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# Trade Between Developing Countries and its Importance for Economic Development

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# **Trade between Developing Countries and its Importance for Economic Development\***

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## **1. Introduction**

In conventional trade theories - its most important representative being the theory of Heckscher and Ohlin - trade is explained according to the principle of comparative advantage. The central factors in these theories are the determinants of the comparative advantage differences between nations. The emphasis is on supply factors as the driving force behind exports. Demand factors are not taken into account.<sup>1</sup> Therefore, no attention is paid to the destination of the export flows.

In the 1970s the shift of purchasing power from the Western countries to the oil producing and -exporting nations - the result of the oil crisis in 1973 - encouraged more attention for the destination of exports. Among academic economists a discussion started on the contributions exports distinguished by direction would provide to economic development. This appears to be of particular importance for developing countries. However, it is amazing that besides empirical studies on the factor content of these trade flows (Havrylyshyn (1985); Khanna (1982)), no econometric studies have been carried out to test for the impact of exports distinguished by direction on a nation's economic development.

In this paper we present some lines of the theoretical discussion in the 1970s and 1980s. Further we propose a framework for empirical research on the relation between exports distinguished by direction and economic development.

## **2. Theoretical remarks on South-South versus South-North trade**

The distinction between trade flows of a country with more developed and less developed trade partners is not a peculiar phenomenon in a world in which nations differ from each other

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\* This paper is based on Chapter 5 of my Ph.D. thesis (Beers 1991). I am very grateful to Hans Linnemann for his helpful comments on an earlier version of this paper. Errors are mine.

<sup>1</sup> Theories stressing demand factors as the most important determinants of trade are those of Linder (1961) and the product cycle approach of Vernon (1966)



regarding levels of economic development. The important question whether there exist significant differences in development potential between the export flows in both directions has received some attention in the 1970s by Amsden (1976) and Stewart (1976). However, the case for South-South trade received much more attention by academic economists since the Nobel lecture of Lewis (1980). Lewis argued that the economic recession would lessen the export possibilities of the less developed countries to the North. That means that the engine of growth, the exports of the developing nations, would not work anymore. Therefore a case could be made for the promotion of South-South trade, i.e. trade between the developing nations, as an alternative engine of growth.<sup>2</sup>

**Table 1 LDC trade flows as distinguished by direction (percentages of LDCs' trade flows to/from the world)**

| year                          | 1970 |    |   |    | 1975 |    |    |    | 1980 |    |    |    | 1985 |    |   |    |
|-------------------------------|------|----|---|----|------|----|----|----|------|----|----|----|------|----|---|----|
| partner                       | A    | B  | C | D  | A    | B  | C  | D  | A    | B  | C  | D  | A    | B  | C | D  |
| <b>LDCs</b>                   |      |    |   |    |      |    |    |    |      |    |    |    |      |    |   |    |
| Exports                       | 72   | 20 | 2 | 18 | 71   | 23 | 3  | 20 | 73   | 25 | 4  | 21 | 70   | 26 | 3 | 23 |
| Imports                       | 74   | 19 | 6 | 14 | 68   | 24 | 12 | 12 | 74   | 28 | 13 | 15 | 73   | 27 | 8 | 19 |
| <b>Non oil exporting LDCs</b> |      |    |   |    |      |    |    |    |      |    |    |    |      |    |   |    |
| Exports                       | 47   | 14 | 2 | 13 | 30   | 12 | 3  | 9  | 33   | 13 | 3  | 10 | 47   | 19 | 3 | 16 |
| Imports                       | 59   | 17 | 5 | 12 | 45   | 21 | 11 | 9  | 51   | 24 | 12 | 12 | 55   | 24 | 8 | 16 |
| <b>Oil exporting LDCs</b>     |      |    |   |    |      |    |    |    |      |    |    |    |      |    |   |    |
| Exports                       | 25   | 6  | 0 | 6  | 41   | 11 | 0  | 10 | 40   | 12 | 1  | 11 | 24   | 8  | 1 | 7  |
| Imports                       | 15   | 2  | 0 | 2  | 23   | 4  | 0  | 3  | 23   | 5  | 1  | 4  | 18   | 4  | 1 | 3  |

**Notes:**

- A=Industrial Countries
- B=Less Developed Countries (= C + D)
- C=Oil Exporting Less Developed Countries
- D=Non-oil Exporting Less Developed Countries

- Industrial countries consist of:  
USA, Canada, Japan, Austria, Belgium, Denmark, France, Germany, Italy, Netherlands, Norway, Sweden, Switzerland, United Kingdom, Finland, Australia, New Zealand, Iceland, Ireland, Spain.
- LDCs = less developed countries are defined as all developing countries (=oil exporting LDCs + non-oil exporting LDC's) excluding: South Africa, Cyprus, Faeroe Islands, Gibraltar, Greece, Hungary, Malta, Portugal, Romania, Turkey, Yugoslavia.
- Oil exporting LDCs are: Algeria, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Oman, Qatar, Saudi Arabia, United Arab Emirates, Venezuela.

**SOURCE:** *Direction of Trade*, several years International Monetary Fund, Washington D.C.

Since the first part of the 1970s the share of LDC trade going to other LDCs is rising, as can be seen in Table 1. A large part of this trade is caused by the strongly rising oil prices of

<sup>2</sup> Lewis' ideas have been attacked by Riedel (1984)

the 1970s. But it is also clear that, when we eliminate the oil exporting LDCs, trade flows between non-oil exporting developing countries are becoming a larger part of the respective trade flows of LDC trade to/from the world. In particular in the first part of the 1980s the rise in the share of intra-LDC trade can be explained by intra-non-oil LDC trade. Exports from all less developed countries to non-oil exporting developing nations increased from 21% to 23% which has been caused by a rise of intra non-oil LDC trade from 10% to 16% and a decrease of that between oil exporting LDCs and non-oil exporting ones from 11% to 7%.

It has been tried to give a theoretical explanation for the existence of South-South trade, in particular in relation to South-North flows.<sup>3</sup> Within the framework of the factor proportions explanations of trade Krueger (1977) developed a model of comparative advantage for  $n$  commodities,  $m$  countries and two factors of production. Under the usual competitive assumptions (Krueger 1977, p. 2-5) she shows that one of the implications of this model is that "countries in the middle of the factor-endowment ranking will tend to specialize in producing commodities in the middle of the factor-intensity ranking. They will import labour-intensive commodities from more labour-abundant countries and capital-intensive commodities from countries with higher capital-labour endowments" (p. 9). This argument, however, does not give a direct explanation for the suggestions that a nation would export relatively labour-(capital) intensive products to relatively less labour (capital) endowed trade partners. Of course, imports of one country are the exports of the other ones but Kruegers' basic model only links the characteristics of the imported commodities to the relative factor endowments of the importer but does not give us information about the *direct* relation between export characteristics and factor endowment features of the exporter.

Moreover, the Krueger analysis is of a static nature. The basic model has been extended by herself to incorporate a certain kind of dynamics. A relative accumulation of capital under constant international prices and constant other countries' factor endowments is considered. It is shown that a rising share of capital relative to labour would lead to the production of more capital-intensive commodities. The production of labour-intensive goods will stop after some time.<sup>4</sup> The mechanism of this process is purely neoclassical and runs through change of the wage-rental rate. Essential conditions of the model are full employment and fixed supply of both factors of production.

Khanna (1982) tested empirically for India (years 1973 and 1978) whether exports would be relatively capital-intensive to the more labour abundant destinations and relatively labour intensive to the more capital abundant destinations.<sup>5</sup> He also investigated whether the distor-

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<sup>3</sup> We believe, however, that the academic interest for the development implications of South-South trade, after having received an impulse in the first part of the 1980s, is declining.

<sup>4</sup> This is the Rybczynski theorem in a multi-country and multi-commodity context.

<sup>5</sup> We notice that this hypothesis cannot exactly be derived from Kruegers' model as we already argued above.

tions in the good- and factor markets of India exerted influence on the factor content of the trade flows. The study points out that the hypothesis regarding the factor content differences between India's exports to North and South could not be rejected. No significant influence of domestic market distortions on the trade patterns of India could be found.

Havrylyshyn<sup>6</sup> (1985) tests empirically the validity of the factor endowments theory for trade flows of developing countries. When distinguishing trade flows by direction he finds that exports of LDCs to the North contain less physical and human capital than those to the South. The implication of this result is that export flows from developing countries to the North would have more advantageous employment opportunities than those going to the less developed nations (see also Krueger (1978), p. 273).

In an empirical paper Amsden (1980) showed that it is not unreasonable to argue that South-South trade flows embody just *marginally more* capital and *overwhelmingly more* skills than those going from South to North. In other papers (1983;1986) she tried to find an explanation for this argument and, moreover, she investigates what its implications for the contribution of South-South trade to economic development would be. When a technology of production embodies a high skill content, the higher its learning effects will be (Amsden (1986), p. 255). This means that production of commodities by such a technology increases the stock of technological knowledge and the level of skills. These rising levels generate a new potential for more production of these goods which means rising productivity. Amsden (1983, p. 333) uses the term *dynamics of comparative advantage* that sectors using relatively much of the production factor skills would have. It means that because of the feedback of skill-intensive commodities to the factor skills itself the *gains in productivity* would be greater than those in sectors using little or no skills.

Suppose it is true, as empirical studies suggest, that exports of developing countries to other developing nations are produced by technologies being significantly more skill-intensive than the commodities exported to developed areas. Then it is to be expected that the higher gains in productivity will emerge in sectors exporting to the South. What does this finding imply for the level of economic development? We define economic development of a country simply as the growth of its real GDP.<sup>7</sup> When southern export sectors reveal higher growth rates of productivity than sectors exporting to the North we may expect that the contribution of the intra-LDC exports to the change of real Gross Domestic Product of the country will increase. It might be possible that these effects will not become visible, after a short period, but when the

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<sup>6</sup> He tests in two ways, i.e. in a cross-country regression and by means of the relations as derived by Leamer [1980].

<sup>7</sup> One may argue whether this definition justifies the many other definitions of economic development incorporating e.g. income distribution or socio-economic variables. We choose growth of real GDP as a rough indicator of economic development because it is most manageable and it corresponds with our way of analysing the gains of productivity at the macro-level.

period of analysis becomes longer and longer the ultimate effect will be a larger contribution of southern export sectors to growth of real GDP.

### 3. The model

We assume the economy consists of three sectors:

$$Y^d = F^d(K_d, L_d) \quad (3.1)$$

$$Y^n = F^n(K_n, L_n) \quad (3.2)$$

$$Y^s = F^s(K_s, L_s) \quad (3.3)$$

$$Y = Y^d + Y^n + Y^s \quad (3.4)$$

$Y$  = aggregated output

$Y^d$  = output of the domestic-oriented sector.

$Y^n$  = output of the export sector oriented towards the North.

$Y^s$  = output of the export sector oriented towards the Southern destinations.

$K_i$  = capital stock of sector  $i$ .

$L_i$  = employment in sector  $i$ .

Equations (3.1) - (3.3) represent the production functions of the three sectors distinguished. We assume that in all sectors technical change is Hicks-neutral and is taking place at a constant rate during the period of analysis. This means that it only affects the level of output and not the marginal rates of substitution between capital and labour inputs.

Taking time derivatives of equations (3.1) - (3.4) and assuming  $\dot{K}_i = I_i$  gives us:<sup>8</sup>

$$\dot{Y}^d = F_K^d I_d + F_L^d \dot{L}_d \quad (3.5)$$

$$\dot{Y}^n = F_K^n I_n + F_L^n \dot{L}_n \quad (3.6)$$

$$\dot{Y}^s = F_K^s I_s + F_L^s \dot{L}_s \quad (3.7)$$

$$\dot{Y} = \dot{Y}^d + \dot{Y}^n + \dot{Y}^s \quad (3.8)$$

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<sup>8</sup> See Chiang (1985) p.194/195 for the mathematical justification

with  $\dot{X} = \frac{dx}{dt}$

$F_l^i$  = marginal productivity of labour in sector  $i$

$F_k^i$  = marginal productivity of capital in sector  $i$

An optimal allocation of resources maximising the aggregated output  $Y$  would require a complete equalisation of the marginal factor productivities between sectors, i.e.

$$F_l^i = F_l^j$$

$$F_k^i = F_k^j, i \neq j$$

It is often argued that in developing countries equalisation of marginal factor productivities between sectors does not occur. Our aim is to test for the possible differences between them. There is a considerable consensus in the literature that the export sector shows a higher productivity than the domestic sector. The export sector is more efficient because it is exposed to a more competitive (international) environment than the (often protected) domestic sector. Thus, the domestic sectors' marginal factor productivity is assumed to be lower than that of the sector exporting to the North. Moreover, we assume that the production of exports to the South shows a higher marginal factor productivity than that of exports to the North for the reasons mentioned above. The final assumption we make is that differences in marginal capital productivity between two sectors are proportional to those between marginal labour productivity. This restriction is made to keep the model simple.

So, the following relations are postulated:

$$\frac{F_k^s}{F_k^n} = \frac{F_l^s}{F_l^n} = (1 + \gamma) \quad (3.9)$$

$$\frac{F_k^n}{F_k^d} = \frac{F_l^n}{F_l^d} = (1 + \theta) \quad (3.10)$$

We will now solve the model to get an equation for which parameter values can be estimated.

We substitute (3.5) - (3.7) in (3.8) and making use of (3.9) and (3.10) we get

$$\begin{aligned}\dot{Y} = & F_k^d I_d + F_l^d \dot{I}_d + (1+\theta) F_k^d I_n + (1+\theta) F_l^d \dot{I}_n \\ & + (1+\gamma)(1+\theta) F_k^d I_s + (1+\gamma)(1+\theta) F_l^d \dot{I}_s\end{aligned}\quad (3.11)$$

Working out (3.11) results in:

$$\begin{aligned}\dot{Y} = & F_k^d \cdot (I_d + I_n + I_s) + F_l^d \cdot (\dot{I}_d + \dot{I}_n + \dot{I}_s) \\ & + \theta F_k^d \cdot I_n + \theta F_l^d \cdot \dot{I}_n + \theta F_k^d \cdot I_s + \gamma F_k^d \cdot I_s \\ & + \theta \gamma F_k^d \cdot I_s + \theta F_l^d \cdot \dot{I}_s + \gamma F_l^d \cdot \dot{I}_s + \theta \gamma F_l^d \cdot \dot{I}_s\end{aligned}\quad (3.12)$$

Noting that  $I_d + I_n + I_s = I$  and  $\dot{I}_d + \dot{I}_n + \dot{I}_s = \dot{I}$ , substituting (3.9) and (3.10) in (3.12) and re-arranging the terms gives:

$$\dot{Y} = F_k^d I + F_l^d \dot{I} + \frac{\theta}{1+\theta} (F_k^d I_n + F_l^d \dot{I}_n) + \frac{\theta+\gamma+\theta\gamma}{(1+\theta)(1+\gamma)} (F_k^d I_s + F_l^d \dot{I}_s)\quad (3.13)$$

Substitute (3.6) and (3.7) in (3.13) we get:

$$\dot{Y} = F_k^d I + F_l^d \dot{I} + \frac{\theta}{1+\theta} \dot{Y}^n + \left(1 - \frac{1}{(1+\theta)(1+\gamma)}\right) \dot{Y}^s\quad (3.14)$$

Both sides of the equation are divided by  $Y$  to get growth rates ( $g_x$  = growth rate of  $x$ )

$$g_y = F_k^d \frac{I}{Y} + F_l^d \frac{\dot{I}}{Y} + \frac{\theta}{1+\theta} \frac{\dot{Y}^n}{Y} + \left(1 - \frac{1}{(1+\theta)(1+\gamma)}\right) \frac{\dot{Y}^s}{Y}\quad (3.15)$$

Equation (3.15) can be estimated as:

$$g_y = \alpha_1 \frac{I}{Y} + \alpha_2 \frac{\dot{L}}{Y} + \alpha_3 \frac{\dot{Y}^n}{Y} + \alpha_4 \frac{\dot{Y}^s}{Y} \quad (3.16)$$

The estimation of parameters  $\alpha_3$  and  $\alpha_4$  allows us also to compute the values of  $\theta$  and  $\gamma$  and to see to what extent they differ from each other. The parameter  $\gamma$  shows the additional factor productivity southern-oriented sectors would have over northern-oriented sectors.

There is still one problem left. It is not quite clear how to interpret the variable  $\dot{L}/Y$  in equation (3.16). To avoid this difficulty we are forced to make an extra assumption, i.e. we assume the existence of a linear relationship between real marginal productivity of labour in the domestic-oriented sector and the average output per employee in the whole economy,<sup>9</sup>

$$F_{1d}^d = \beta_2 \left( \frac{Y}{L} \right)$$

Substitution of this relation in (3.15) generates:

$$g_y = \beta_1 \frac{I}{Y} + \beta_2 \frac{\dot{L}}{L} + \beta_3 \frac{\dot{Y}^n}{Y} + \beta_4 \frac{\dot{Y}^s}{Y} \quad (3.17)$$

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<sup>9</sup> We follow Feder (1982) in making this assumption. The argument in favour of this assumption can be found in Arrow, Chenery, Minhas and Solow (1961, p.228). These authors state that (1) at a macro-level the level of wages is determined by the level of labour productivity  $Y/L$ , and (2) at the industrial level the decision to hire labour is dependent on the economy-wide wage level,  $w$ . This mechanism affects the labour productivity of the industry. A high level of labour productivity at the macro-level goes together with a high macro-level of wages. Then an individual industry may decide to hire less labour and more capital per unit of output. The ultimate result is an increase in the industry's labour productivity which means that the marginal product of labour  $(\partial Y/\partial L)_i$  of an industry depends on the macro wage level as well. The following relations are valid then:

$$(\partial Y/\partial L)_d = F_{1d}^d = f(w) = f(Y/L)$$

Assuming the functional form to be a linear one, leads to :

$$F_{1d}^d = \beta_2 \cdot (Y/L).$$

which can be reformulated as:

$$g_y = \beta_0 + \beta_1 \frac{I}{Y} + \beta_2 g_L + \beta_3 g_{yn} \frac{Y^n}{Y} + \beta_4 g_{ys} \frac{Y^s}{Y} \quad (3.18)$$

with  $g_x$  being the annual growth rate of  $x$ . Equation (3.18) is a *weighted* growth equation. As the weights are the Export/GDP ratio's, they are not constant but do change in the course of time. As can be seen from equation (3.17) we now have  $\dot{L}/L$  which is the growth rate of the labour force, instead of  $\dot{L}/Y$  for which there is no straightforward economic interpretation. A constant term,  $\beta_0$ , has also been added to the equation. This is necessary to incorporate the error term of the econometric specification.

#### 4. Estimation results of the model

The model presented in the preceding section is a modification of a family of models used to investigate the relation between individual sectors of the economy and economic growth.<sup>10</sup> The basic model was developed by Robinson (1971) to analyse the several sources of growth in less developed countries. He particularly stresses the productivity differences between the agricultural and the manufacturing sectors of developing countries. Feder (1982) used this kind of model to analyse productivity differences between the domestic and the export sectors of an economy, and he extended it by including intersectoral effects.

Our model is a modification of the one formulated by Feder. We do not include intersectoral effects but allow the export sector to be divided into two sectors, one with exports to the North and the other one with exports to developing countries. We are mainly interested in productivity differences, and by imposing them on both parts of the export sector we can test for their existence empirically.

Equation (3.18) will be estimated on a cross-section data set consisting of 20 developing economies. The Asian countries included are Bangladesh, Hong Kong, India, Indonesia, Korea Rep., Malaysia, Pakistan, Philippines, Singapore, Sri Lanka and Thailand. From Latin-America, nine countries are included: Argentina, Bolivia, Brazil, Colombia, Costa Rica, Honduras, Mexico, Peru and Uruguay. Our data cover the period 1973-1985, which gives us 13 annual observations per country.

Filling in the variables of the model empirically, we use the following definitions:

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<sup>10</sup> Rati Ram (1986) uses such a model to estimate the influence of government size on economic growth.

$Y$  = real gross domestic product (corrected with GDP-deflator)

$I$  = real gross domestic investment (corrected with GDI-deflator)

$\dot{L}$  = first difference in labour force proxied by first difference in the population size

$\dot{Y}^n$  = first difference in the output of the northern export sector (i.e. the export sector that is assumed to produce for the northern destinations only). Output of this sector is measured as the real exports to the North (corrected with a price index that measures changes in the aggregate price level of a country's merchandise exports over time, base year 1980=100)

$\dot{Y}^s$  = first difference in the output of the southern export sector which is measured as the real exports to the other developing countries (corrected with the same price index as exports to northern countries)<sup>11</sup>

**Table 2 Mean and standard deviation of the relevant variables (20 countries)**

|               | 1973-1985 |       | 1973-1979 |       | 1980-1985 |       |
|---------------|-----------|-------|-----------|-------|-----------|-------|
|               | mean      | s.d.  | mean      | s.d.  | mean      | s.d.  |
| $Y/Y$         | 0.047     | 0.044 | 0.060     | 0.038 | 0.032     | 0.046 |
| $I/Y$         | 0.271     | 0.101 | 0.271     | 0.088 | 0.271     | 0.114 |
| $\dot{L}/L$   | 0.022     | 0.008 | 0.023     | 0.009 | 0.021     | 0.007 |
| $\dot{Y}^n/Y$ | 0.010     | 0.035 | 0.010     | 0.028 | 0.010     | 0.026 |
| $\dot{Y}^s/Y$ | 0.008     | 0.027 | 0.007     | 0.058 | 0.009     | 0.025 |

The source of the export values is Direction of Trade Statistics, several issues.  $Y$ ,  $I$ ,  $L$  and the export prices index are from World Tables, 1988-1989 Edition.<sup>12</sup> A summary of mean and standard deviation statistics can be found in Table 2.

<sup>11</sup> It is noteworthy to observe that GDP is measured in value added and the export variables as gross output, i.e. including the inputs delivered by other sectors in the domestic and foreign economies. This problem can only be dealt with when at the sectoral level input-output relations between the export- and other sectors of the domestic economy are specified. Our analysis is at the macro-level and therefore we are not able to do so. Its consequences for the analysis are limited; a little more intercorrelation between the independent variables  $\dot{Y}^n$  and  $\dot{Y}^s$  on the one hand and  $I$  on the other side. A rise in the output of the investment sector may result in an increase of the export sectors' output because their input factor capital may rise.

<sup>12</sup> To trace the possible influence of the three deflators on the estimation results, we calculated their values in 1985 with 1967=100 for all three series. It appeared that in most cases the export price index was lower than the GDP index. High values of the export deflator were found for Indonesia, Malaysia and Singapore. The oil price increases are an important explanation for it and their effects may bias the estimation results. Later on in this chapter we will pay attention to this empirical problem.

We estimated the model with pooled data because such a data set has three advantages compared to a cross-section of averaged values over the period of study. Firstly, the number of observations is increased, and consequently testing with t-statistics is more reliable than in case of estimation on a data set consisting of averages. Secondly, the period of analysis, 1973-1985, is characterized by instability.<sup>13</sup> The oil price shocks of 1973 and 1979 may exert a disturbing influence on the regression results of the averaged data. Thirdly, the use of pooled data avoids the loss of information that necessarily occurs when taking averages. Table 3 reports the results.

**Table 3 Estimates of the model parameters. Annual data are pooled for 20 countries over 1973-1985**

| cases | $\beta_0$           | $\beta_1$           | $\beta_2$          | $\beta_3$           | $\beta_4$        | $\beta_5$           | $\tilde{R}^2$ |
|-------|---------------------|---------------------|--------------------|---------------------|------------------|---------------------|---------------|
| 3.1   | -0.024**<br>(0.010) | 0.213***<br>(0.023) | 0.586*<br>(0.287)  |                     |                  |                     | 0.236         |
| 3.2   | -0.023**<br>(0.010) | 0.190***<br>(0.025) | 0.687**<br>(0.285) |                     |                  | 0.146***<br>(0.049) | 0.258         |
| 3.3   | -0.022**<br>(0.009) | 0.194***<br>(0.024) | 0.650**<br>(0.282) | 0.226***<br>(0.070) |                  |                     | 0.263         |
| 3.4   | -0.024**<br>(0.010) | 0.205***<br>(0.025) | 0.635**<br>(0.289) |                     | 0.120<br>(0.094) |                     | 0.238         |
| 3.5   | -0.022**<br>(0.009) | 0.192***<br>(0.025) | 0.662**<br>(0.285) | 0.218***<br>(0.074) | 0.034<br>(0.098) |                     | 0.261         |

- standard errors are in parentheses.

Number of observations : 260

\* = significant at 10%-level

\*\* = significant at 5%-level

\*\*\* = significant at 1%-level

The picture emerging from Table 3 shows that except  $\beta_4$  all coefficients are significantly different from zero. The investment variable is significant at a level of 1% in all cases. Addition of the export variable results in a higher significance of the labour force influence on economic growth ( $\beta_5$  is the coefficient of the export variable regardless of direction, i.e.,  $\beta_3 = \beta_4$ ). The division of the export flows into those going to the North and those destined to developing nations reveals a strong impact of the change in northern exports on economic growth. Regression (3.3) fits the data better than in case of including all exports as shown in the second regression. The southern exports appear to have no significant impact on economic growth. The consequences for the productivity differences are<sup>14</sup>  $\theta = 0.279$  and  $\gamma = -0.218$  (calculated under assumption that  $\beta_4 = 0$  because its value of 0.034 appears to be insignificant). It shows a significantly higher productivity of the northern export sector compared with the domestic sector.

<sup>13</sup> Feder (1982) estimated his model using averages for 1964-1973. This is a rather undisturbed period of ongoing postwar economic growth. His analysis stops before the first oil price shock.

<sup>14</sup> The relation between the productivity parameters  $\theta$ ,  $\gamma$  and the coefficients of the equation is:  $\theta = \beta_3/(1-\beta_3)$  and  $\gamma = (\beta_4-\beta_3)/(1-\beta_4)$ ; see (3.15) and (3.17).

The southern exports reveal no *additional* productivity with regard to the northern export flows. However, because  $(\theta - \gamma) > 0$  the southern export sector still shows a higher productivity than the *domestic sector*.

In view of the economic disturbances within the period 1973-1985, in particular the second oil price shock of 1979 we estimated the model over two subperiods, 1973-1979 and 1980-1985. The results for the first subperiod are presented in Table 4.

**Table 4** Estimates of the model parameters. Annual data are pooled for 20 countries over 1973-1979

| cases | $\beta_0$          | $\beta_1$           | $\beta_2$        | $\beta_3$           | $\beta_4$         | $\beta_5$          | $\tilde{R}^2$ |
|-------|--------------------|---------------------|------------------|---------------------|-------------------|--------------------|---------------|
| 4.1   | -0.0002<br>(0.012) | 0.188***<br>(0.033) | 0.392<br>(0.323) |                     |                   |                    | 0.189         |
| 4.2   | 0.0007<br>(0.011)  | 0.172***<br>(0.033) | 0.447<br>(0.318) |                     |                   | 0.128**<br>(0.051) | 0.220         |
| 4.3   | 0.003<br>(0.011)   | 0.167***<br>(0.033) | 0.411<br>(0.313) | 0.234***<br>(0.071) |                   |                    | 0.244         |
| 4.4   | -0.0004<br>(0.012) | 0.186***<br>(0.034) | 0.408<br>(0.327) |                     | 0.045<br>(0.108)  |                    | 0.184         |
| 4.5   | 0.003<br>(0.011)   | 0.169***<br>(0.033) | 0.378<br>(0.315) | 0.261***<br>(0.077) | -0.102<br>(0.112) |                    | 0.243         |

- standard errors are in parentheses.

Number of observations : 140

\* = significant at 10%-level

\*\* = significant at 5%-level

\*\*\* = significant at 1%-level

The results over the period 1973-1979 reveal, again, a strongly significant estimate for the investment variable. The labour force growth appears to have an insignificant effect on economic growth which is in contrast with the results of Table 3. More important is that in Table 4 the same picture as in Table 3 emerges when the exports are included in the regression, i.e. the northern exports exert a strongly significant influence on economic growth while the effect of exports going to the South are not significantly different from zero.

Table 5, however, shows a remarkable contrast for the second subperiod (1980-1985). Now the southern exports have a stronger positive effect on economic growth than the exports to the northern nations. In regression 5.5 the  $\beta_4$ -coefficient has not been starred but  $\beta_4 = 0.250$  is significant at a 10.85% level. This finding shows that in the first half of the 1980s the southern exports did have a stronger influence on economic growth than during the 1970s. Calculation of the productivity parameters gives us for 1973-1979:  $\theta = 0.353$  and  $\gamma = -0.261$  (under the assumption that  $\beta_4 = 0$ ) and for 1980-1985 :  $\theta = 0.0$  and  $\gamma = 0.333$  ( $\beta_3 = 0$  and  $\beta_4 = 0.250$  have been assumed). This means that during the 1980s the southern export sector, indeed, shows a higher marginal factor productivity than the northern one, while in the 1970s the same picture as that of Table 3 emerged. The switch of significance in the coefficients for the northern and the southern exports can be considered as a *tendency* that tells in favour of

**Table 5** Estimates of the model parameters. Annual data are pooled for 20 countries over 1980-1985

| cases | $\beta_0$            | $\beta_1$           | $\beta_2$        | $\beta_3$        | $\beta_4$         | $\beta_5$          | $\bar{R}^2$ |
|-------|----------------------|---------------------|------------------|------------------|-------------------|--------------------|-------------|
| 5.1   | -0.043***<br>(0.015) | 0.231***<br>(0.032) | 0.596<br>(0.486) |                  |                   |                    | 0.303       |
| 5.2   | -0.042***<br>(0.014) | 0.196***<br>(0.035) | 0.812<br>(0.491) |                  |                   | 0.205**<br>(0.099) | 0.322       |
| 5.3   | -0.044***<br>(0.015) | 0.216***<br>(0.033) | 0.725<br>(0.494) | 0.192<br>(0.147) |                   |                    | 0.308       |
| 5.4   | -0.041***<br>(0.015) | 0.206***<br>(0.034) | 0.697<br>(0.485) |                  | 0.271*<br>(0.154) |                    | 0.316       |
| 5.5   | -0.042***<br>(0.015) | 0.195***<br>(0.036) | 0.800<br>(0.493) | 0.163<br>(0.147) | 0.250<br>(0.155)  |                    | 0.317       |

- standard errors are in parentheses.

Number of observations : 120

\* = significant at 10%-level

\*\* = significant at 5%-level

\*\*\* = significant at 1%-level

Amsden's argument that South-South trade shows higher gains in productivity than South-North trade and as it is plausible that the ultimate effect of southern exports on GDP growth will come out only towards the end of the sample period.

The fact that learning effects emerge only after some time, e.g. after  $k$  years, means that the exports of skill-intensive goods at  $t$  may positively affect the gains of productivity at  $t+k$ . One may wonder whether it would not be better to construct a model incorporating such lags. The problem is that it will be very difficult to determine them. The theoretical arguments that underlie the learning effects give no indication about the length of the lags. So, they would have to be estimated in a statistical way, which is a cumbersome and possibly unrewarding task. Our purpose is only to find out whether exports to the South after a certain time period generate larger productivity gains than those going to the North. Whether these gains can be attributed to growth at earlier dates is not investigated. This might be an important although time-consuming task for further research.

One might expect a certain heterogeneity of the sample as regards the cross-section units, i.e. the countries. Hence we estimated the model once more but now separately for the 9 Latin American and for the 11 Asian nations. The results are given in Table 6.

Again, the investment variable is very significant in all regressions. For Asia the export variable provides a positively significant contribution to economic growth. Especially the northern exports have a strongly positive impact, unlike export flows to developing countries. In the Latin American cases all export variables appear to be insignificant. Moreover, it is remarkable that the  $\beta_0$ -estimates of these regressions have a negative sign and are strongly significant. This means that if the independent variables in the equation are set equal to zero, economic growth is found to be negative. How is this finding to be explained? In such a stationary economy the

**Table 6 Estimates of the model parameters. Annual data are pooled for 11 Asian countries (A) and 9 Latin American nations (LA). Period: 1973-1985.**

| cases  | $\beta_0$            | $\beta_1$           | $\beta_2$         | $\beta_3$           | $\beta_4$        | $\beta_5$           | $\bar{R}^2$ |
|--------|----------------------|---------------------|-------------------|---------------------|------------------|---------------------|-------------|
| 6.1 A  | -0.009<br>(0.014)    | 0.123***<br>(0.029) | 0.595<br>(0.370)  |                     |                  |                     | 0.104       |
| 6.1 LA | -0.054***<br>(0.013) | 0.427***<br>(0.059) | -0.515<br>(0.461) |                     |                  |                     | 0.318       |
| 6.2 A  | 0.010<br>(0.014)     | 0.101***<br>(0.029) | 0.712*<br>(0.362) |                     |                  | 0.144***<br>(0.047) | 0.154       |
| 6.2 LA | -0.054***<br>(0.013) | 0.418***<br>(0.059) | -0.469<br>(0.459) |                     |                  | 0.243<br>(0.153)    | 0.327       |
| 6.3 A  | 0.010<br>(0.014)     | 0.104***<br>(0.028) | 0.664*<br>(0.358) | 0.229***<br>(0.070) |                  |                     | 0.163       |
| 6.3 LA | -0.054***<br>(0.013) | 0.419***<br>(0.059) | -0.488<br>(0.460) | 0.226<br>(0.166)    |                  |                     | 0.323       |
| 6.4 A  | 0.009<br>(0.014)     | 0.114***<br>(0.029) | 0.665*<br>(0.371) |                     | 0.136<br>(0.091) |                     | 0.112       |
| 6.4 LA | -0.055***<br>(0.013) | 0.426***<br>(0.059) | -0.501<br>(0.463) |                     | 0.200<br>(0.307) |                     | 0.315       |
| 6.5 A  | 0.010<br>(0.014)     | 0.103***<br>(0.029) | 0.680*<br>(0.362) | 0.219***<br>(0.075) | 0.038<br>(0.095) |                     | 0.158       |
| 6.5 LA | -0.054***<br>(0.013) | 0.418***<br>(0.059) | -0.469<br>(0.461) | 0.241<br>(0.167)    | 0.251<br>(0.308) |                     | 0.321       |

- standard errors are in parentheses

\* = significant at 10%-level

\*\* = significant at 5%-level

\*\*\* = significant at 1%-level

Number of observations :

Asia 143

Latin America 117

labour force and the export levels are constant. The capital stock declines in the course of time because obsolete machinery is not replaced (the investment variable is measured as Gross Domestic Investment). It is the declining capital stock that may be held responsible for the negative  $\beta_0$ -estimate. An estimate not significantly different from zero, like in the Asian cases, can only be found if there would be another factor that compensates for the declining capital stock. Because the other primary input, labour, is assumed to be constant too, that factor must be *the more productive use of inputs* often referred to as *intensive growth*. The estimation results thus would seem to imply that the growth of productivity of the inputs in the Asian countries is larger than in the Latin American ones.<sup>15</sup> This picture emerges for both subperiods 1973-1979 and 1980-1985. The more productive use of inputs might mean that the type of technical change

<sup>15</sup> The incorporation of the export variables in the Asian regressions, indeed, does not change the  $\beta_0$ -estimate. The exports only explain a part of the factor productivity which in cases without exports is picked up by the investment variable. Note the decline of the  $\beta_1$ -value when the export variables are added.

is different. However, we assumed technical change for all sectors in all countries to be the same, Hicks-neutral and constant. If we maintain this assumption there must be other causes that affect the productive use of inputs negatively in the case of LA. They have to be found in the economic policy environment of the individual nations. The economic policy environment can roughly be divided in two categories, 1) trade policies and 2) macroeconomic policies.

With regard to trade strategies there are several differences between the Latin American and the Asian countries. In the World Development Report 1987 (p. 82/83) a classification of trade strategies is proposed. Four strategies are distinguished: 1) strongly outward oriented, 2) moderately outward oriented, 3) moderately inward oriented, 4) strongly inward oriented. The first two trade strategies focus on a minimization of disincentives to exports (as might follow from import barriers) while the latter two create incentives in favour of production for the domestic market<sup>16</sup>

Our 20 sample countries can be classified as follows (period 1973-1985):<sup>17</sup>

| Strongly outward oriented | Moderately outward oriented | Moderately inward oriented | Strongly inward oriented |
|---------------------------|-----------------------------|----------------------------|--------------------------|
| Hong Kong                 | Brazil                      | Colombia                   | Argentina                |
| Korea                     | Malaysia                    | Costa Rica                 | Bangladesh               |
| Singapore                 | Thailand                    | Honduras                   | Bolivia                  |
|                           | Uruguay                     | Indonesia                  | India                    |
|                           |                             | Mexico                     | Peru                     |
|                           |                             | Pakistan                   |                          |
|                           |                             | Philippines                |                          |
|                           |                             | Sri Lanka                  |                          |

The classification clearly demonstrates that nations with outward-oriented trade policies are mostly the Asian countries. Particularly the strongly outward-oriented alternative consists of Asian countries only.

With respect to the macroeconomic performance the World Development Report shows that nations adopting outward-oriented strategies have a lower incremental capital-output ratio in 1973-1985 than the inward-oriented countries (WDR 1987, p.82). A lower incremental capital-output ratio indicates that investment is more productive, which means that there will be a larger intensive growth in the outward-oriented economies than in those implementing inward-looking trade policies.<sup>18</sup> Although the majority of the outward-oriented economies classified

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<sup>16</sup> Exact definitions of the strategies can be found in WDR 1987, p. 82

<sup>17</sup> A critique on the analysis of the World Bank has been formulated by Singer (1989)

<sup>18</sup> There are many arguments explaining why outward-oriented trade policies will reveal higher productivity of input factors than inward-oriented strategies. Among them are 1) the rent-seeking behaviour of economic subjects in an inward-looking regime resulting from rationing of foreign exchange, import, etc., and 2) scale economies that can be achieved under outward-looking policies because the market is extended by the exports. Other arguments can be found in World Development Report 1987, p.90/91.

above are in developing Asia, it cannot be denied that there are also Asian countries classified as inward-looking, particularly South Asian nations like India, Pakistan, Bangladesh and Sri Lanka. Like many Latin American countries these four economies tried to liberalize trade. The essential difference with the Latin American cases is that the macroeconomic policies implemented by the governments of these South Asian developing nations did in fact contribute to stability. Cost-price distortions were corrected, trade policies liberalized, industrial regulations relaxed with the purpose to improve the efficiency of investment and resource allocation. These policies were supported by restrained financial policies to achieve price stability. Especially in India and Pakistan these policies have been quite successful. The macroeconomic stability in the South Asian countries has contributed to the avoidance of economic crises that are characteristic for the liberalization attempts in Latin America.<sup>19</sup> In the latter nations stabilization and liberalization policies were implemented after the domestic economies had plunged in a deep crisis already, i.e. high inflation rates, large government budget deficits, large deficits on the current account balance and very volatile capital flows. In the mid-1970s countries like Argentina and Uruguay started a policy of trade liberalization. They liberalized the capital account rather soon. With regard to the trade balance export taxes were removed but imports remained strongly protected. Exports were increased and gave rise to expectations of currency appreciation. The results were a large capital inflow and an appreciated real exchange rate. Domestic macroeconomic instability increased the risk of productive investment.<sup>20</sup> The productivity of the production factors was strongly negatively affected by these developments. Countries like Brazil and Colombia achieved better results than Argentina with regard to export performance. However, domestic financial management was weak and increased foreign debt commitments and the inflation rate. Particularly after 1979, the beginning of the international debt crisis started a period of domestic economic instability with declining productivity of the production factors.

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<sup>19</sup> We are not pretending that the four countries have been successful in all respects. Due to several external developments like the oil crisis of 1979, droughts, etc., some of the successes were nullified. But with regard to the Latin American countries the outcome of the liberalization and stabilization policies was rather successful.

<sup>20</sup> The public sector deficit of Argentina remained very high, pushing up the interest rate and increasing the foreign debt of the country. Particularly after the oil price increases of 1979 the fragile domestic economic situation collapsed. The terms of trade deteriorated and capital inflows reversed into an enormously growing capital flight.

**Table 7 Estimates of the model parameters. Annual data are pooled for 11 Asian countries (A) and 9 Latin American nations (LA). Period: 1973-1979.**

| cases  | $\beta_0$           | $\beta_1$           | $\beta_2$           | $\beta_3$           | $\beta_4$         | $\beta_5$          | $\bar{R}^2$ |
|--------|---------------------|---------------------|---------------------|---------------------|-------------------|--------------------|-------------|
| 7.1 A  | 0.015<br>(0.016)    | 0.142***<br>(0.038) | 0.518<br>(0.421)    |                     |                   |                    | 0.139       |
| 7.1 LA | -0.044**<br>(0.019) | 0.489***<br>(0.104) | -1.174*<br>(0.636)  |                     |                   |                    | 0.274       |
| 7.2 A  | 0.014<br>(0.016)    | 0.129***<br>(0.038) | 0.569<br>(0.412)    |                     |                   | 0.113**<br>(0.053) | 0.178       |
| 7.2 LA | -0.045**<br>(0.019) | 0.484***<br>(0.103) | -1.166*<br>(0.631)  |                     |                   | 0.234<br>(0.166)   | 0.286       |
| 7.3 A  | 0.016<br>(0.016)    | 0.125***<br>(0.037) | 0.538<br>(0.403)    | 0.213***<br>(0.077) |                   |                    | 0.211       |
| 7.3 LA | -0.043**<br>(0.019) | 0.490***<br>(0.102) | -1.259**<br>(0.623) | 0.334*<br>(0.169)   |                   |                    | 0.307       |
| 7.4 A  | 0.014<br>(0.016)    | 0.140***<br>(0.038) | 0.539<br>(0.425)    |                     | 0.058<br>(0.112)  |                    | 0.130       |
| 7.4 LA | -0.043**<br>(0.019) | 0.499***<br>(0.104) | -1.294**<br>(0.645) |                     | -0.416<br>(0.384) |                    | 0.276       |
| 7.5 A  | 0.017<br>(0.016)    | 0.125***<br>(0.037) | 0.507<br>(0.406)    | 0.242***<br>(0.086) | -0.091<br>(0.119) |                    | 0.207       |
| 7.5 LA | -0.042**<br>(0.019) | 0.498***<br>(0.102) | -1.344**<br>(0.633) | 0.313*<br>(0.172)   | -0.313<br>(0.381) |                    | 0.304       |

- standard errors are in parentheses

\* = significant at 10%-level

\*\* = significant at 5%-level

\*\*\* = significant at 1%-level

Number of observations:

Asia 77

Latin America 63

So far our explanation of the Table 6 findings that refer to the entire period under review. What happens when we split the period into the two subperiods referred to earlier? This is shown in Tables 7 and 8. The 1970s show for both Asian and Latin American countries significant  $\beta_3$ -coefficients, although for Asia a 1%- and for Latin America a 10%-level of significance is obtained. For both continents the  $\beta_4$ -coefficients are not significantly different from zero. In the 1980s the effects of exports to the South become significant in the Asian part of the sample only. In Latin America both kinds of exports do not contribute to economic growth. This finding is not in line with Havrylyshyn (1986) who states that South-South trade is due to inefficiencies of import substitution policies. For Latin America our analysis provides evidence for this. Nevertheless, it does not mean that South-South trade is always due to such inefficiencies. The Asian cases present proof of trade between developing countries as a provider of economic growth. This corresponds to Amsdens' line of reasoning.

**Table 8 Estimates of the model parameters. Annual data are pooled for 11 Asian countries (A) and 9 Latin American nations (LA). Period: 1980-1985.**

| cases  | $\beta_0$            | $\beta_1$           | $\beta_2$        | $\beta_3$        | $\beta_4$          | $\beta_5$          | $\bar{R}^2$ |
|--------|----------------------|---------------------|------------------|------------------|--------------------|--------------------|-------------|
| 8.1 A  | 0.003<br>(0.026)     | 0.127***<br>(0.045) | 0.326<br>(0.730) |                  |                    |                    | 0.105       |
| 8.1 LA | -0.055**<br>(0.021)  | 0.306***<br>(0.082) | 0.071<br>(0.698) |                  |                    |                    | 0.194       |
| 8.2 A  | 0.002<br>(0.025)     | 0.085*<br>(0.047)   | 0.699<br>(0.722) |                  |                    | 0.228**<br>(0.096) | 0.167       |
| 8.2 LA | -0.055***<br>(0.020) | 0.286***<br>(0.082) | 0.178<br>(0.696) |                  |                    | 0.356<br>(0.258)   | 0.208       |
| 8.3 A  | 0.001<br>(0.026)     | 0.111**<br>(0.046)  | 0.536<br>(0.740) | 0.209<br>(0.149) |                    |                    | 0.119       |
| 8.3 LA | -0.055**<br>(0.021)  | 0.292***<br>(0.084) | 0.170<br>(0.712) | 0.241<br>(0.310) |                    |                    | 0.187       |
| 8.4 A  | 0.005<br>(0.026)     | 0.094**<br>(0.046)  | 0.526<br>(0.716) |                  | 0.313**<br>(0.146) |                    | 0.154       |
| 8.4 LA | -0.055***<br>(0.020) | 0.308***<br>(0.081) | 0.010<br>(0.696) |                  | 0.554<br>(0.446)   |                    | 0.202       |
| 8.5 A  | 0.003<br>(0.257)     | 0.083*<br>(0.047)   | 0.677<br>(0.727) | 0.166<br>(0.147) | 0.289*<br>(0.147)  |                    | 0.157       |
| 8.5 LA | -0.055***<br>(0.020) | 0.293***<br>(0.084) | 0.114<br>(0.709) | 0.258<br>(0.309) | 0.570<br>(0.448)   |                    | 0.197       |

- standard errors are in parentheses

\* = significant at 10%-level

\*\* = significant at 5%-level

\*\*\* = significant at 1%-level

Number of observations:

Asia : 66

Latin America : 54

In Table 9 we present the values of the productivity parameters calculated from the regression estimates. The figures show that during the period 1980-1985, for the Asian countries southern exports had a higher marginal productivity than northern exports.

**Table 9 Calculations of  $\theta$  and  $\gamma$  from the estimates of the parameters  $\beta_3$  and  $\beta_4$**

| PERIOD    | ASIA     |          | LATIN AMERICA |          |
|-----------|----------|----------|---------------|----------|
|           | $\theta$ | $\gamma$ | $\theta$      | $\gamma$ |
| 1973-1979 | 0.319    | -0.242   | 0.456         | -0.313   |
| 1980-1985 | 0.0      | 0.406    | 0.0           | 0.0      |
| 1973-1985 | 0.280    | -0.219   | 0.0           | 0.0      |

Note :  $\gamma$  is calculated with  $\beta_4 = 0$  for 1973-1979 and for 1973-1985.

The question that still remains after having considered the findings reported in the tables above is: is the significant  $\beta_4$ -coefficient (and the resulting positive  $\gamma$ ) possibly due to the Amsden effect in certain countries, or can it be attributed to a general phenomenon that gives rise to the differences in productivity between southern and northern export production in Asia?

It appears that especially Malaysia and Singapore can be held responsible for the significant  $\beta_4$ -estimate in the 1980s. Table 10 shows estimates that must be compared with regression 8.5 A.

**Table 10 Estimates of the model parameters. Annual data are pooled for Asian countries only over 1980-1985**

|   | $\beta_0$         | $\beta_1$          | $\beta_2$        | $\beta_3$          | $\beta_4$          | $\beta_5$ | $\bar{R}^2$ |
|---|-------------------|--------------------|------------------|--------------------|--------------------|-----------|-------------|
| A | -0.005<br>(0.027) | 0.130**<br>(0.055) | 0.497<br>(0.743) | 0.258<br>(0.186)   | 0.151<br>(0.221)   |           | 0.123       |
| B | -0.011<br>(0.029) | 0.094*<br>(0.052)  | 1.213<br>(0.833) | 0.300*<br>(0.162)  | 0.244<br>(0.150)   |           | 0.173       |
| C | -0.034<br>(0.032) | 0.169**<br>(0.063) | 1.327<br>(0.849) | 0.562**<br>(0.214) | -0.0065<br>(0.238) |           | 0.185       |

- standard errors are in parentheses.

\* = significant at 10%-level

\*\* = significant at 5%-level

\*\*\* = significant at 1%-level

A.without Singapore

B.without Malaysia

C.without Singapore and Malaysia

The elimination of Singapore has a very strong influence on the regression results. The  $\beta_3$ -estimate gains some significance, although it still remains insignificant even at the 10%-level. The statistical significance of the coefficient of  $\dot{E}^S/Y$  is completely lost. The effect of Singapore is strongly concentrated on  $\beta_4$ . When Malaysia is excluded from the sample the  $\beta_4$ -estimate is not really affected but the  $\dot{E}^N/Y$ -coefficient, however, strongly gains significance. Elimination of both countries results in a reversed picture as compared with case 8.5 A, i.e., now  $\beta_3$  becomes significant while the coefficient of  $\dot{E}^S/Y$  is not significantly different from zero.

To interpret this finding, we have to remember that the productivity parameters of the model are assumed to differ between Northern-directed and Southern-directed exports as a consequence of the use of different technologies of production. Transit trade is very important in the case of Singapore, and goods that are re-exported are obviously not produced in the country itself. For the purpose of our analysis, trade data for such countries as Singapore are somewhat 'suspect', and there are good reasons for leaving them out. In other words, the results of case 10.C are probably more reliable than those of case 8.5 A. This forces us to conclude that it is not possible to argue that Amsden's statement of relatively higher productivity gains of southern exports is valid for the nations in our sample.

An additional comment is in place regarding the assumption with respect to the marginal productivity of labour  $F_1^d$ . The term  $F_1^d(\dot{L}/Y)$  as in (3.15) can be written as  $F_1^d(\dot{L}/L)(L/Y)$  which behaves in the same way as  $F_1^d\dot{L}/L$  - introduced in (3.17) - only if  $L/Y$  is constant.

Because of the heterogeneity of the sample it is reasonable to suggest that  $L/Y$  will not be constant, neither in a time-series for a country nor in a cross-section over nations. In Korea  $Y$  will probably have risen more rapidly than  $L$ , while in Bangladesh the labour productivity will increase much slower or even decrease. However, renewed estimation of the model with  $\dot{L}/Y$  instead of  $\dot{L}/L$  as an independent variable did not alter our conclusions.

## 5. The model extended with manufactured exports

The model in the preceding sections only considered total exports divided into those sent to developing countries and the flows destined to developed nations. Amsden's arguments are derived from an analysis based on exports and production in the manufactured sector. It is not inconceivable that the non-manufacturing part of the exports exert an important influence on the results. In order to make our analysis more strict we introduce manufactured and non-manufactured exports separately in the model. It now consists of four sectors.

$$Y^d = F^d (K_d, L_d) \quad (5.1)$$

$$Y^{nm} = F^{nm} (K_{nm}, L_{nm}) \quad (5.2)$$

$$Y^{sm} = F^{sm} (K_{sm}, L_{sm}) \quad (5.3)$$

$$Y^r = F^r (K_r, L_r) \quad (5.4)$$

$$Y = Y^d + Y^{nm} + Y^{sm} + Y^r \quad (5.5)$$

The explanations of the symbols are the same as in section 3. The newly introduced superscripts stand for:

nm = manufactured exports to the north

sm = manufactured exports to the south

r = non-manufactured exports

Taking time derivatives of the equations (5.1) - (5.5) yield:

$$\dot{Y}^d = F_K^d \dot{K}_d + F_L^d \dot{L}_d \quad (5.6)$$

$$\dot{Y}^{nm} = F_{K_n}^{nm} \dot{K}_{nm} + F_{L_n}^{nm} \dot{L}_{nm} \quad (5.7)$$

$$\dot{Y}^{sm} = F_{ks}^{sm} \dot{I}_{sm} + F_{ls}^{sm} \dot{L}_{sm} \quad (5.8)$$

$$\dot{Y}^r = F_k^r \dot{I}_r + F_l^r \dot{L}_r \quad (5.9)$$

$$\dot{Y} = \dot{Y}^d + \dot{Y}^{nm} + \dot{Y}^{sm} + \dot{Y}^r \quad (5.10)$$

The reader should note that

$$\dot{Y}^{tot} = \text{change in total exports} = \dot{Y}^{nm} + \dot{Y}^{sm} + \dot{Y}^r \quad (5.11)$$

With respect to the productivity differences between the sectors we assume

1. productivity in the manufactured export sector destined to the South is higher than that of the northern oriented manufactured export sector.

$$\frac{F_{ks}^{sm}}{F_{kn}^{sm}} = \frac{F_{ls}^{sm}}{F_{ln}^{sm}} = 1 + \theta \quad (5.12)$$

The reasons for this assumption are the same as those put forward by Amsden in her studies on South-South trade (see also section 3 and 4).

2. productivity in the manufactured export sector directed at the northern markets is higher than the productivity results achieved in the sector of non-manufactured exports.

$$\frac{F_{kn}^{nm}}{F_k^r} = \frac{F_{ln}^{nm}}{F_l^r} = 1 + \mu \quad (5.13)$$

This proposition can be justified by arguments mentioned by Chenery (1960). He concluded that there was a strong correlation between increase in per capita income and the rise of value added in the manufacturing sector. Moreover, production processes in the manufacturing sector have characteristics (like large division of specialized labour, continually changing technologies, etc.) that are conducive to rapid productivity growth, while in non-manufactured sectors these characteristics are not present. The argument that manufacturing production would result in a higher contribution to economic growth than non-manufacturing sectors has often been used by governments of developing countries to achieve the goal of fast economic growth.

3. the productivity in the sector of non-manufactured exports lies above that of the domestic sector.

$$\frac{F_k^r}{F_k^d} = \frac{F_l^r}{F_l^d} = 1 + \lambda \quad (5.14)$$

Actually the propositions 1-3 correspond with the earlier assumption that the total (manufactured + non-manufactured) export sector generates higher productivity than the domestic production sector. The reasons for it have already been formulated in section 3 of this paper.

The procedure of solving the model and achieving an equation that can be estimated is the same as in section 3. Therefore we will not repeat the exercise but only give the ultimate outcomes resulting from the Annex. The theoretically derived equation to be estimated is:

$$g_y = \alpha_1 \frac{I}{Y} + \alpha_2 g_l + \alpha_3 \frac{\dot{Y}^{tot}}{Y} + \alpha_4 \frac{\dot{Y}^{nm}}{Y} + \alpha_5 \frac{\dot{Y}^{sm}}{Y} \quad (5.15)$$

which can be reformulated as

$$g_y = \zeta_1 \frac{I}{Y} + \zeta_2 g_l + \zeta_3 g_{y^{tot}} \frac{Y^{tot}}{Y} + \zeta_4 g_{y^{nm}} \frac{Y^{nm}}{Y} + \zeta_5 g_{y^{sm}} \frac{Y^{sm}}{Y} \quad (5.16)$$

with:  $\zeta_1 = F_k^d$

$$\zeta_2 = F_l^d$$

$$\zeta_3 = \frac{\lambda}{1+\lambda}$$

$$\zeta_4 = \frac{\mu}{(1+\mu)(1+\lambda)}$$

$$\zeta_5 = \frac{\theta + \mu + \theta\mu}{(1+\mu)(1+\lambda)(1+\theta)}$$

Estimation of the parameters allows us to calculate the productivity parameters.<sup>21</sup>

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<sup>21</sup> The values of the productivity parameters can be calculated as :

$\lambda = \zeta_3/(1-\zeta_3)$  ;  $\mu = \zeta_4/(1-\zeta_3-\zeta_4)$  and  $\theta = (\zeta_5-\zeta_4)/(1-\zeta_3-\zeta_5)$

## 6. Results of the model with manufactured exports

Manufactured exports are defined as the exports of "Major Division 3" of the International Standard Industrial Classification (ISIC) system. The export flows are converted from the UN Standard International Trade Classification, Rev. 1 into the ISIC system by means of a conversion key of the World Bank. The conversion factors of the UNCTAD used to convert the exports from local currency to US dollars as published in the International Trade Statistics Yearbook of the UNCTAD have been used to change the manufactures export values in US dollars of 1980 to the local currency value. In this way the variables  $\dot{Y}^{nm}/Y$  and  $\dot{Y}^{sm}/Y$  could be calculated. The values of  $\dot{Y}^{tot}/Y$  were computed by converting the 1980 dollar values of the total (manufacturing + non-manufacturing) exports into local currency values. The empirical filling in of the other variables of equation (5.15) is the same as in section 4. The sample is confined to the Asian developing economies as listed in section 4, except that the observations of Bangladesh are limited to 1979-1985, those of India to 1973-1982 and those of Sri Lanka to 1975-1985. The results of the first calculations are given in Table 11.

**Table 11** Parameter estimates of the model extended with manufactured exports. Annual data are pooled for Asian countries: 1973-1985

| case | $\zeta_0$        | $\zeta_1$           | $\zeta_2$          | $\zeta_3$           | $\zeta_4$           | $\zeta_5$         | $\bar{R}^2$ |
|------|------------------|---------------------|--------------------|---------------------|---------------------|-------------------|-------------|
| 11.1 | 0.007<br>(0.016) | 0.146***<br>(0.033) | 0.607<br>(0.378)   |                     |                     |                   | 0.122       |
| 11.2 | 0.009<br>(0.015) | 0.088**<br>(0.035)  | 0.783**<br>(0.365) |                     | 0.396***<br>(0.111) |                   | 0.196       |
| 11.3 | 0.004<br>(0.016) | 0.130***<br>(0.036) | 0.638*<br>(0.379)  |                     |                     | 0.121<br>(0.118)  | 0.123       |
| 11.4 | 0.009<br>(0.015) | 0.090**<br>(0.037)  | 0.780**<br>(0.367) |                     | 0.404***<br>(0.119) | -0.023<br>(0.121) | 0.190       |
| 11.5 | 0.002<br>(0.015) | 0.121***<br>(0.033) | 0.711*<br>(0.368)  | 0.147***<br>(0.048) |                     |                   | 0.176       |
| 11.6 | 0.007<br>(0.015) | 0.089**<br>(0.037)  | 0.802**<br>(0.364) | 0.091*<br>(0.052)   | 0.316**<br>(0.128)  | -0.039<br>(0.120) | 0.203       |

- standard errors are in parentheses.

-. Number of observations: 132

\* = significant at 10%-level

\*\* = significant at 5%-level

\*\*\* = significant at 1%-level

The regressions must be compared with those for Asia in Table 6. Case 11.6 is the one we are mainly interested in because it is the equation resulting from our model. It confirms the picture of Table 6. The exports of manufactures to the North exert a strong influence on economic growth, while the contribution of the manufactured exports to the South is not significantly different from zero. The significance of the variable  $\dot{Y}^{nm}/Y$  is not so good as that

of  $\dot{Y}^n/Y$  in the estimated equation (3.17). This can be explained by the inclusion of total exports  $\dot{Y}^{tot}/Y$  in the model. The variables  $\dot{Y}^{tot}/Y$  and  $\dot{Y}^{nm}/Y$ , indeed, show a significant intercorrelation, as was to be expected. However, we have to include  $\dot{Y}^{tot}/Y$  to remain consistent with the equation that has theoretically been derived. Case 11.4 demonstrates that the restriction of  $\zeta_3 = 0$  makes the coefficient of  $\dot{Y}^{nm}/Y$  more significant than that of  $\dot{Y}^n/Y$  in case 6.5.A. In all cases of Table 11 in which  $\zeta_5$  is included we did not find its estimates significantly different from zero, not even at the 10%-level.

**Table 12** Parameter estimates of the model extended with manufactured exports. Annual data are pooled for Asian countries: 1973-1979.

| cases | $\zeta_0$         | $\zeta_1$           | $\zeta_2$        | $\zeta_3$          | $\zeta_4$          | $\zeta_5$          | $\bar{R}^2$ |
|-------|-------------------|---------------------|------------------|--------------------|--------------------|--------------------|-------------|
| 12.1  | 0.003<br>(0.020)  | 0.177***<br>(0.048) | 0.486<br>(0.429) |                    |                    |                    | 0.152       |
| 12.2  | 0.014<br>(0.020)  | 0.115**<br>(0.055)  | 0.645<br>(0.424) |                    | 0.308**<br>(0.143) |                    | 0.197       |
| 12.3  | -0.001<br>(0.020) | 0.201***<br>(0.058) | 0.410<br>(0.442) |                    |                    | -0.133<br>(0.178)  | 0.147       |
| 12.4  | 0.007<br>(0.020)  | 0.152**<br>(0.058)  | 0.517<br>(0.425) |                    | 0.401**<br>(0.151) | -0.308*<br>(0.183) | 0.219       |
| 12.5  | 0.003<br>(0.019)  | 0.163***<br>(0.047) | 0.527<br>(0.416) | 0.122**<br>(0.054) |                    |                    | 0.203       |
| 12.6  | 0.004<br>(0.020)  | 0.160***<br>(0.058) | 0.501<br>(0.419) | 0.094*<br>(0.056)  | 0.313*<br>(0.158)  | -0.313*<br>(0.180) | 0.241       |

- standard errors are in parentheses.

Number of observations: 69

\* = significant at 10%-level

\*\* = significant at 5%-level

\*\*\* = significant at 1%-level

In Table 12 we present the outcomes of the regressions that must be compared with the "Asian" cases in Table 7, i.e. for the estimation period 1973-1979. Actually, our conclusions from Table 10 are also valid here. There is, however, one exception. Case 12.6 shows a negative  $\zeta_5$ -coefficient which is significant at 10%-level. The implication of this finding (see also Table 14 below) is that the additional marginal factor productivity of southern exports relative to the flows going to the North is negative and in absolute value nearly as large as the positive extra marginal factor productivity of the northern exports with respect to the domestic sector. That means that *per unit of extra export* the additional marginal factor productivity generated in the northern sector is more or less nullified by the negative effect coming from the southern sector. If we restrict the sample to 1980-1985 (see Table 13) and compare the results with those of Table 8 (Asian subset), it is clear that the significant effect of the southern-oriented exports on

economic growth has disappeared. Case 13.4, in which  $\zeta_3$  has been fixed at zero, shows that the manufactured exports to the South have no significant higher factor productivity than those going to the North. The picture is the opposite of 8.5.A, where the southern-oriented exports variable is a significant contributor to economic growth.

**Table 13 Parameter estimates of the model extended with manufactured exports. Annual data are pooled for Asian countries: 1980-1985.**

| cases | $\zeta_0$          | $\zeta_1$           | $\zeta_2$        | $\zeta_3$          | $\zeta_4$          | $\zeta_5$        | $\bar{R}^2$ |
|-------|--------------------|---------------------|------------------|--------------------|--------------------|------------------|-------------|
| 13.1  | 0.001<br>(0.027)   | 0.131***<br>(0.046) | 0.337<br>(0.741) |                    |                    |                  | 0.111       |
| 13.2  | 0.004<br>(0.026)   | 0.088*<br>(0.048)   | 0.596<br>(0.729) |                    | 0.394**<br>(0.181) |                  | 0.163       |
| 13.3  | 0.010<br>(0.028)   | 0.102**<br>(0.049)  | 0.256<br>(0.737) |                    |                    | 0.223<br>(0.154) | 0.127       |
| 13.4  | 0.010<br>(0.027)   | 0.076<br>(0.051)    | 0.514<br>(0.736) |                    | 0.345*<br>(0.190)  | 0.138<br>(0.158) | 0.160       |
| 13.5  | -0.0003<br>(0.026) | 0.088*<br>(0.047)   | 0.733<br>(0.731) | 0.235**<br>(0.097) |                    |                  | 0.178       |
| 13.6  | 0.005<br>(0.027)   | 0.076<br>(0.051)    | 0.664<br>(0.753) | 0.145<br>(0.151)   | 0.173<br>(0.262)   | 0.081<br>(0.169) | 0.158       |

- standard errors are in parentheses.

- number of observations: 63

\* = significant at 10%-level

\*\* = significant at 5%-level

\*\*\* = significant at 1%-level

In Table 14 we have calculated the consequences of the estimated values for the productivity parameters.

**Table 14 Calculations of  $\lambda$ ,  $\mu$  and  $\theta$  for Asian countries only**

| period       | $\lambda$ | $\mu$ | $\theta$ |
|--------------|-----------|-------|----------|
| 1973-1979*** | 0.104     | 0.528 | -0.514   |
| 1980-1985**  | 0.0       | 0.0   | 0.0      |
| 1973-1985*   | 0.100     | 0.533 | -0.348   |

\* = calculated under assumption that  $\zeta_5 = 0$

\*\* = calculated assuming  $\zeta_3 = \zeta_4 = \zeta_5 = 0$

\*\*\* = calculated under assumption that the coefficients  $\zeta_3, \zeta_4$  and  $\zeta_5$  are significant at least at the 10%-level

The calculations are based on the estimates of cases 11.6, 12.6, 13.6 significant at the 10%-level

For both periods 1973-1985 and 1973-1979 the export sector has a higher productivity than the domestic sector ( $\lambda > 0$ ), and the sector exporting manufactured products to the North shows higher productivity gains than the non-manufactured exports. However, the sector of manufactured exports going to the South shows a productivity that is not higher than that of the northern-oriented one. The estimates for the period 1980-1985 are all insignificant which means that the productivity parameters must be set at zero too. Again, we are not able to find empirical support for Amsden's 'productivity argument'.

## 7. Conclusions and Suggestions for Further Research

In this paper we presented an econometric framework for testing an argument that has been put forward in the discussion on the importance of South-South trade for economic development of developing nations. The argument is that the production of commodities exported to other developing countries reveals a higher growth of factor productivity than that of goods exported to developed areas.

The main problem to be considered is the dynamic character of the 'productivity argument'. Many empirical analyses of South-South trade are of a static character, i.e., they test hypotheses for one or maybe two years. The 'productivity hypothesis', however, requires an empirical analysis over a much longer time period. The framework we propose indeed allows for such an analysis, although it is not a truly dynamic framework in the sense that time lags are (theoretically or statistically) determined. The model allows us to estimate the *additional* marginal productivity of the southern-oriented export sector relative to the northern one. The marginal productivity of the latter has been estimated relative to that of the domestic sector of the economy. Estimation of the model for subperiods allows us to assess the development of the change in these variables. Our investigations lead us to the conclusion that the "productivity hypothesis" concerning South-South trade in manufactures is not supported by the data.

As in many empirical studies in economics there are some shortcomings that are worth to be mentioned. A first remark in this respect relates to the data. Their sources are the World Tables 1988-1989 for the domestic variables, and the Direction of Trade Statistics and UN trade data tapes for the export figures. Although these sources are often used in empirical research it is important to note that regarding the World Tables data the so-called Summers-Heston (1988) data may give more accurate figures with respect to the rate of investment. Repeating the analysis with the Summers-Heston data is useful and may give other outcomes although we cannot *a priori* argue how they will differ.

The second shortcoming we would like to point out is connected with the model itself. It allows us to estimate the *additional* marginal factor productivity southern-oriented export sectors would reveal relative to the northern-oriented ones. The determination of the changes of the productivity parameters in both sectors has been done by estimating the model for two sequencing subperiods and afterwards comparing them. Although we believe such a procedure

might be a good starting point for testing the hypothesis, we also admit that it would be an enrichment of the discussion to develop a model allowing the higher growth of southern-oriented factor productivities to come out from the structure of the model itself. Although we do not think it is an impossible task for further research, we are aware of the many theoretical and empirical obstacles that have to be dealt with - several of which we already pointed out in this paper.

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# ANNEX: ELABORATION OF THE MODEL WITH MANUFACTURED EXPORTS

The economy consists of four sectors:

$$Y^d = F^d(K_d, L_d) \quad (1)$$

$$Y^{nm} = F^{nm}(K_{nm}, L_{nm}) \quad (2)$$

$$Y^{sm} = F^{sm}(K_{sm}, L_{sm}) \quad (3)$$

$$Y^r = F^r(K_r, L_r) \quad (4)$$

$$Y^{tot} = Y^{nm} + Y^{sm} + Y^r \quad (5)$$

$$Y = Y^d + Y^{nm} + Y^{sm} + Y^r \quad (6)$$

Explanation of the variables:

- $Y$  = aggregated output
- $Y^d$  = output of the domestic oriented sector
- $Y^{nm}$  = output of manufactured export sector mainly oriented towards the North
- $Y^{sm}$  = output of manufactured export sector mainly oriented towards the Southern destinations
- $Y^r$  = output of the non-manufactured export sector
- $Y^{tot}$  = sum of the outputs of the three export sectors
- $K_i$  = capital stock of sector  $i$
- $L_i$  = employment in sector  $i$

Taking derivatives yields the following relations:

$$\dot{Y}^d = F_k^d \cdot \dot{K}_d + F_L^d \cdot \dot{L}_d \quad (7)$$

$$\dot{Y}^{nm} = F_{kn}^{nm} \cdot \dot{K}_{nm} + F_{ln}^{nm} \cdot \dot{L}_{nm} \quad (8)$$

$$\dot{Y}^{sm} = F_{ks}^{sm} \cdot \dot{K}_{sm} + F_{ls}^{sm} \cdot \dot{L}_{sm} \quad (9)$$

$$\dot{Y}^r = F_k^r \cdot \dot{K}_r + F_L^r \cdot \dot{L}_r \quad (10)$$

$$\dot{Y} = \dot{Y}^d + \dot{Y}^{nm} + \dot{Y}^{sm} + \dot{Y}^r \quad (11)$$

$$\dot{Y}^{tot} = \dot{Y}^{nm} + \dot{Y}^{sm} + \dot{Y}^r \quad (12)$$

We postulate the following relations reflecting the productivity differences between the sectors.

- 1) productivity in the manufactured export sector South > productivity in the manufactured export sector North

$$\frac{F_{ks}^{sm}}{F_{kn}^{sm}} = \frac{F_{ls}^{sm}}{F_{ln}^{sm}} = 1 + \theta$$

- 2) Productivity in the manufactured export sector North > productivity in non-manufactured export sector R.

$$\frac{F_{kn}^{sm}}{F_k^r} = \frac{F_{ln}^{sm}}{F_l^r} = 1 + \mu$$

- 3) Productivity in the non-manufactured export sector > productivity in the domestic sector

$$\frac{F_k^r}{F_k^d} = \frac{F_{lr}^r}{F_{ld}^d} = 1 + \lambda$$

Solving equations (7) - (12) and substituting the postulated productivity relation gives:

$$\begin{aligned} \dot{Y} = & F_k^d \cdot I_d + F_l^d \cdot \dot{L}_d + (1 + \lambda) F_k^d \cdot I_r \\ & + (1 + \lambda) F_l^d \cdot \dot{L}_r + (1 + \mu) (1 + \lambda) F_k^d \cdot I_{nm} \\ & + (1 + \mu) (1 + \lambda) F_l^d \cdot \dot{L}_{nm} + (1 + \theta) (1 + \mu) (1 + \lambda) F_k^d \cdot I_{sm} \\ & + (1 + \theta) (1 + \mu) (1 + \lambda) F_k^d \cdot \dot{L}_{sm} \end{aligned} \quad (13)$$

Working out this relation generates:

$$\begin{aligned} \dot{Y} = & F_k^d \cdot I + F_l^d \cdot \dot{L} + \lambda F_k^d \cdot I_r + \lambda F_l^d \cdot \dot{L}_r \\ & + (\mu + \lambda + \mu\lambda) F_k^d \cdot I_{nm} + (\mu + \lambda + \mu\lambda) F_l^d \cdot \dot{L}_{nm} \\ & + (1 + \theta) (\mu + \lambda + \mu\lambda) F_k^d \cdot I_{sm} \\ & + (1 + \theta) (\mu + \lambda + \mu\lambda) F_k^d \cdot \dot{L}_{sm} \end{aligned} \quad (14)$$

$$\begin{aligned} \dot{Y} = & F_k^d \cdot I + F_l^d \cdot \dot{L} + \frac{\lambda}{1 + \lambda} (F_k^r \cdot I_r + F_l^r \cdot \dot{L}_r) \\ & + \frac{\mu + \lambda + \mu\lambda}{(1 + \mu)(1 + \lambda)} (F_{kn}^{sm} \cdot I_{nm} + F_{ln}^{sm} \cdot \dot{L}_{nm}) \\ & + \left( \frac{(1 + \theta)(\mu + \lambda + \mu\lambda)}{(1 + \theta)(1 + \mu)(1 + \lambda)} + \frac{\theta}{(1 + \theta)(1 + \mu)(1 + \lambda)} \right) (F_{ks}^{sm} \cdot I_{sm} \\ & + F_{ls}^{sm} \cdot \dot{L}_{sm}) \end{aligned} \quad (15)$$

$$\begin{aligned}\dot{Y} = & F_k^d \cdot I + F_l^d \cdot \dot{L} + \frac{\lambda}{1+\lambda} \dot{Y}^r + \frac{\mu+\lambda+\mu\lambda}{(1+\mu)(1+\lambda)} (\dot{Y}^{nm} + \dot{Y}^{sm}) \\ & + \frac{\theta}{(1+\theta)(1+\mu)(1+\lambda)} \cdot \dot{Y}^{sm}\end{aligned}\quad (16)$$

Noting that:

$\dot{Y}^r = \dot{Y}^{tot} - (\dot{Y}^{nm} + \dot{Y}^{sm})$  and substituting it in (16) gives:

$$\begin{aligned}\dot{Y} = & F_k^d \cdot I + F_l^d \cdot \dot{L} + \frac{\lambda}{1+\lambda} \dot{Y}^{tot} \\ & + \left( \frac{\mu+\lambda+\mu\lambda}{(1+\lambda)(1+\mu)} - \frac{\lambda}{1+\lambda} \right) (\dot{Y}^{nm} + \dot{Y}^{sm}) \\ & + \frac{\theta}{(1+\theta)(1+\mu)(1+\lambda)} \cdot \dot{Y}^{sm}\end{aligned}\quad (17)$$

$$\begin{aligned}\dot{Y} = & F_k^d \cdot I + F_l^d \cdot \dot{L} + \frac{\lambda}{1+\lambda} \cdot \dot{Y}^{tot} \\ & + \frac{\mu}{(1+\mu)(1+\lambda)} \cdot \dot{Y}^{nm} \\ & + \left( \frac{\mu}{(1+\mu)(1+\lambda)} + \frac{\theta}{(1+\mu)(1+\lambda)(1+\theta)} \right) \dot{Y}^{sm}\end{aligned}\quad (18)$$

Dividing both sides of (18) through  $Y$  to get growth rates leads to:

$$\begin{aligned}\frac{\dot{Y}}{Y} = & F_k^d \cdot \frac{I}{Y} + F_l^d \cdot \frac{\dot{L}}{Y} + \frac{\lambda}{1+\lambda} \frac{\dot{Y}^{tot}}{Y} \\ & + \frac{\mu}{(1+\mu)(1+\lambda)} \cdot \frac{\dot{Y}^{nm}}{Y} \\ & + \left( \frac{\theta}{(1+\mu)(1+\lambda)(1+\theta)} + \frac{\mu}{(1+\mu)(1+\lambda)} \right) \frac{\dot{Y}^{sm}}{Y}\end{aligned}\quad (19)$$

Assuming  $F_{ld}^d = \zeta_2 \left( \frac{Y}{L} \right)$  and adding a constant term  $\zeta_0$  gives us equation (20):

$$\begin{aligned} \frac{\dot{Y}}{Y} = & \zeta_0 + \zeta_1 \frac{I}{Y} + \zeta_2 \frac{\dot{L}}{L} + \zeta_3 \frac{\dot{Y}^{tot}}{Y} + \zeta_4 \frac{\dot{Y}^{nm}}{Y} \\ & + \zeta_5 \frac{\dot{Y}^{sm}}{Y} \end{aligned} \quad (20)$$

with:

$$\begin{aligned} \zeta_1 &= F_{kd}^d \\ \zeta_2 &= F_{ld}^d \\ \zeta_3 &= \frac{\lambda}{1+\lambda} \\ \zeta_4 &= \frac{\mu}{(1+\mu)(1+\lambda)} \\ \zeta_5 &= \frac{\theta + \mu + \theta\mu}{(1+\mu)(1+\lambda)(1+\theta)} \end{aligned}$$