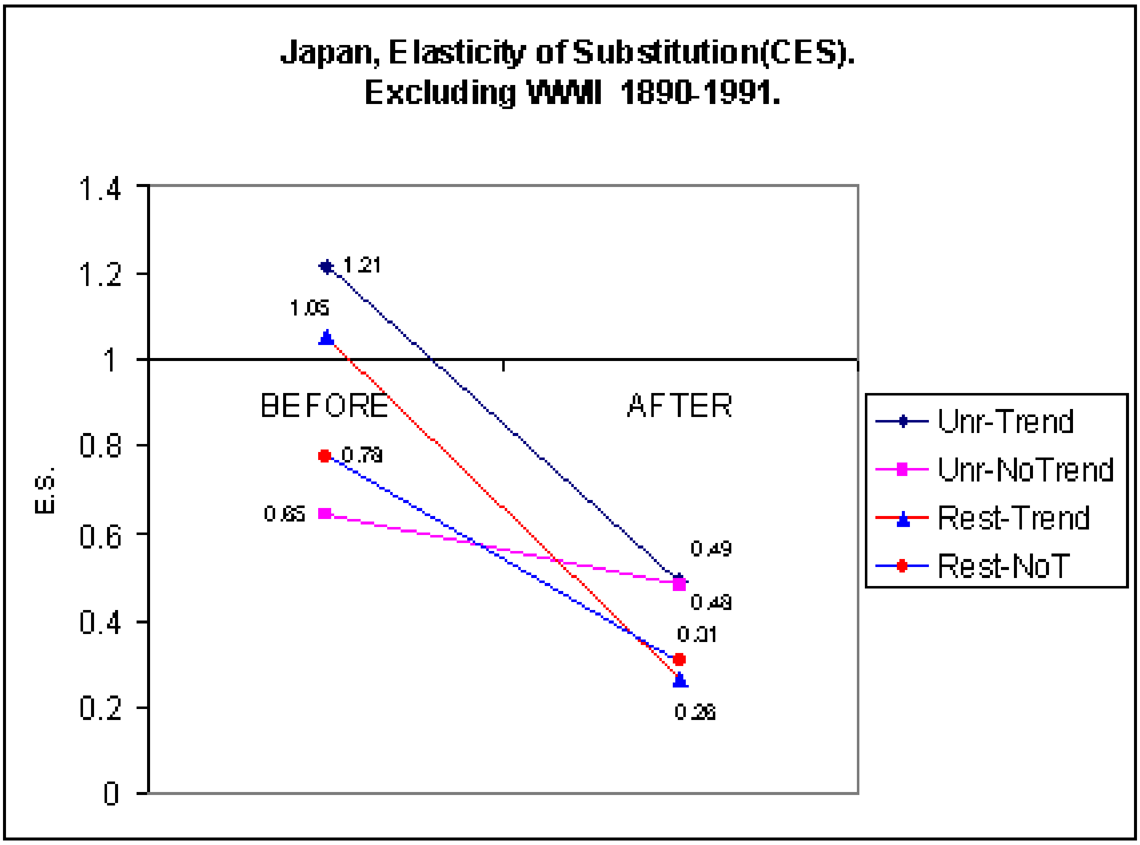

Figure B.22: Elasticity of Substitution (VES). Excluding WWII UK, 1890-1991.

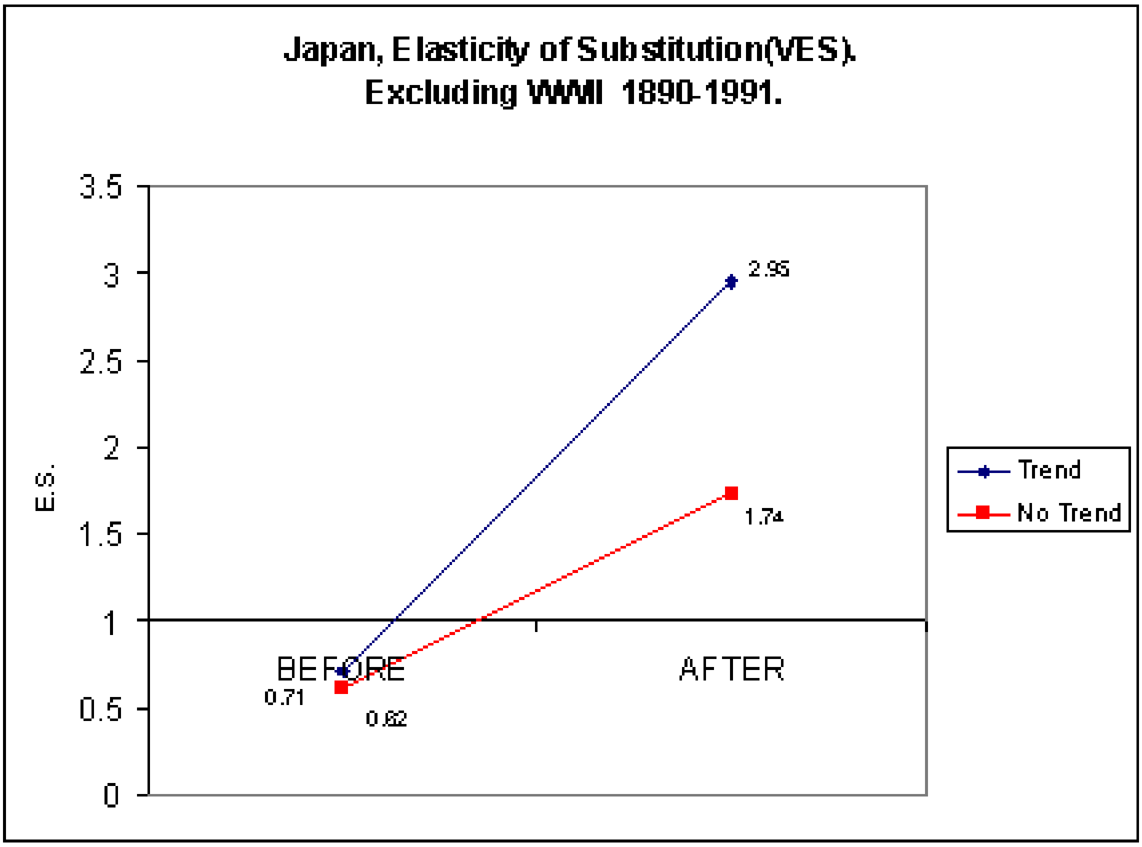

Figure B.23: Elasticity of Substitution (VES). Excluding WWII USA,UK,and Japan.

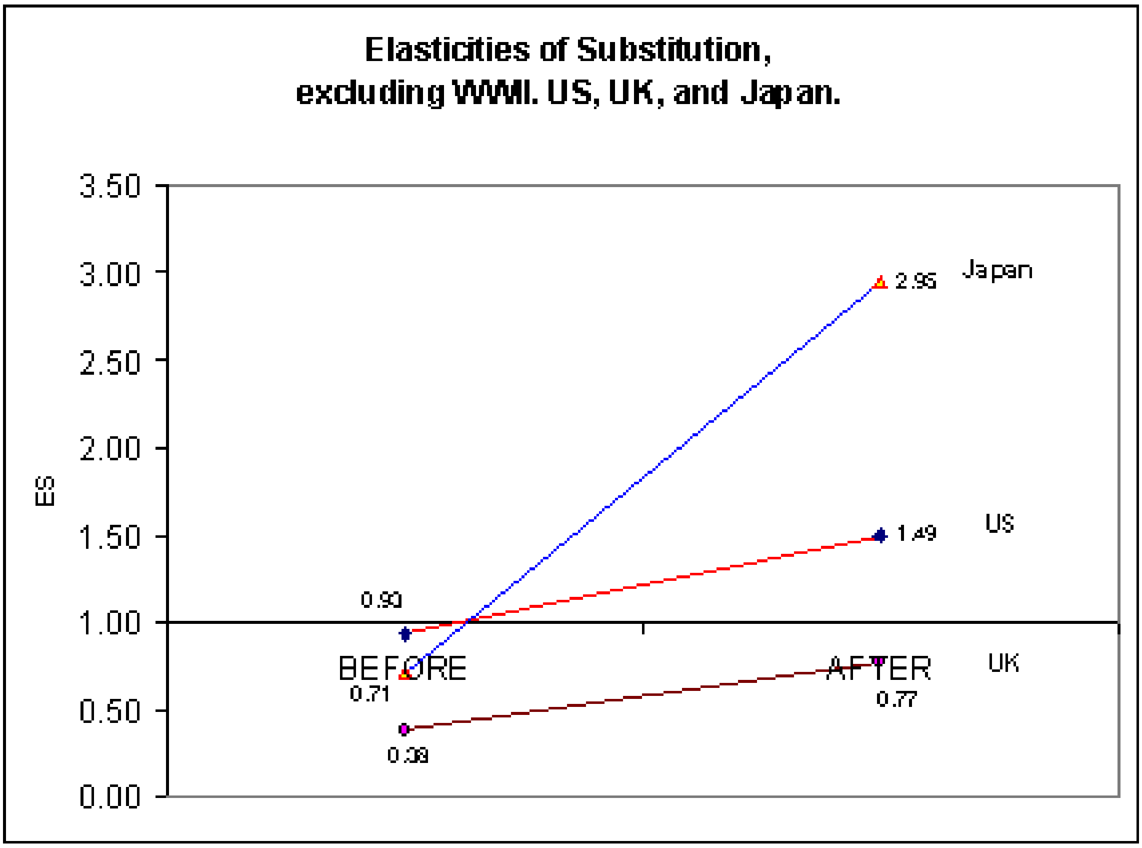

Figure B.24: Behavior of the estimators over time.

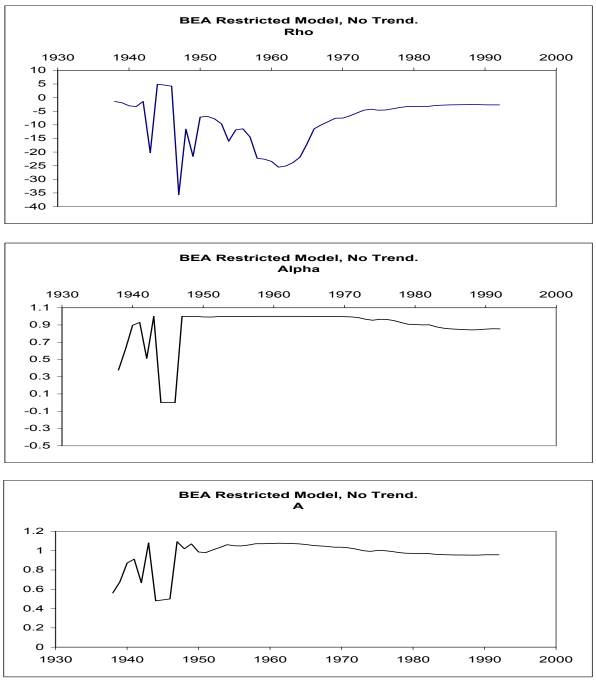

Figure B.25: Elasticity of Substitution and Capital-Intensity. China.

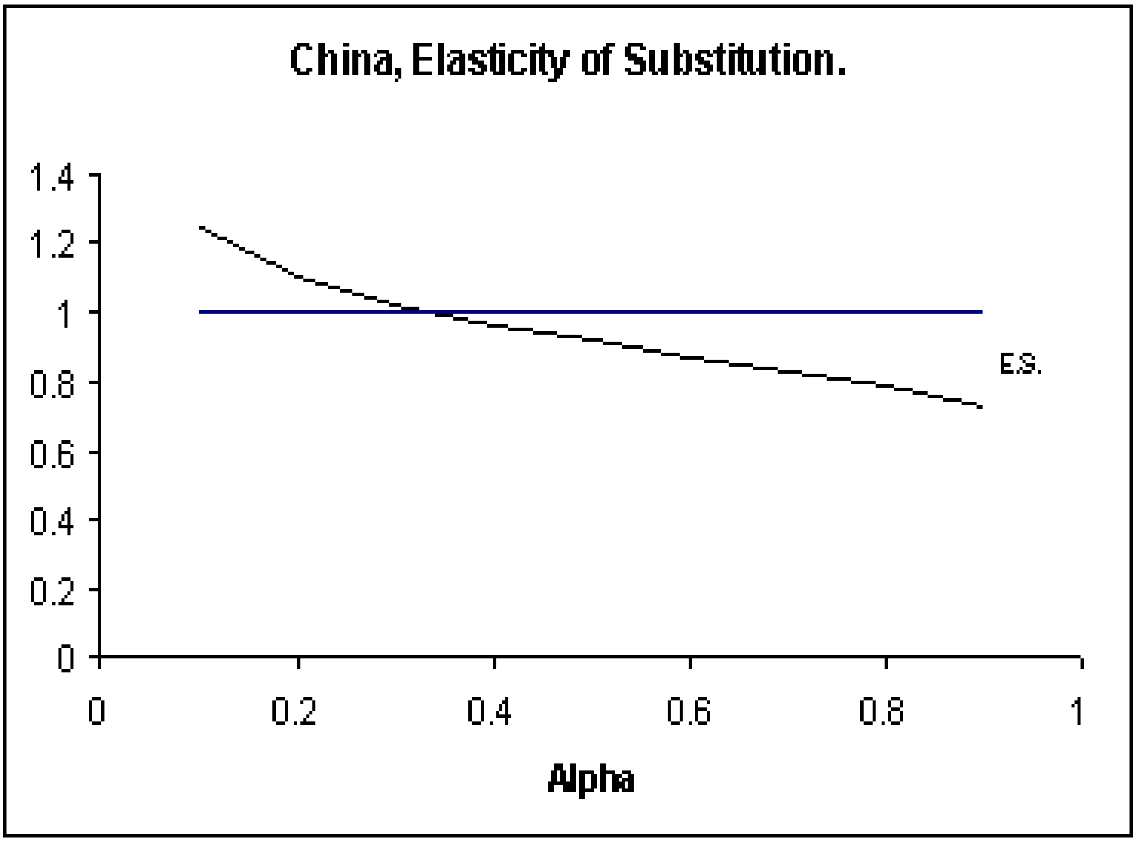

Figure B.26: Elasticity of Substitution and Capital-Intensity. Zaire.

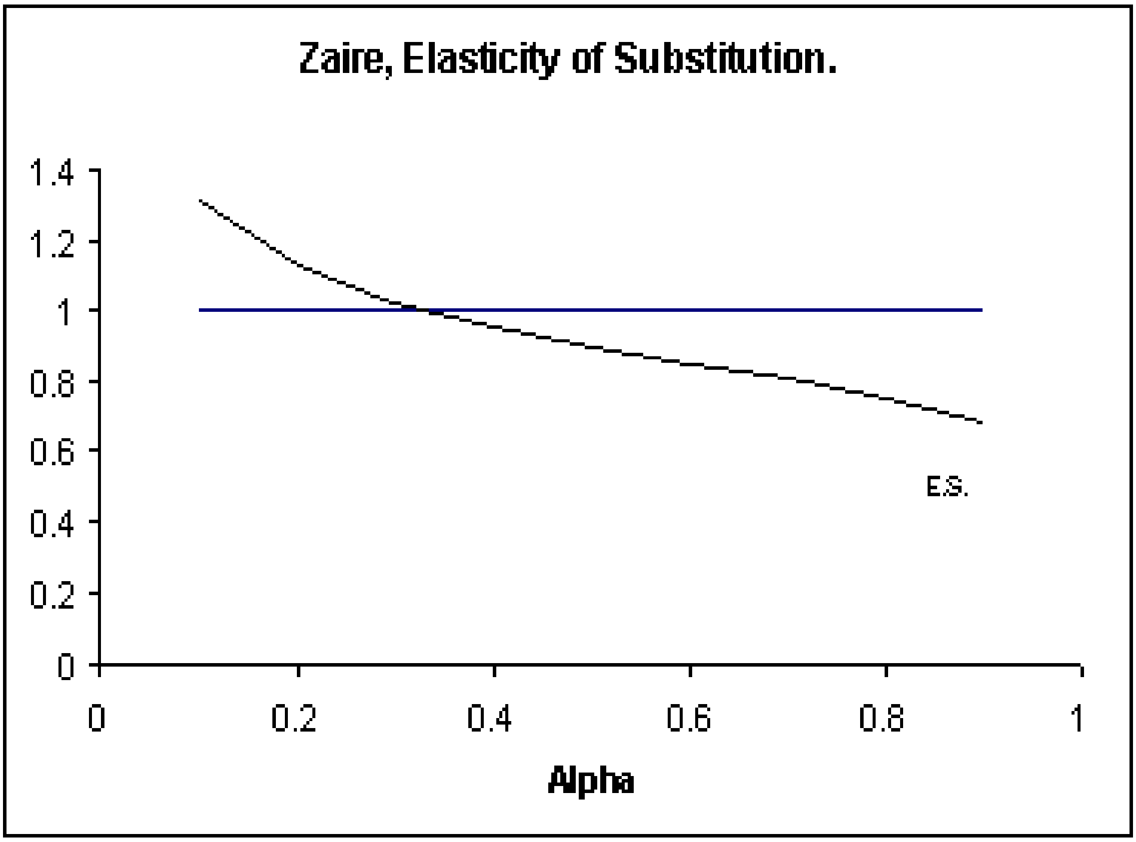

Figure B.27: Elasticity of Substitution and Capital-Intensity. Italy.

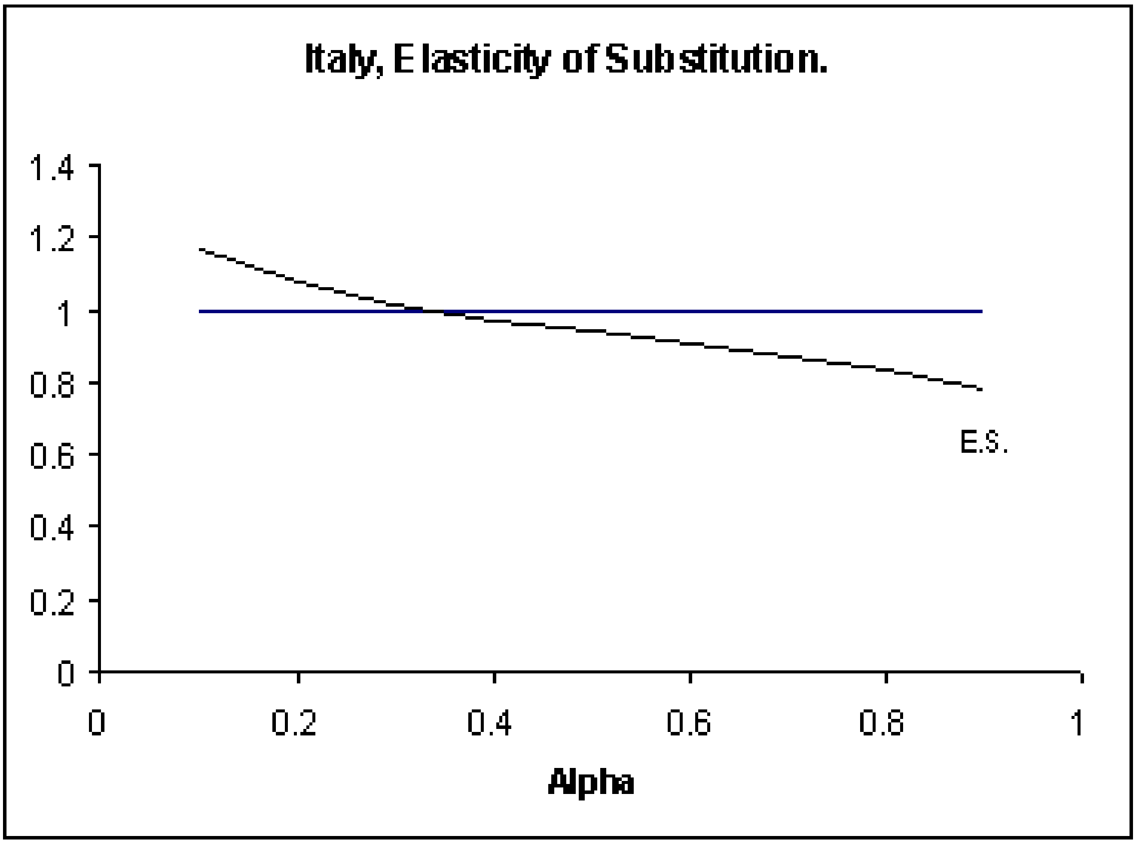

Figure B.28: Elasticity of Substitution and Capital-Intensity. USA.

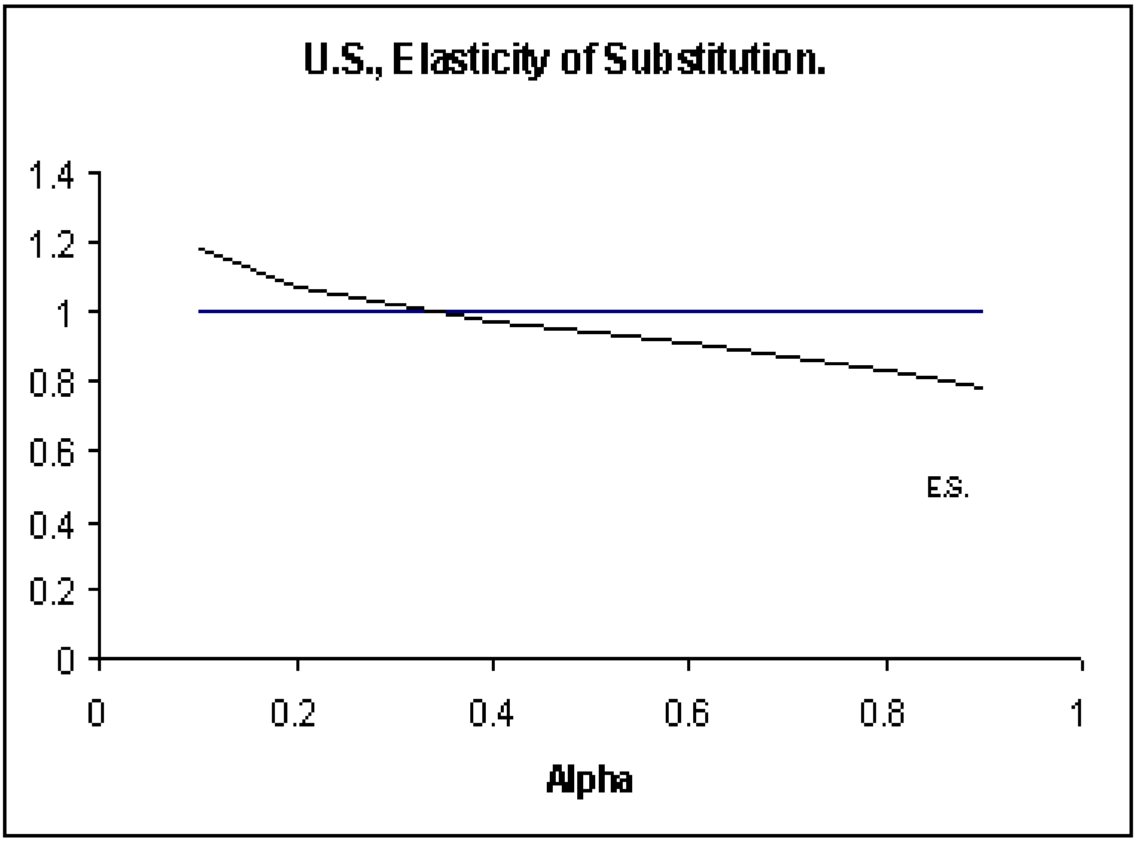

Figure B.29: Elasticity of Substitution and Income per Worker.

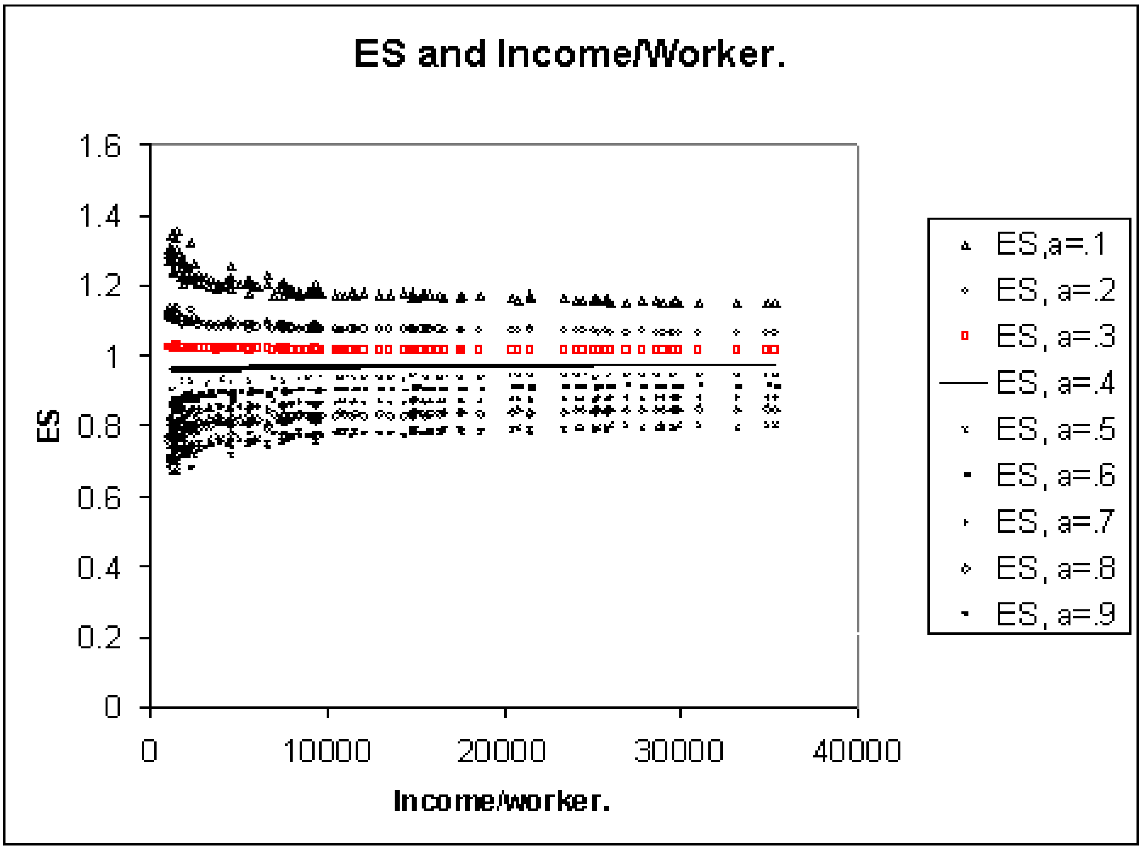

Figure B.30: Elasticity of Substitution and Income per Worker.$\alpha = .2$.

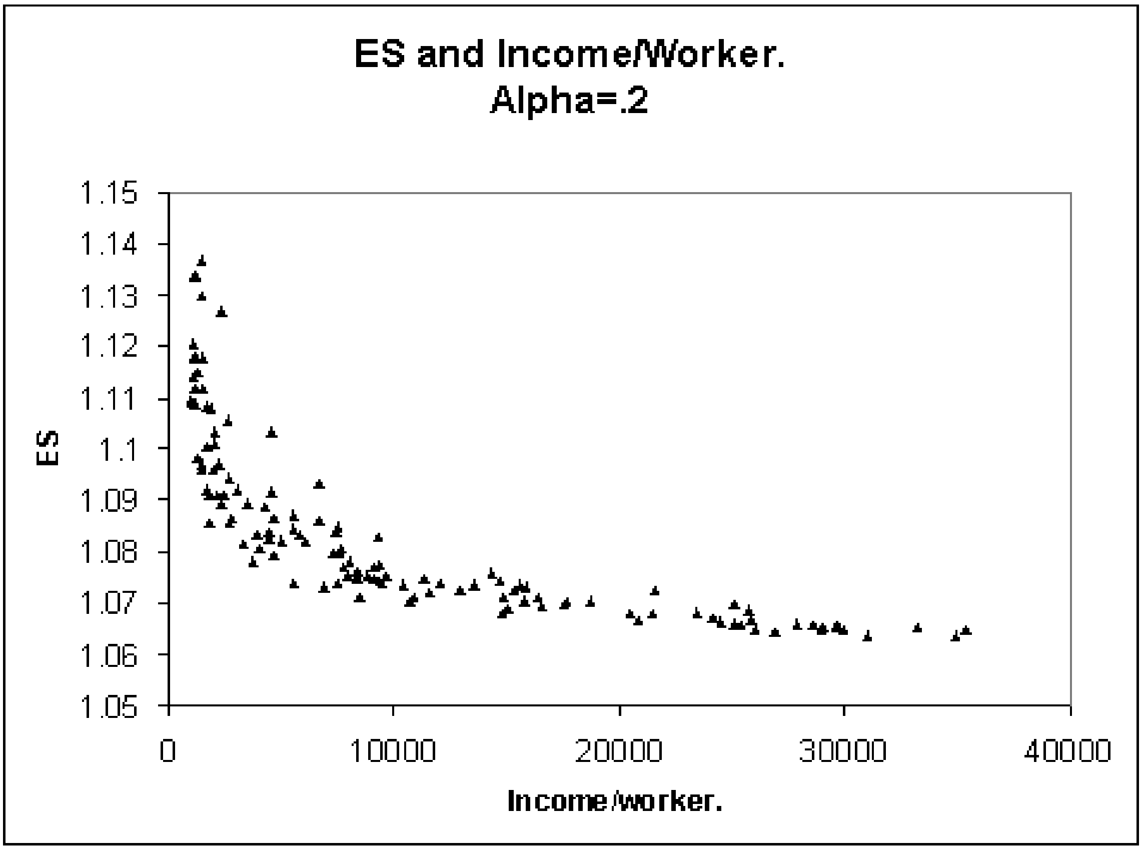

Figure B.31: Elasticity of Substitution and Income per Worker.$\alpha = .3$.

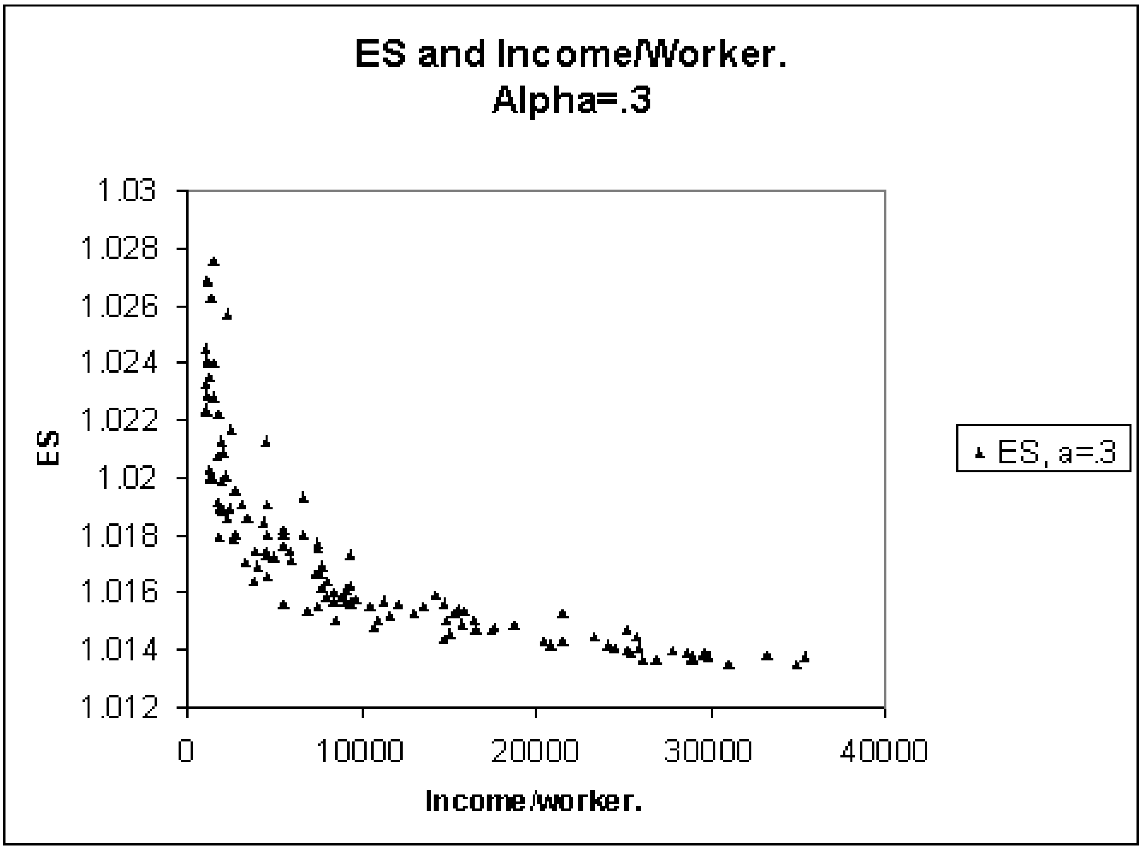

Figure B.32: Elasticity of Substitution and Income per Worker.$\alpha = .6$.

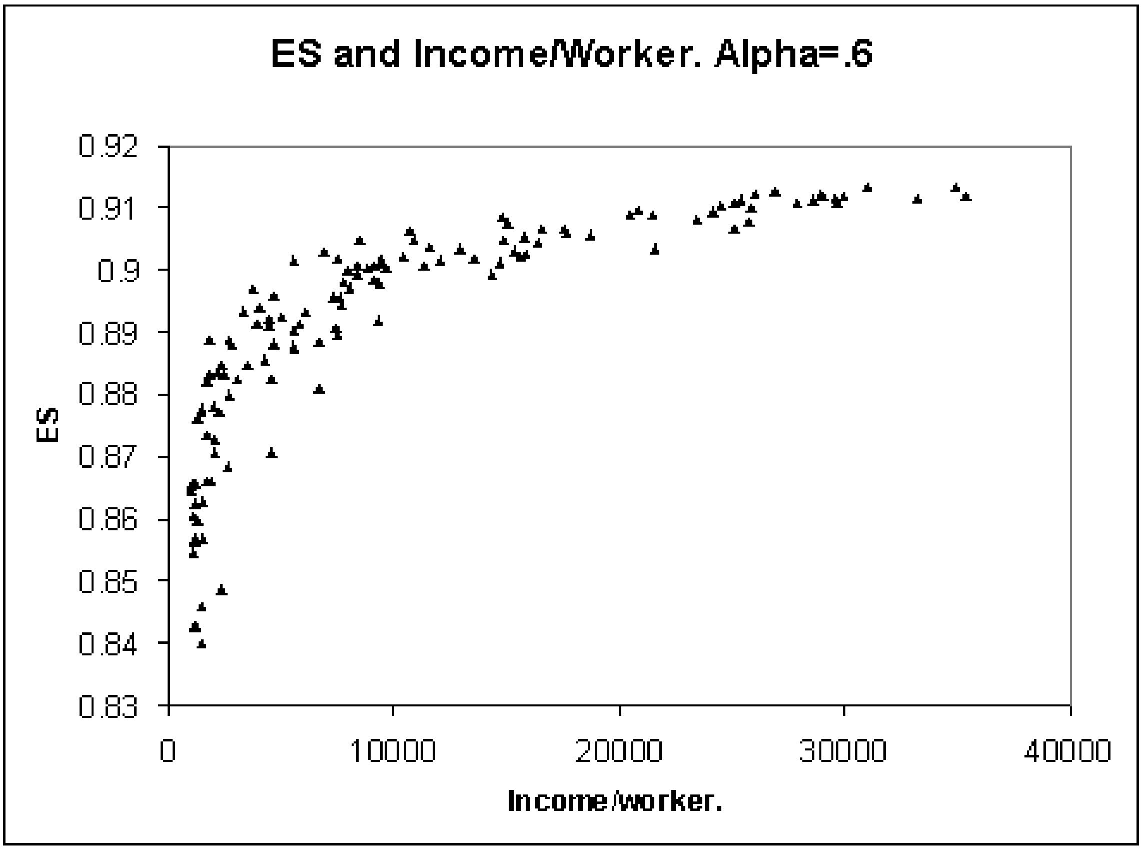

Figure B.33: Elasticity of Substitution and Income per Worker.$\alpha = .9$.

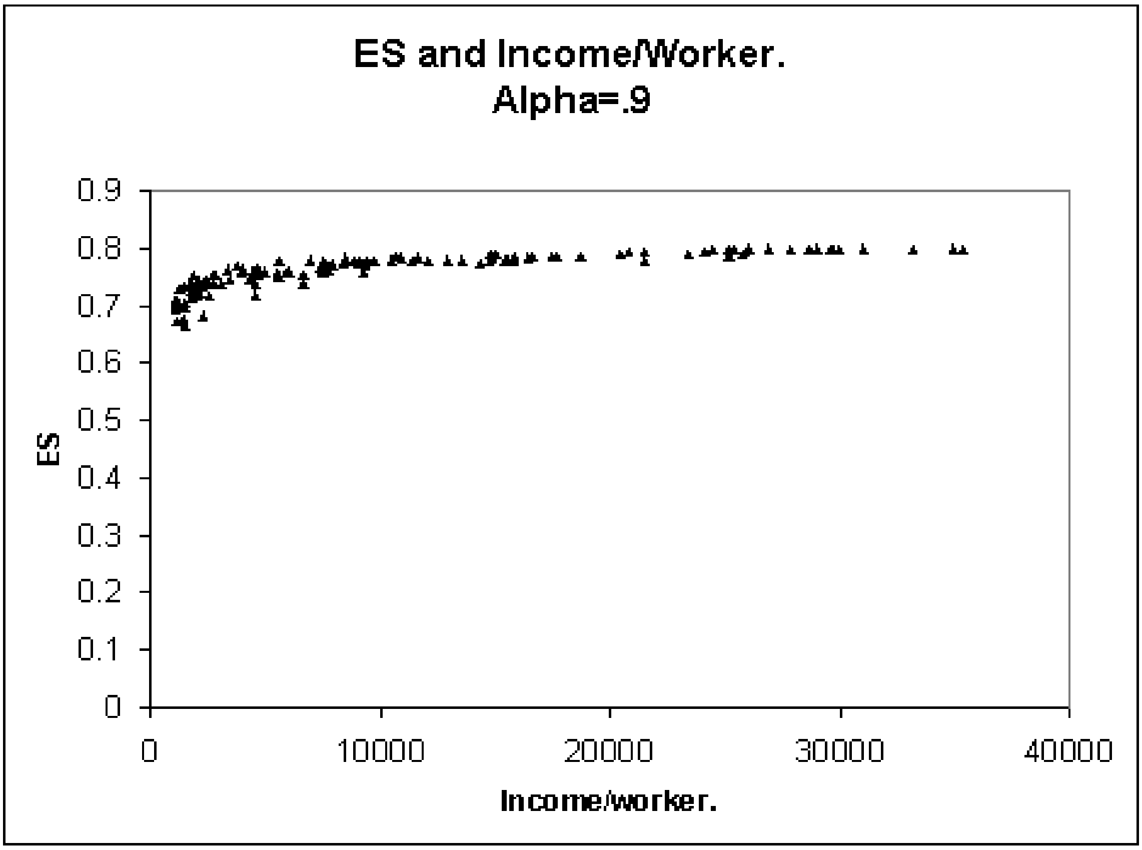

Figure B.34: TFP ratio to the US. Italy.

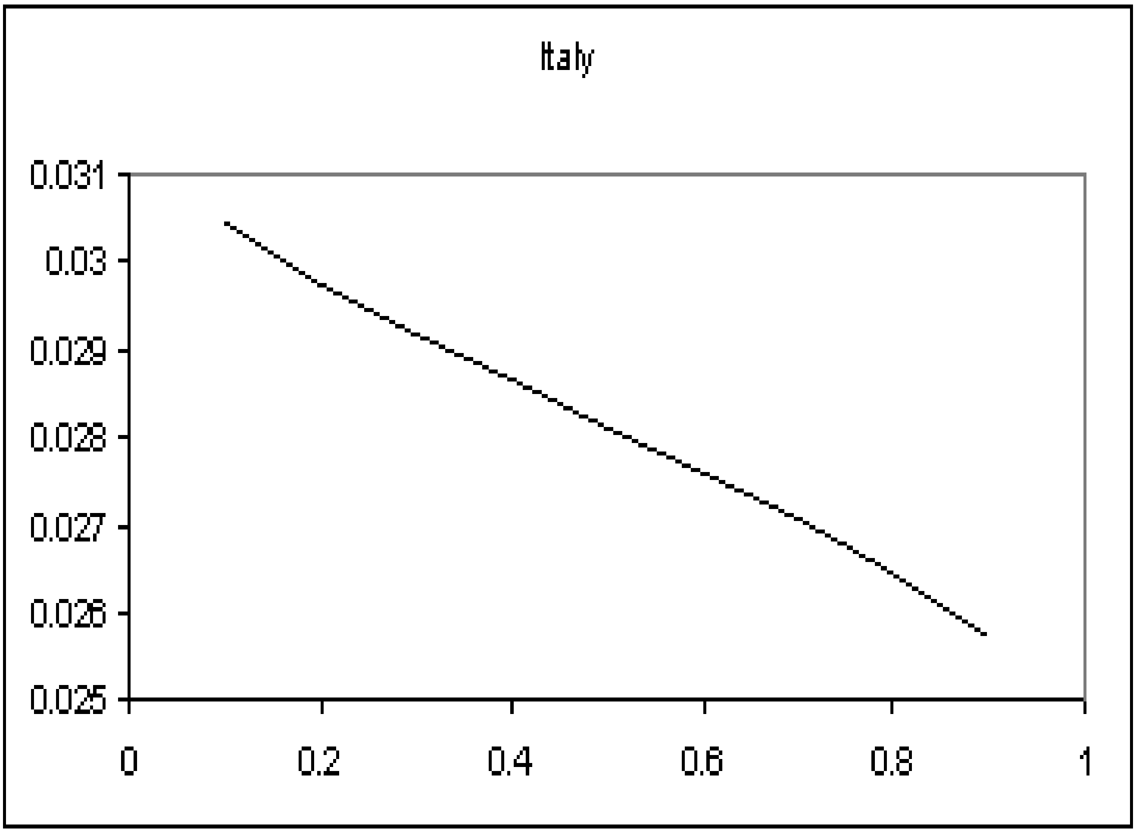

Figure B.35: TFP ratio to the US. Zaire.

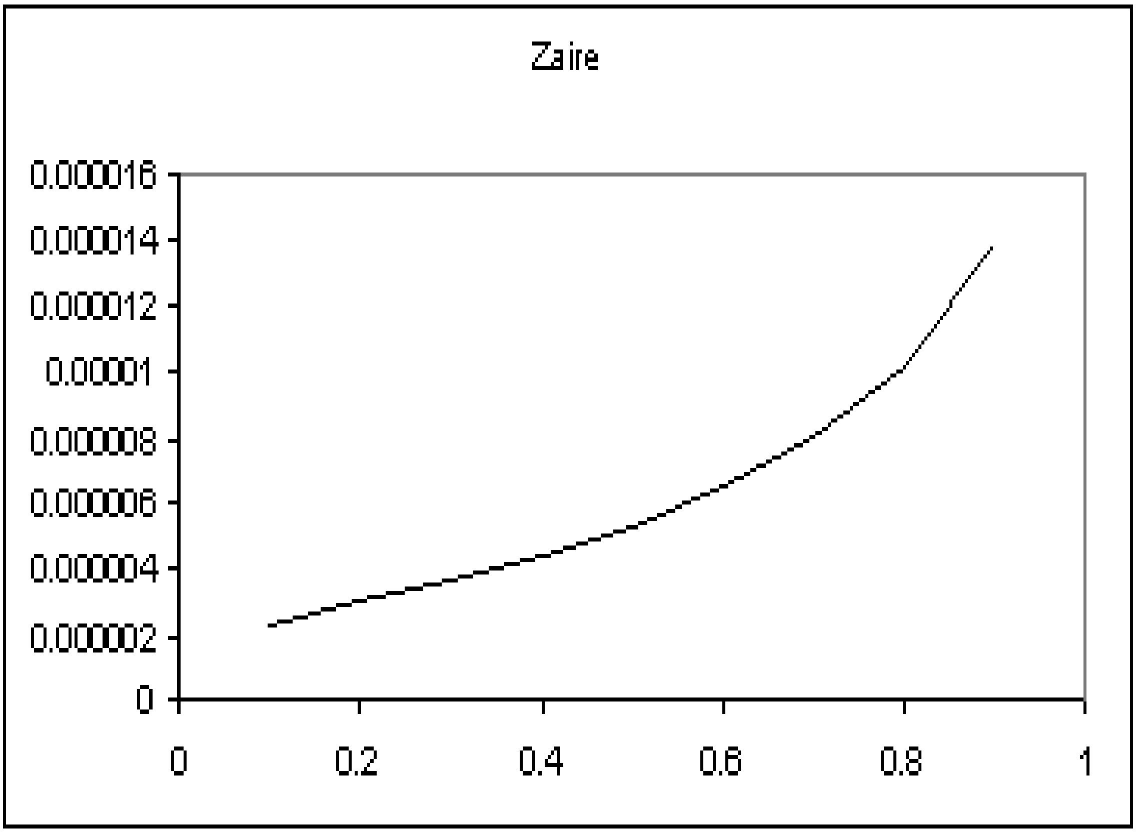

Figure B.36: TFP ratio to the US. China.