Trade policy and its impact on economic growth: Can openness speed up output growth?

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1. Introduction

"Economic theory generally supports the conclusion that trade liberalization has positive effects on economic growth. Theorists disagree as to whether increases in the growth rate of a country's economy after a single episode of liberalization last indefinitely or are time-limited, and some have constructed scenarios in which liberalization might slow growth. Some empirical studies have identified a positive linkage between a country's rate of economic growth and its openness to international trade, while others have failed to demonstrate this linkage". (U. S. International Trade Commission, 1997).

Starting from this general presumption, it is the purpose of this paper to bring more light onto the relationship between trade policy and growth and to answer the following questions: What impact does trade policy have on growth, i. e. under which conditions does it have a positive impact, under which conditions does it have a negative impact? Does openness speed up output growth when the analysis is based on longer time horizons? How can the dynamic effects of trade, which refer to the effects of openness on the *rate of economic growth*, be examined?

When analyzing the role of trade policy for economic growth, one will notice a certain (oftentimes striking) difference regarding the policy conclusions following from different theories. Besides, one will realize that empirical studies have also come to an array of different results, either proving the positive and significant impact of 'good' trade policy, or questioning the robustness of trade policy as a growth-determining factor.

In Chap. 2 the main conclusions of different economic theories concerning the role of trade policy will be summarized and put into perspective. Perspective is necessary because, according to the theory one chooses, one ends up with different conclusions as far as the role of trade policy is concerned. The assumptions under which trade policy will have a positive or negative impact will be briefly addressed by looking at different trade models. Different growth models will then be analyzed in order to find out about the duration of those positive or negative effects.

In Chap. 3 it will be made clear that the confusion concerning the duration of impact of trade policy is not alleviated by empirical analyses, given the way they have been modeled. There are numerous empirical studies on the impact of trade policy on economic growth. They usually rely on different trade policy indicators, which makes a comparison of the results difficult. Most analyses look only at the impact of trade policy on growth at *one* point of time. Besides, one can notice in most of the studies that trade policy is assigned a direct impact that cannot be justified from a theoretical point of view.

In Chap. 4 the connection between two very simple trade policy indicators, which characterize trade openness, and output growth will be tested in a way suitable to do justice to the indirect impact of trade policy. Two impact-channels will be tested: 1) the savings/investment channel, which is implicit in the AK model[1] and 2) the TFP channel, which is implicit in the endogenous technical progress model. This procedure has the purpose to determine for Chile whether trade policy has speeded up economic growth.

In Chap. 5 finally some often repeated assertions about the growth-relevance of trade policy will be put into perspective given the insights gained within the Chilean scenario.

2. The impact of trade policy from a theoretical point of view

The following questions concerning the effects of trade policy on growth shall be answered in this section: Do we have to worry about the growth impact of trade policy from a theoretical point of view? Is trade liberalization always a good economic strategy to enhance (long-run) growth? It will be shown that the answer to this question depends on the theoretical concepts you look at.

Therefore, first a look will be taken at trade theories (Chap. 2.1): the traditional trade theory (section 2.1.1), the dynamic trade theory (section 2.1.2) and the new trade theory (section 2.1.3). The welfare implications of trade will be summarized in the corresponding sections. Second, to complete the picture, another look will be taken at the growth theories (Chap. 2.2): the neoclassical growth theory (section 2.2.1) and

the new/endogenous growth theories (section 2.2.2). The effects of trade on the growth rate of GDP will be examined in the corresponding sections. In Chap. 2.3 conclusions will be drawn. Finally a mediation approach will be taken to accomodate and reconcile the different theoretical branches.

2.1 The impact of trade policy from the trade theory point of view

2.1.1 The impact of trade policy according to traditional trade theory

As we all know, according to traditional trade theory, free trade or the liberalization of trade via a reduction of import impediments (import tariffs, NTBs) and of export impediments are the best strategies from a welfare point of view.

These welfare improvements are due to specialization gains (increased efficiency due to production according to comparative advantage) and to consumption gains (increased choice of goods at lower prices for consumers).

However, these conclusions are only valid, if perfect competition prevails first of all. Other market imperfections such as externalities, public goods or uncertainty have to be absent. Furthermore, other distortions must not exist in the relevant markets, otherwise, restricting trade might be a second best strategy. It is obvious that these conditions will not always be fulfilled (to put it mildly) and that, therefore, it might be reasonable to restrict trade in certain ways.[2]

This is not to say that the above-mentioned static gains are absent. It might rather be a hint that those static gains are smaller than under 'perfect competiton'-assumptions. Static gains imply a once and for all increase in output and only a short-run increase in the rate of output growth.

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[1]This model takes output to be a linear function of the accumulable factor capital (in a broad sense). Broad capital encompasses physical and human capital and is assumed to have constant returns to scale. In the AK model approach capital is the only determinant of the long-term growth rate.

[2] This holds when first-best measures are not feasible.

2.1.2 The impact of trade policy according to dynamic trade theory

Dynamic trade theory is based on neoclassical assumptions and is mainly verbal in character. According to dynamic trade theory the static gains from trade - due to specialization and reallocation of *existing* resources - are small compared to the dynamic gains due to an increase in the growth rate and the volume of *additional* resources made available to, or employed by, the trading country (Kreinin, 1998). Dynamic gains are caused by an accelerated accumulation of physical capital and human capital (perhaps due to a higher rate of domestic and/or foreign saving), enhanced technological transmissions and improvements in the quality of macroeconomic policy. Besides, forward and backward linkages (stimuli) of the expanding (mostly exporting) sectors, improvements in X-efficiency (improved managerial skills, less slack in the production process) should be pointed out. In contrast to the static traditional trade theory which emphasizes the efficiency gains from trade, dynamic trade theory draws attention to the *indirect* gains from trade. The above-mentioned dynamic gains manifest themselves in increased growth rates of output in the medium and long-run. Baldwin (1992) analyzes the measurable dynamic gains from trade, whereas Funk (1996), Rutherford and Tarr (1999) as well as Eicher (1999) try to formalize the findings of the times in which economics was much more verbalized.

2.1.3 The impact of trade policy according to the new trade theory

New trade theory is associated with the names of Brander and Spencer (1983), Krugman (1986), Dixit (1986, 1987), Grossman (1992), d'Andrea Tyson (1992) and Klodt (1992) to mention only a few. New trade theory relaxes the restrictive assumptions of perfect competition and the absence of market failures, which are key in the traditional trade theory.

New trade theory concludes that under conditions of imperfect competition (eventually due to economies of scale and the existence of externalities (spillovers)) restrictions to trade might be welfare-improving.

As far as imperfect competition is concerned, trade restrictions in the international arena are then used to win market power (monopoly power, oligopoly power or become the winner in monopolistic competition). Market power can be used to get rid of foreign competitors in various ways. E. g. products can be temporarily underpriced (sold below marginal cost) until competitors will have left the market (predatory pricing). After that producers with market power will switch to mark-up pricing. Having market power (in international terms) is equivalent to be able to increase output and the market share. As it is well-known these strategies will allow to produce at decreasing average cost in industries characterized by economies of scale. In such an environment smaller foreign competitors have no chance because they cannot produce under economies of scale. Even though national welfare will rise in the economy that has relatively more market power, the gains are *static* since average cost do not fall indefinitely, but stop decreasing at a certain point. *Dynamic* gains are possible if high entry costs, high learning effects and externalities (spillovers) prevail in the protected industries.

As far as externalities are concerned, the existence of positive spillovers in the production process, driving a wedge between private and social marginal costs, can also be welfare-improving. Externalities of relevance are those linked to 1) the accumulation of physical capital, 2) the accumulation of human capital, i.e. the improvement of skills (education of workers, engineers; on the job training; learning by doing) and 3) 'knowledge production' (to learn how to imitate (use a blueprint); to adapt technology to one's own needs; to innovate (create new technology). If there are positive externalities between firms or sectors of the economy, other firms or other sectors will profit from their existence. However, the incentive to produce knowledge will be too low, since market prices do not (fully) reflect the input of the innovators' physical and human capital and their knowledge. The issue in trade policy is in how far it might be justified to subsidize innovative sectors or supposedly innovative sectors (pick winners) and therefore enhance spillovers in the economy. The existence of spillovers in production is able to lead to an increase in the long-run rate of growth. Permanent growth becomes possible due to positive externalities which result in constant or even increasing returns of the accumulable or

reproducible factors (physical and human capital).[3] One will notice that all these factors also impact positively on technical progress.

2.2 The impact of trade policy according to growth theories

2.2.1 The impact of trade policy according to neoclassical growth theory

Neoclassical growth theory goes back to Solow (1956) and Swan (1956) and has not yet lost its attraction (see studies of Mankiw, Romer, Weil, 1992; Barro and Sala-i-Martin, 1992, 1995). Its starting point is a neoclassical Cobb-Douglas production function with constant returns to scale and with substitutability between capital and labor. All factors (also the accumulable/reproducible factor capital) are paid their marginal products and each of them has decreasing returns. The original version of the neoclassical growth theory assumed a closed economy.

However, in the 90s questions of economic policy making started to play a bigger role in the neoclassical growth model. Therefore, the model was applied to the analysis of open economies and the role of institutional arrangements (Barro, Mankiw and Sala-i-Martin, 1995; Klump, 1995; Maußner and Klump, 1996).

It has been mentioned earlier that - according to *neoclassical trade theory* -, trade liberalization has a positive impact on the *level of income.*

This view is confirmed by the neoclassical growth theory when applied to open economies. According to the neoclassical growth approach, a rise in the savings rate - as a result of e. g. trade liberalization[4] - would translate into investment *almost* like in a closed economy due to capital markets imperfections, home country bias of investors, fear of expropriation etc (Schmidt-Hebbel et al., 1996).[5] This increase in investment will in turn raise the level of per capita income and its growth rate. However, this will happen only temporarily, up until the point at which the available savings is only sufficient to cover depreciation and growth in the labor force. Then capital per worker stops increasing, although saving and investment continue to take place. This means that growth in per capita income would also stop, if there were no

[3] Decreasing returns of the accumulable factors lead to a stop of the growth process once the steady state is reached.
[4] Compare the predictions of dynamic neoclassical trade theory.
[5] A rise in savings increases investment under the realistic assumption of limited international capital mobility (compare the empirical findings of Feldstein-Horioka (1980) and especially the explanations of Schmidt-Hebbel et al. (1996)).

technological change. Therefore, trade policy has only a short-term impact on the rate of growth.

Viewed another way, during transition (most probably in the short- and medium-run) growth in per capita income is possible even without technological change, but in the long-run the growth in per capita income is just equal to the rate of technological change, and is entirely dependent on technological change which is exogenous.

Besides, the labor force growth rate, the rate of savings, and the depreciation rate are exogenous in the basic neoclassical model. There are refinements of the basic model concerning the growth of the labor force which is seen to depend on income-related household decisions about childbearing and about labor force participation (Becker and Barro, 1988; Barro and Becker, 1989). As far as the rate of savings is concerned, it is also seen to be a function of household decisionmaking and might therefore fluctuate over time (Ramsey, 1928; Cass, 1965, Koopmans, 1965).

2.2.2 The impact of trade policy according to endogenous growth theory

The beginnings of endogenous growth theory are associated with Romer (1986, 1990), Lucas (1988), Rebelo (1991), Rivera-Batiz and Romer (1991) as well as Grossman and Helpman (1991a, 1991b) and Grossman (1992).

Endogenous growth theory can explain long-run increases in output growth rates because of three phenomena, which are interdependent (Rebelo, 1991, 1998):

First, endogenous technical progress makes the long-run growth permanent. Innovation, imitation and adaptation are driven by the profit-maximizing behavior of firms. Even though externalities might be connected with those activities, the costs of innovating, imitating or adapting new products and/or new technologies are covered by temporary profits that allow to set prices correspondingly (mark-up pricing), an idea already propagated by Schumpeter (Judd, 1985; Romer, 1990; Aghion and Howitt, 1992; Grossman and Helpman, 1991; Young, 1993). Trade liberalization could enhance technical progress which, in turn, makes the long-run growth permanent. A speed up in technical progress could be caused by stronger capital goods imports, increased transfer of technology, higher foreign direct investment and/or more incentives to imitate and innovate, factors which are all positively correlated to trade liberalization as far as the empirics are concerned.

Second, according to the AK model an increase in savings and investment does not curb the incentives to accumulate capital. Crucial for this result is the assumption of constant returns to scale of the accumulable factor capital (which comprises physical and human capital) and the 'unimportance' of nonreproducible factors, such as land[6], Capital accumulation becomes thus a profitable long-run business (Jones and Manuelli, 1990; Rebelo, 1991; Jones, 1995). If trade liberalization positively impacts on savings and capital accumulation, then an adequate trade policy can promote growth in the long-run.

Third, positive externalities linked to capital (in a broader sense) accumulation lead to constant or even increasing returns of the accumulable factor (Romer, 1986, 1987). Positive externalities suspend the assumption of diminishing returns to capital as in the neoclassical model and thus make permanent increases in the growth rate of output possible. Romer refers to the positive externalities of physical investment and knowledge, whereas Lucas points to the positive externalities of human capital accumulation. (Romer, 1986; Lucas, 1988; Azariadis and Drazen, 1990; Murphy, Shleifer and Vishny, 1989).

Externalities lead to the result that one-time improvements in efficiency (as induced by trade liberalizations) can permanently increase the rate of economic growth (U. S. ITC, 1997).[7] Even though externalities prevail also in closed economies, they are supposedly stronger in open economies (and in open trade regimes), especially as far as developing countries are concerned. LDCs benefit tremendously from trade with technologically leading countries.

2.3 Conclusions

According to the neoclassical (trade and growth) model trade policy has only a level effect on per capita income. Liberalization does increase the long-run level of per capita income but not its long-run rate of growth. It has to be pointed out, however, that *during transition* the growth rate in the neoclassical model is in fact an endogenous function of underlying parameters, and actual economies spend most or all of the time in a transitional state (U.S. ITC, 1997). In the endogenous growth

[6] Rebelo (1991) proved that perpetual growth can be consistent with the presence of capital goods produced with nonreproducible factors.

[7] This is in contrast with the neoclassical model where decreasing returns of capital cause the rate of output growth to decline and to become zero in the steady state if no technological change is present.

model, in contrast, the trade regime can have an impact on the long-run rate of growth.

This is meant to say that - after all - the differences between the neoclassical model and the endogenous model are not that big, if the transitional state is the rule or lasts for many years. Under comparable time intervals, capital accumulation, the rate of depreciation, the rate of labor force growth *and* - of course- the rate of technological progress have a similar impact on the growth rate of output.

The only difference would be that in the endogenous growth model the rate of technological advance is explained by decisions of profit-maximizing firms to imitate and/or to innovate. Besides, the existence of externalities (spillovers) makes the accumulation of physical and human capital and knowledge more attractive, thus enabling higher rates of output growth if certain positive conditions are fulfilled. However, the impact of trade liberalization might be negative, if a country has a comparative disadvantage in innovation and imitation. Also, externalities might not be that big or they might be internalized by far-reaching laws relating to the protection of intellectual property. Therefore, the issue of the impact of trade policy on economic growth remains a matter for empirical testing.

3. The dynamic impact of trade policy from an empirical point of view

3.1 The impact of trade policy according to cross-country studies

Not long ago cross-country studies used to be the most common form of doing empirical research on growth. Those studies were facilitated by the availability of the datasets of Summers and Heston (1991) and the World Bank Social Indicators on CD-ROM. Besides, researchers were curious of whether the growth rates of different countries would converge or not (convergence controversy). Following the neoclassical growth theory the growth rates would converge, at least if some variables (e.g. investment rates) were controlled for. According to the endogenous growth theory growth rates were allowed to differ due to diverging technical progress. With a revived interest in growth theories, however, an additional issue came up. It was an open question which growth model (the neoclassical or the endogenous

growth model) was relevant and whether economic policy did have a transitory or permanent impact on growth. This new issue could not be answered by those static cross-country analyses. Nevertheless, cross-country studies gave an answer to the question whether trade policy would have *any* impact on growth or correlation with growth.[8]

Harrison (1996) gives an excellent overview over the impact of openness on growth in cross-country studies which were written in the 1980s and 1990s. Indicators for openness are either measures based on trade shares or price-based and administrative measures. The main finding of those studies is a positive impact of openness (as the result of an open trade policy) on growth.

However, these analyses have to be looked at with care. Most of them are examples for modelling without theory. In various cases the simplest growth determining factors were left out from the analysis. This drawback relates especially to the analyses of the 1980s. Therefore, it is indispensable to use growth models based on production functions to test the impact of trade policy on economic growth. This insight was disseminated in the 1990s. Furthermore, it became also clear that trade policy acts only indirectly on growth, either via the factor accumulation or via total factor productivity (TFP) growth. The indirect link was confirmed by the findings of Levine and Renelt (1992). They revealed for a cross-country analysis of 84-86 countries (1960-1989) that, first of all, growth is determined by the basic growth variables (the growth primitives): initial income in 1960, investment and secondary school enrollment. These variables were tested to be robust. Second, they proved that trade policy measured by 6 different openness variables had no robust impact on growth (only if crucial variables were left out in the specification). For 4 out of those 6 trade policy indicators, however, they could confirm a positive and robust impact on the investment share, thus validating the indirect channel of openness on growth.

3.2 The impact of trade policy according to time series studies

Harrison (1996) performed her own analyses based on a production function for 16-51 countries. Within this growth model approach, she ran three different regressions and used seven different trade policy indices. When using 27-year averages

[8] However, in cross-country studies it is impossible to decide whether a certain policy has an impact on growth because of the policy 'per se' or because of certain country characteristics or accompanying

(regression No. 1) of the growth and trade variables (pure cross country analysis), two trade indices (distortion indices) had a significant, negative (as expected) impact on growth. The other five had no significant impact on growth. Harrison used the same country samples in order to perform two more pooled analyses, one with annual data and the other with 5-year averages.

The pooled analysis with annual data (regression No. 2) resulted in a higher explanation of growth through trade. *Four* of the seven trade indices had a significant impact on growth and carried the expected signs, whereas the other three did not have any significant impact. However, - as Harrison remarks -one major problem with using annual data in order to identify the determinants of long-run growth is that short-term or cyclical fluctuations could affect the observed relationship between policy variables and growth. This view is confirmed by Quah and Rauch (1990) who found that most of the observed relationship between openness and growth is due to short-run cyclical fluctuations.

Finally, Harrison utilized 5-year averages (regression No. 3) in order to smooth that sort of fluctuations. In this exercise *two* out of seven indicators of trade policy proved to be significant and showed the expected sign.

These results would lead one to think that the longer the time horizon the less confirmed is the impact of openness on growth. Besides, it has to be borne in mind that this result should be intuitively clear because of the likelihood that growth effects of trade liberalization are relatively small compared with other determinants of economic growth and because of the fact that the concept of 'openness' is difficult to quantify objectively (U. S. ITC, 1997).

Jones (1995) was the first who did time series tests of endogenous growth models. He examined the growth rate of the US economy (1880-1987) and of 14 OECD countries (1900-1987) by applying time series tests. He looked at the time series properties of the per capita GDP growth in the United States and concluded from its constant mean and its stationarity (in the statistical sense) that "either nothing in the U.S. experience since 1880 has had a large, persistent effect on the growth rate, or whatever persistent effects have occurred have miraculously been offsetting". The same applied to the fourteen OECD countries[9] when looking at the ADF-test[10] which

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policy measures.

[9] Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, Norway, Sweden and the United Kingdom.

[10] ADF-test = Augmented Dickey Fuller - test (a unit root test; test on non-stationarity/stationarity of time series.

proved the growth rates to be stationary. These results call into question the implicit prediction of many endogenous growth models that growth rates should exhibit large permanent increases (Jones, 1995).

However, when Jones examined the period of 1950-1988, the picture was mixed. One would realize a positive mean shift after World War II for some countries. The countries with significant mean shifts were Australia, Austria, Germany, Italy, Japan and the United Kingdom. With the exception of Australia, these were all countries that were severely affected by the war and where the recovery in the ensuing decades was tremendous due to the Marshall Plan which facilitated the inflow of capital.

To sum up:

Measuring the impact of trade policy over time necessitates time series analyses. The longer the time horizon the less confirmed is the impact of openness on growth.

Jones, by applying time series techniques, could not detect endogenous growth for the US and the OECD economies over periods of about 100 years. A time interval of quite long-lasting growth (1950-1988) emerged in the economies most destroyed by the war. This period of time, however, could be interpreted as a stage of transition to a new 'post' war equilibrium.

Besides, it has to be kept in mind that Jones did not test the relevance of trade policy in specific, but rather the growth-relevance of a growing capital stock in general terms, neglecting the causing factors of increased investment.

3.3 What role for trade? Some reflections

Even though Jones' analysis implicitly allows to make statements on the nature of the growth process (neoclassical versus endogenous), it abstracts from the explicit role of economic policy in general and from trade policy in specific.

In this context, one has to be aware that the impact of many key determinants of economic growth: a) savings, b) capital accumulation (domestic and foreign investment(FDI)) and c) TFP growth *is primarily influenced by other factors than trade liberalization*. The saving behavior is basically determined by the age structure of the population and the local availability of a variety of local assets. FDI and domestic investment are often determined by the endowment with natural resources and the rule of law/political stability. Decisions about the schooling of children,

especially girls, are heavily influenced by social and cultural factors (see U.S. ITC, 1997). TFP growth might be influenced more by political and diplomatic ability to attract technical assistance and reach good terms concerning the transfer of technology. Given these arguments, one should think of a rather minor role for trade.
Furthermore, none of the theories touched upon so far suggested a direct link between trade policy and growth. The modelling of direct effects of trade policy cannot be justified on theoretical grounds. Neither the neoclassical model nor the endogenous growth theory mentions a possible direct channel. All the theories emphasized the *indirect* link between trade policy and growth. Trade policy impacts through factor accumulation and TFP-growth on output growth. Given the indirect role played by trade policy on economic growth, the empirical procedure should be stepwise).

4. Has trade policy speeded up output growth in Chile?

To get an idea about the growth effects of trade liberalization, the Chilean economy shall serve as a - of course - 'limited' case study. Since the choice of openness indicators is controversial, some often utilized trade policy indicators shall be discussed (Chap. 4.1). In analogy to Jones (1995) a sort of AK model is tested, according to which an improvement in trade policy should be reflected in an improvement of the growth rate of the capital stock which, in turn, is supposed to be linked to an improvement of output growth (Chap. 4.2). In Chap. 4.3 a simple hypothesis of endogenous growth shall be examined, according to which the growth rate of total factor productivity (TFP) should be a positive function of increased trade openness.

4.1 The problem of choosing an openness indicator

In general it is not easy to find the perfect *indicator for the goodness of trade policy or openness*. A multitude of different indicators has entered empirical studies, not surprisingly also leading to mixed results. Some studies found strong positive effects of openness on growth while others found little or no effect (U.S. ITC, 1997).
Anne Krueger and Jagdish Bhagwati (1978) provided the first systematic attempt at formally classifying trade regimes. They measured trade orientation by the degree by

which the protection (and incentives) structure was biased against exports. In the Bhagwati-Krueger project trade liberalization was defined as any policy that reduces the degree of anti-export bias (Edwards, 1993). This idea is also reflected in the real exchange rate that is relevant for exports. For this purpose usually an export-trade weighted real exchange rate is computed that covers at least 80% of export trade, i. e. exports to the most important trading partners. The export-trade weighted real exchange rate measures international price competitiveness of exports.

The U. S. ITC report (1997) summarizes nicely the most common indicators for trade policy, citing Pritchett (1996) who compared and screened the most important indicators: average tariffs, the percentage of imports covered by non-tariff barriers (NTBs), an index of structure-adjusted trade intensity, Edward Leamer's (1988) measures of openness and trade distortion, Dollar's (1992) measure of price distortion and Sachs and Warner (1995) dummy variable to characterize a country as closed or open. Pritchett laments that the different indicators do not even signal openness, i. e. the rough direction of trade policy, in a uniform way. In 5 cases out of 15 possible comparisons countries scored as open by one measure have been scored as closed by another. This adds plausibilty to the inconsistency of the results of different empirical analyses. Preference is finally given by Pritchett to the indicator 'average tariff' which is also positively linked to the ratio of imports covered by NTBs. However, even though this indicator might be the best for cross-country studies, it is not too practical for time series country studies. The variation of 'average tariff' might not be big enough to draw any conclusions on the impact of trade policy.

However, for time series studies the ratio (exports+imports)/GDP might be preferable and the only viable choice. [11] To round up the picture, this volume index of openness should be complemented by a price index of openness, the export-weighted real exchange rate as an indicator of international competitiveness. This latter indicator ought to be an adequate indicator for an export-oriented economy like Chile.

Therefore, the author will rely on two measures when performing the empirical time series analyses: 1) a change in the ratio: (exports+imports)/GDP, expressed by WTR and 2) a change in the real exchange rate, expressed by WRER.

[11] It has to be pointed out that this measure is not very useful for cross-country comparisons, since this ratio does vary with the size of a country, large countries usually having smaller ratios and tiny countries having huge ratios.

Since trade openness impacts only indirectly - via investment and TFP growth - on output growth, these two channels will be subject to a time series test in section 4.2 and 4.3.

The dataset underlying the statistical analysis comprises GDP, capital stock, occupation and trade data for the period of 1960-1998. The data used have been taken from statistics of Chile's Central Bank, Coeymans' data base and World Development Indicators 2000 on CD-ROM and International Financial Statistics (see Appendix 1 for the data).

4.2 Testing the link: trade openness - capital accumulation - output growth (the AK model)

In a *first step* the link 'investment and output growth', such as propagated by the **AK model,** will be tested. The AK model in its simplified version and its implications concerning long-run growth will be exposed in the following equations. The production function is given by:

(1) $Y_t = A\, K_t^1$

where:

Y is GDP in real terms, A stands for level of technology (assumed to be constant), K is the broadly defined capital stock in real terms[12] and t denotes time (1960-1998).

Taking logs of (1) the production function is:

(2) $LNY_t = LNA + LNK_t$

To analyze the steady state relationship between the growth rate of real GDP ($WY = LNY_t - LNY_{t-1} = \dot{Y} / Y$) and broad capital ($WK = LNK_t - LNK_{t-1} = \dot{K} / K$), one has to differentiate the logs and gets to (3)

(3) $LNY_t - LNY_{t-1} = 0 + LNK_t - LNK_{t-1} \quad \Rightarrow \quad WY_t = WK_t$

[12] The broadly defined capital stock encompasses physical and human capital. Besides, constant returns to the accumulable factor capital are assumed, which will generate endogenous growth.

(4) $\dot{K} = i^K Y - d\,K = i^K AK - d\,K$

where:

i^K = investment rate for broad capital

Since it can be shown that the two components of broad capital, physical (k) and human capital (hk), move together (see Jones, 1995, 503-505), equation (4) can be written in small 'k's. Carrying this thought further, one can even drop the variable 'human capital', for which no convincing and also no continuous indicator was available for Chile, from the analysis. Consequently, it can be concluded in analogy to (3) and (5) that the growth rate of physical capital (Wk) and of real GDP (WY) must be the same.

(5) $Wk = -d + A\,i^k = WY$

with:

Wk = growth rate of physical capital

d = rate of depreciation

WY = growth rate of real GDP

Jones (1995) concludes from equation (5) that *in the AK model the dynamics of the growth rate should be similar to the dynamics of the investment rate (i. e. growth rate of the physical capital stock)*.

Following this line of thought the AK-model will be tested. Endogenous growth - according to the AK-model - requires that an increase of the growth of the physical capital stock (Wk=WK)[13] is paralleled by an increase in output growth (WY) over the long run.

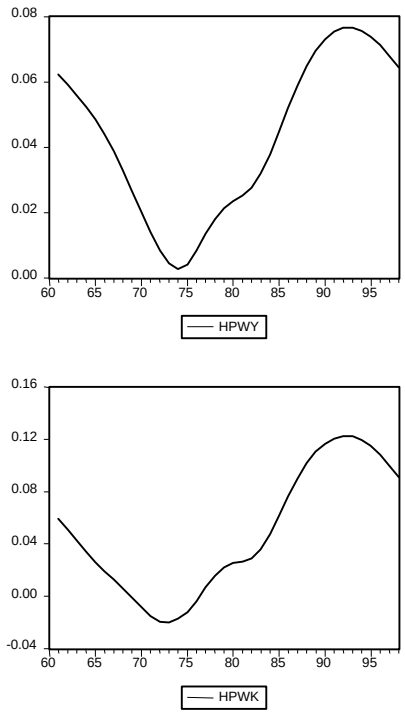
Unlike in Jones (1995) all data (see Appendix 1: Figure 3) will be cleared from short-run fluctutations (giving them the prefix 'HP'), before entering the model and the time series tests. This is achieved by the Hodrick-Prescott filter, thus creating the

[13] In EViews the names of series appear in capital letters, i.e. Wk the growth rate of physical capital is written as WK. This might be confusing, but in any case the growth rate of Wk (physical capital) and WK (human and physical capital) are the same under equilibrium growth conditions.

equilibrium condition (6), which states that the filtered growth rate of real GDP and physical capital should move together.

(6) HPWY ~ HPWK (compare with Diagram 1)

Diagram 1: The co-movement of HPWY and HPWK



Note: The data lend support to the AK model.

HPWY and HPWK have been tested as non-stationary (see Appendix 2: Table 1) and checked for cointegration, i. e. long-run equilibrium. The series HPWY and HPWK turned out to be cointegrated (see Appendix 2: Table 2). Therefore, one can con-clude that the Chilean data lend support to the AK model (see Nowak-Lehmann D., 2000).

In a *second step* the impact of trade openness - measured by WTR and WRER, on the rate of investment will be examined, since trade policy could have an indirect impact on WY through WK (respectively HPWY through HPWK)

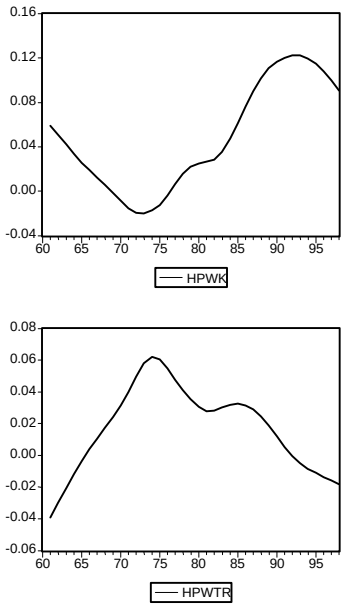
To get rid of misleading short-run influences, the variables WTR and WRER have also been filtered, thus leading to HPWTR and HPWRER.

If both variable-sets (HPWTR and HPWK on the one hand and HPWRER and HPWK on the other) are non-stationary (see Appendix 2: Table 1) and cointegrated (see

Appendix 2: Table 2), it will be concluded that there exists a long-run equilibrium between them.

The Johansen cointegration test showed that HPWK and HPWTR are cointegrated. This is equivalent to saying that HPWTR and HPWK were in equilibrium during the period of 1960-1998 (see Diagram 2).

Diagram 2: HPWK and HPWTR are cointegrated.

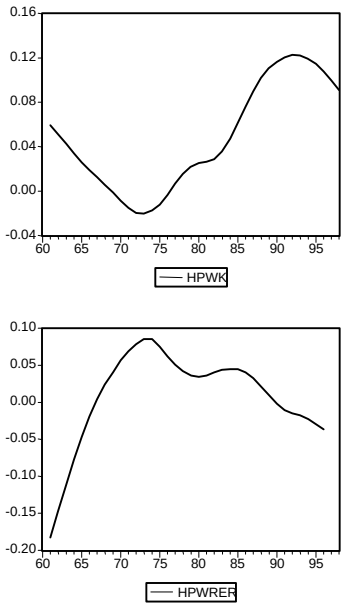


Note: Increased trade volumes do influence the rate of capital accumulation in the long-run.

What does this mean in more practical terms? It could mean that investment prospects are driven by factors related to the external market. An increase in the volume of trade in the period of 1975-1998 (see Appendix 1: Figure 1) is paralleled by increasing investment rates.

Also the second indicator of trade openness, the change in the real exchange rate (HPWRER), was cointegrated - according to the Johansen cointegration test (see Appendix 2: Table 2) - with the investment rate (HPWK), indicating a long-run equilibrium in the period of 1960-1998 (see Diagram 3).

Diagram 3: HPWK and HPWRER are cointegrated.



Note: A competitive real exchange rate is favorable to investment over the long-run.

By looking at the export-trade weighted real exchange rate (see Appendix 1: Figure 1), it becomes clear that a relatively appreciated real exchange rate (in the period of 1960-1973) was linked to low investment rates whereas a relatively depreciated real exchange rate (in the period of 1974-90) went hand in hand with increasing investment rates.

To sum up: Since trade openness is cointegrated with investment (capital accumulation), one can contend that trade openness speeded up output growth via increased growth of investment (in the period of 1960-1998).

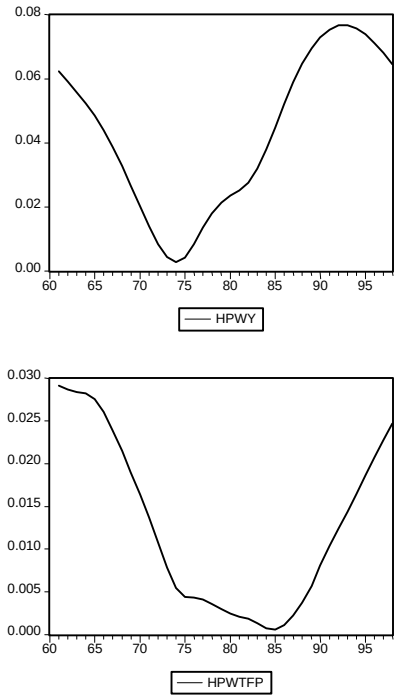
4.3 Testing the link: trade openness - TFP growth - output growth (endogenous technical progress)

In the following sections the TFP-channel through which openness could impact on output growth will be investigated. According to endogenous growth theory national spillovers and international spillovers in both physical and human capital formation and in knowledge accumulation are responsible for endogenous growth.

In a *first step* the relationship between TFP growth and output growth shall be subject to time series analysis.

According to the Johansen cointegration test (see Appendix 2: Table 2) the series HPWY and HPWTFP are not cointegrated, i. e. in long-run equilibrium (see Diagram 4).

Diagram 4: The movements of HPWY and HPWTFP

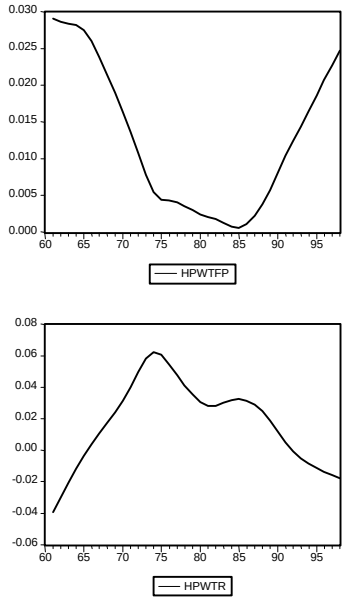


Note: HPWY and HPWTFP are not cointegrated.

In a *second step* the indirect channel 'openness-TFP growth' will be looked at, examining the role of HPWTR and HPWRER.

From the Johansen cointegration test (see Appendix 2: Table 2), one can conclude that the series HPWTFP and HPWTR are cointegrated and therefore in long-run equilibrium (see Diagram 5).

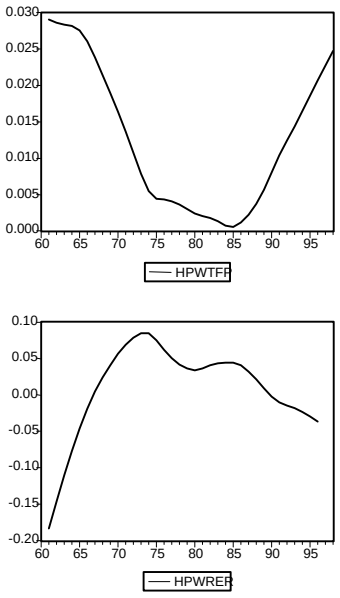
Diagram 5: The movements of HPWTFP and HPWTR



Note: HPWTFP and HPWTR are cointegrated. Openness to trade does influence the growth rate of total factor productivity in the long-run.

As far as HPWRER is concerned, the Johansen cointegration test implies cointegration between HPWTFP and HPWRER (see Appendix 2: Table 2 and Diagram 6).

Diagram 6: The movements of HPWTFP and HPWRER



Note: HPWTFP and HPWRER are cointegrated. They are in long-run equilibrium in the period of 1960-1998.

To sum up: Cointegration between trade openness and TFP growth suggests that trade openness speeded up TFP growth (in the period of 1960-1998).

4.4 Does openness have a transitory or permanent impact on growth? Some preliminary results

So far only statements like: "In the period of 1960-1998 openness has shown to be important for output growth" are possible.
To learn more about the relationship between output growth and trade openness, measured by the trade volume and the export-weighted real exchange rate, distributed lag models would have to be built. Since estimation routines with time series, especially with non-stationary time series, and the modelling of lags would overwhelm this paper, this sort of exercise shall be left to the future.
Preliminary studies of the cross-correlations between output growth and trade openness suggest that trade policy ceases to impact on output growth after 4-5 years. However, this preliminary result would have to be subject to statistical tests.

5. Conclusions

To sum up, the empirical analyses revealed two things:
First, the long-term role of capital accumulation for output growth. This implies that sticking to a good economic policy which promotes investment is crucial for economic growth over longer periods.
Second, the finding that trade openness seems to be important for output and TFP-growth holds when longer periods of time are analyzed. For the period of 1960-1998 this result could be confirmed after having examined the two channels, through which trade openness could impact on output growth, namely capital accumulation and TFP-growth. All time-series analyses revealed that trade openness - measured by a quantity and a price indicator, was in long-run equilibrium with both investment and total factor productivity. Therefore one can contend that both output growth and TFP-growth in the period of 1960-1998 were speeded up by increased trade openness in the period of 1960-1998.

However, the empirical analyses performed so far do not allow rigorous conclusions on whether the Chilean economy will continue to experience endogenous growth from today's trade policy. The question of 'For how many years trade openness can speed up economic growth?' remains largely unanswered - in the sense - that it continues to be a matter of empirical testing whether trade openness has a transitory or a permanent effect on output growth. This is due to the fact that the time series analyses performed so far did not involve an impact study of trade openness.

In order to make more concrete statements on the impact of trade policy over time one should revert to dynamic macroeconometric models, such as distributed lag models. This would enable economists to find out about the strength and the impact over time that trade policy might have on the rate of growth. This should be a line of research to be followed in the future.

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Appendix 1:

Table 1: The original data: Y, K, L, TRADE and RER

obs	Y	K	L	TRADE	RER
1960	1599874.	420897.8	2380.188	29.17528	0.570000
1961	1695669.	426309.9	2400.419	28.09670	0.470000
1962	1786247.	478616.5	2446.038	25.54676	0.310000
1963	1864170.	549267.9	2499.670	26.75920	0.380000
1964	1955303.	517968.7	2556.488	25.96154	0.310000
1965	2081513.	486669.5	2616.594	26.16431	0.310000
1966	2288199.	502330.0	2668.582	28.50796	0.310000
1967	2318502.	513067.3	2752.730	27.39726	0.380000
1968	2400311.	561591.9	2784.067	27.13258	0.380000
1969	2532403.	589924.2	2797.321	30.64264	0.260000
1970	2621427.	628004.8	2842.015	28.63349	0.380000
1971	2758959.	613442.0	2934.382	23.05277	0.380000
1972	2743418.	490190.7	2987.604	23.05643	0.310000
1973	2714225.	460652.1	2970.548	29.12191	0.310000
1974	2533861.	548702.7	2861.126	40.08821	1.000000
1975	2113474.	423756.0	2733.620	52.84821	0.830000
1976	2219192.	360972.9	2782.012	45.92082	0.680000
1977	2480256.	416735.4	2887.428	43.04376	0.570000
1978	2684069.	489147.4	2994.693	44.50862	0.680000
1979	2906350.	571568.5	3081.512	49.38460	0.680000
1980	3132501.	696678.3	3226.177	49.79783	0.570000
1981	3305784.	813419.8	3336.730	43.17142	0.470000
1982	2840122.	537389.4	3039.436	40.62206	0.680000
1983	2819928.	457435.2	3120.543	45.32737	0.830000
1984	2998736.	498504.5	3336.086	49.57657	0.570000
1985	3072177.	572188.0	3524.197	53.86046	0.830000
1986	3246107.	586023.0	3709.040	55.12007	1.000000
1987	3644681.	713263.0	3867.340	57.66447	1.030000
1988	3911154.	814209.0	4059.560	62.17463	1.100000
1989	4324181.	1058456.	4293.700	67.13586	1.150000
1990	4484071.	1085096.	4398.750	65.97198	1.000000
1991	4841447.	1083169.	4421.680	61.83836	0.670000
1992	5435881.	1343405.	4643.070	59.93592	0.670000
1993	5815646.	1584627.	4894.980	57.44505	0.920000
1994	6147610.	1682653.	4969.900	57.28934	0.920000
1995	6800952.	2078072.	5018.040	59.27743	0.880000
1996	7305141.	2263410.	5141.500	58.44057	0.800000
1997	7858481.	2526156.	5194.900	56.11638	NA
1998	8126506.	2579026.	5257.239	56.40190	NA

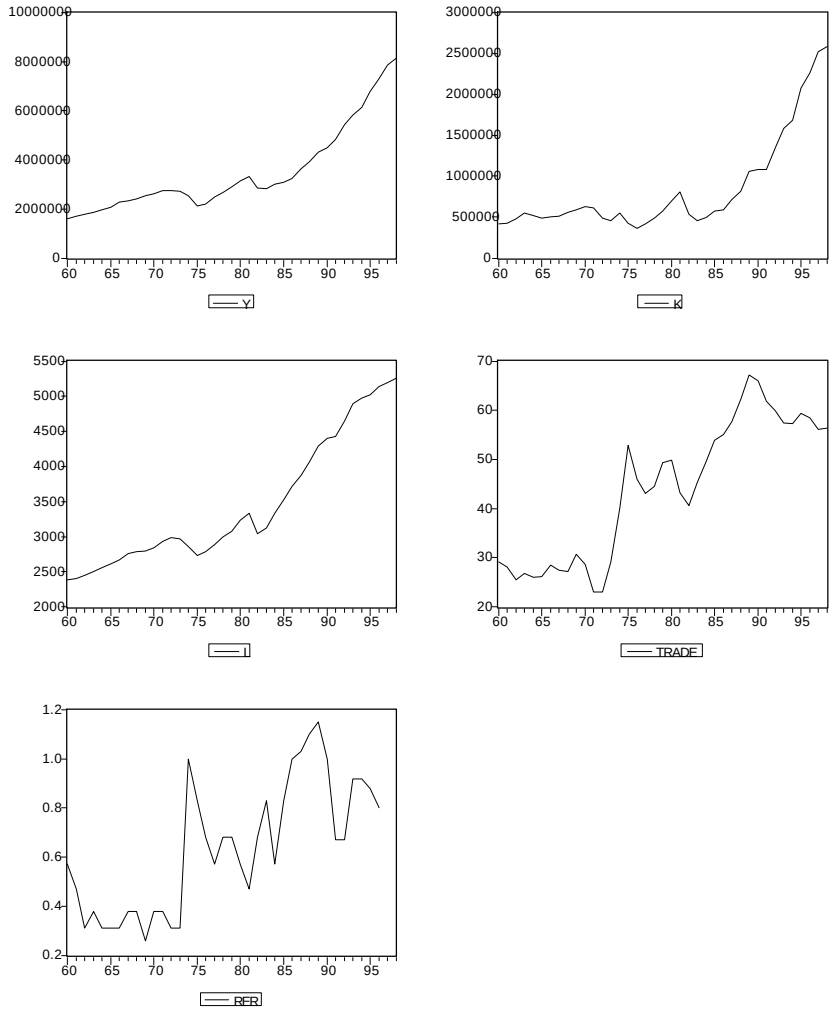
Y = GDP in real terms (millions of 1986 pesos); K = capital stock in real terms (millions of 1986 pesos); L = employment (thousands of persons); TRADE = trade share = (exports+imports)/GDP; RER = export trade-weighted real exchange rate

Source: Y, K: Banco Central de Chile: Boletín Mensual, various issues;

L : Professor Coeymans' database; Universidad Católica de Chile, Santiago

TRADE: World Development Indicators 2000, CD-ROM; RER: IFS , own calculations

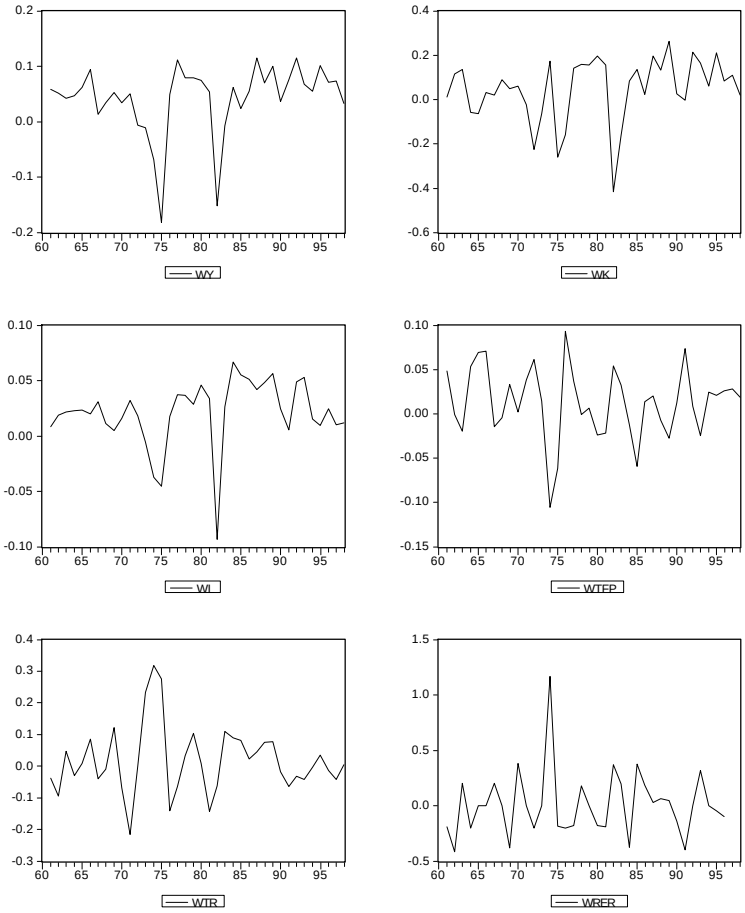
Figure 1: Y, K, L, TRADE, RER



Note:

Y, K, L ,TRADE and RER are all non-stationary.

Figure 2: WY, WK, WL, WTFP, WTR and WRER

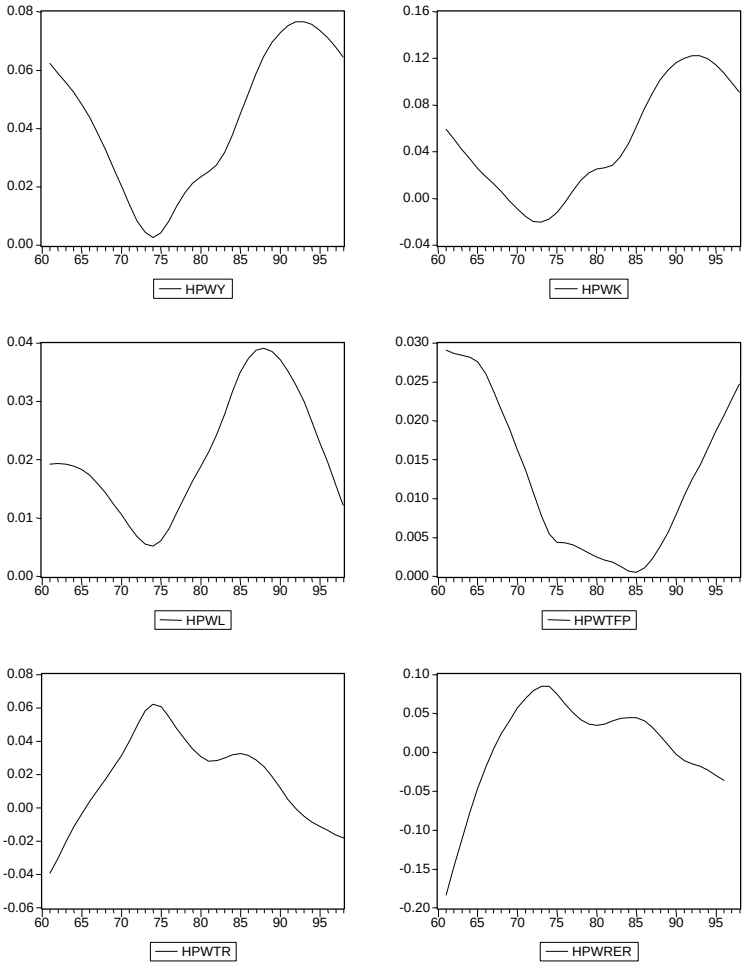


Note:

WY, WK, WL, WTFP; WTR and WRER are all stationary.

WTFP= WY - 0.35 WK - 0.65 WL (see Coeymans, 1999a and 1999b)

Figure 3: Growth rates freed from short-run fluctuations



Note:

WY, WK, WL, WTFP, WTR and WRER have been freed from short-run fluctuations by applying the Hodrick-Prescott filter. Filtered growth rates carry the prefix 'HP'. HPWY, HPWK, HPWL, HPWTFP, HPWTR and HPWRER are all non-stationary.

Appendix 2

Table 1: Stationarity of the time series is tested by the Phillips-Perron test[14]

series to be tested	test assumptions[15]	test result (a =1%)	PP test statistics
Y	trend and intercept	non-stationary	1.02
K	trend and intercept	non-stationary	1.07
L	trend and intercept	non-stationary	-0.98
TRADE	trend and intercept	non-stationary	-2.31
RER	trend and intercept	non-stationary	-1.91
LNY	trend and intercept	non-stationary	-1.02
LNK	trend and intercept	non-stationary	-0.89
LNL	trend and intercept	non-stationary	-1.42
LNTR(ADE)	trend and intercept	non-stationary	-2.35
LNRER	trend and intercept	non-stationary	-3.82
WY	intercept	stationary	-3.95
WK	intercept	stationary	-4.55
WL	intercept	stationary	-4.23
WTR	intercept	stationary	-3.80
WRER	intercept	stationary	-7.27
WTFP	intercept	stationary	-4.97
HPWY	trend and intercept	non-stationary	-2.02
HPWK	trend and intercept	non-stationary	-2.30
HPWL	trend and intercept	non-stationary	-0.91
HPWTR	trend and intercept	non-stationary	-2.28
HPWRER	trend and intercept	non-stationary	-0.47

[14] The Phillips-Perron test (unit root test) is a test on the stationarity/non-stationarity of the series.
[15] The test assumptions follow from the line graphs.

Table 2: Testing for cointegration: Results of the Johansen cointegration test[16]

series tested	**test assumptions**	**test result (a =5%)**
HPWY, HPWK	linear deterministic trend (intercept)	cointegration
HPWK, HPWTR	linear deterministic trend (intercept)	cointegration
HPWK, HPWRER	linear deterministic trend (intercept)	cointegration
HPWY, HPWTFP	linear deterministic trend (intercept)	no cointegration
HPWTFP, HPWTR	linear deterministic trend (intercept)	cointegration
HPWTFP, HPWRER	linear deterministic trend (intercept)	cointegration

[16] The cointegration test requires non-stationarity of the series!