CUSTOMS UNIONS: INFLUENCE OF THEIR SIZE ON THEIR EFFECT*

1. MODEL USED

In this note we propose to focus on only one aspect of the effects of customs unions, namely how these effects change with an increasing number of members and how they are distributed over members and non-members. The nature of the problem implies that we are not primarily interested in the qualitative differences between various types of unions, or even between the goods produced in the countries concerned. We will therefore use a model which in these respects is as simple as possible, and in which attention is concentrated on the countries as entities and the number of them. The model is a macro-model with regard to each country, using the concepts known from such models. Each country is assumed to produce one product, its national product, which it sells both at home and abroad. Each country imports the products of all the other countries, the prices of which, via the cost of living, influence the cost of production. The prices of the national products influence the relative demand for them, and total demand exerted by any one country is equal to its income. Customs unions, by influencing the prices at which consumers and producers can buy, influence the relative demand for the various nations' products.

The countries will be supposed to be of "equal importance", meaning that demand for their products (at a given income and price level), will be assumed equal and the supply functions of their products will be taken to depend in an identical way on the relevant variables (*cf.* section 2). This makes it unimportant in which country a customs union originates. The restriction that the countries must be of equal importance is not a real one, since countries may be combined into larger units. The number of countries will be taken to be N.

A process will be studied which starts with a state 1, characterized by

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equal import duties levied by all countries on all other countries' imports. Then a union between two members is established which eliminates duties between them. The union is expanded by letting the number of members, n, grow until all nations are included and a state of completely free trade exists. At any stage in the process, the production and real income of each country can be calculated and so their level of economic development can be ascertained.

2. SPECIFICATION OF DEMAND AND SUPPLY FUNCTIONS

Individual countries will be indicated by one subscript and commodity flows between them by two subscripts whose order indicates the direction of movement. Thus V_{ki} represents the value of exports from country k to country i, and is the mathematical product of the quantity v_{ki} and the price p_k of k's economic output.

$$V_{ki} = v_{ki}\, p_k. \tag{2.1}$$

Zeros indicate summation over the subscript concerned; *i.e.* v_{k0} is the total volume of product k shipped to consumers in all countries and is assumed to be equal to the quantity supplied. Similarly, V_{k0} is the total value of this product, representing at the same time country k's national income.

Duties are assumed to be *ad valorem* duties of level t, and the price paid by a consumer in a country levying an import duty on k's product will be $p_k\,(1+t)$.

Demand is taken to be of similar structure in all countries. Demand for product k by country i is given by the equation:

$$V_{ki} = \frac{1}{N} V_{i0} - \frac{\varphi}{N^2}\left(p_k T_{ki} - \frac{1}{N}\sum_h p_h T_{hi}\right). \tag{2.2}$$

This may be interpreted in the following way:

Basically a fixed proportion $1/N$ of income V_{i0} is spent on commodity k. This amount is adjusted, however, if the price level at which the commodity is available to the consumer, $p_k T_{ki}$, diverges from the average price level at which all commodities are made available $1/N\ \sum_h p_h T_{hi}$. In these two expressions T_{ki} or T_{hi} stands for $1+t$ if import duties are levied on commodities k or h, and for 1, if no duties are imposed. The coefficient φ is indicative of the degree of this adjust-

ment, or this substitution between goods. If quantities of goods and of money are so measured as to make all prices and total money income in the free-trade situation equal to 1, φ represents the *elasticity with which the value of product k varies in response to relative price changes.* The demand function (2.2) satisfies the condition that total income is completely spent on all commodities, a fact easily verified by adding up (2.2) for all values of k from 1 to N.

Supply is assumed to satisfy the relation:

$$v_{k0} = \frac{1}{N}\bar{\sigma} - \sigma \frac{\sum_h p_h T_{hk}}{N^2 p_k}. \tag{2.3}$$

This equation may be interpreted to mean that supply is equal to a fixed quantity $\bar{\sigma}/N$, to be called productive capacity (and assumed equal for all countries), minus a correction which varies directly with the ratio of "costs" $1/N \sum_h p_h T_{hk}$ to price received p_k. Costs are taken equal to an unweighted average of the prices to be paid for all goods consumed by country k, and therefore roughly represent "costs of living", as observed in section 1, for that country. As long as all changes in relative prices are small—an assumption we make throughout—the corrections which must be made in the weights because of unequal consumption of different goods are second-order corrections.

The shape of the supply curve may be said to represent the producers' willingness to expand production if a higher real price can be obtained for the product. At the same time it reflects the existence of decreasing returns and the possibility of expanded production, both of which are essential for a realistic setting of our problem.

A few words may be said about the most probable values of the coefficients used in the equations. Assuming that we choose the units of the commodities and of money in such a way as to make all prices and total money demand in the free-trade position equal to one, we will later find [(*cf.* equation (5.3)] that this implies that $\bar{\sigma} - \sigma = 1$. It also implies that all supply elasticities are equal to σ (in that free-trade position). Since under conditions of full employment supply the elasticity is very small, it follows that then also σ should be small, implying that $\bar{\sigma}$ is only a little greater than 1. However, under conditions of overcapacity, σ and $\bar{\sigma}$ may both be higher.

Our coefficient φ, as was already observed, represents the elasticity of substitution for the value of, or expenditure on, each commodity. With regard to volume, such elasticities have often been found to be in the neighbourhood of 2, implying that φ may be about 1. Deviations to both sides seem possible. Perhaps in the short run the lower, and in the long run the higher figures may prevail.

3. WELFARE CONCEPTS TO BE USED

In order to appraise the effects of customs unions of different size, we shall have to use welfare concepts. We propose to use as the main concept one usually applied in questions of international trade, namely total production (for all countries together) and real income (for each separate country). Real income represents the value of national product divided by the price level of goods consumed, taking into account any changes in the terms-of-trade. In addition to the main concept, we shall pay some attention to the distribution among countries (already implied if we calculate real incomes for the separate countries) and among commodities. It has to be assumed that a more evenly distributed consumption basket represents a higher satisfaction than a more unevenly distributed one. In our case of symmetry between goods, this is a reasonable and simple assumption, which in other cases however would have to be replaced by references to utility functions.

From the symbols introduced in section 2, it follows that our main welfare concepts satisfy the following formulae:

Total production:

$$v_{00} = \bar{\sigma} - \frac{\sigma}{N^2} \sum_k \frac{\sum_h p_h T_{hk}}{p_k}. \tag{3.1}$$

Real income of country k:

$$w_k = \frac{v_{k0}\, p_k}{\sum_h p_h} = \frac{\bar{\sigma}\, p_k}{\sum_h p_k} - \sigma \frac{\sum p_h T_{hk}}{N \sum p_h}. \tag{3.2}$$

These expressions will be given more specific and simpler forms for the various states we are going to deal with in section 4. The essence is that there are two average price levels appearing in (3.2): the average *after duty* [also appearing in (3.1)], representing costs to producers

and determining supply (together with p_k), and the average *before duty*, appearing in the denominator of real income, being the price paid by the country at large.

4. EQUILIBRIUM BEFORE AND AFTER UNION BETWEEN n OF N COUNTRIES

Our task will now be to solve the system of equations described in section 2 for different sets of data. The first set, corresponding with state I, would be one where between any two countries $T_{hk} = 1 + t$, whereas for $h = k$, $T_{hk} = 1$. With the establishment of the union, the values of T_{hk} between members of the customs union have to be taken equal to 1 also, and the number of members has to be gradually increased, in order to end up with a state III of free trade in which all $T_{hk} = 1$. We can obtain all these results at once by considering a state II in which n countries are united in a customs union; taking these as the countries 1, 2 . . . n, and indicating by m the number of countries outside the union, we have the following matrix of T_{hk}:

k \ h	1	2	. . .	n	$n+1$	. . . . .	$n+m$
1	1	1	. . .	1	$1+t$	. . . . .	$1+t$
2	1	1	. . .	1	$1+t$	. . . . .	$1+t$
. . .	. . .	. . .	. . .	. . .	. . .	. . . . .	. . .
n	1	1	. . .	1	$1+t$	. . . . .	$1+t$
$n+1$	$1+t$	$1+t$	. . .	$1+t$	1	. . . . .	$1+t$
. . .	. . .	. . .	. . .	. . .	. . .	. . . . .	. . .
$n+m$	$1+t$	$1+t$	. . .	$1+t$	$1+t$	. . . . .	1

It can be shown in a general way that the variables p_k of our system of equations of section 2 have to satisfy the following set of equations which express equilibrium between supply (2.3) and demand [derived from (2.2)]:

$$(4.1) \qquad (\bar{\sigma} + \varphi T_k)\, p_k - \frac{1}{N} \sum_h p_h (\sigma T_{hk} + \varphi T_h) = V_{00}$$

where

$$(4.2) \qquad T_k = \frac{1}{N} \sum_i T_{ki}$$

and

$$V_{00} = \sum_i V_{i0}. \tag{4.3}$$

Because of the symmetry assumed in section 3 between our countries, we can expect that there will be only two different duty-free price levels, namely p_u for the custom union member countries and p_s for the separate countries. Hence, there are two equations (4.1) only, one where k is a member country and one where k is a non-member country. In each, the index h will, in succession, indicate member and non-member countries. Keeping in mind the number of each type, we will find:

k a member:

$$\left\{\bar{\sigma} + \varphi\left(1 + \frac{m}{N}t\right)\right\}p_u - \frac{1}{N}\left[np_u\left\{\sigma + \varphi\left(1 + \frac{m}{N}t\right)\right\} + mp_s\left\{\sigma\,(1+t) + \varphi\left(1 + \frac{N-1}{N}t\right)\right\}\right] = V_{00}$$

k a non-member:

$$\left\{\bar{\sigma} + \varphi\left(1 + \frac{N-1}{N}t\right)\right\}p_s - \frac{1}{N}\left[np_u\left\{\sigma\,(1+t) + \varphi\left(1 + \frac{m}{N}t\right)\right\} + mp_s\left\{\sigma\left(1 + \frac{m-1}{mN}t\right) + \varphi\left(1 + \frac{N-1}{N}t\right)\right\}\right] = V_{00}.$$

From these equations we deduce:

$$\frac{p_s}{p_u} = \pi = \frac{\bar{\sigma} + \varphi\left(1 + \frac{m}{N}t\right) + \sigma\frac{n}{N}t}{\bar{\sigma} + \varphi\left(1 + \frac{N-1}{N}t\right) + \sigma\frac{t}{N}} = 1 - \alpha \tag{4.4}$$

where

$$\alpha = \frac{n-1}{N}\,\frac{\varphi - \sigma}{\bar{\sigma} + \varphi}\,t.$$

We now proceed to the calculation of our welfare concepts. Here it will be useful to introduce two other symbols, namely $p_{(u)}$, the price level of goods inside a union member country, and $p_{(s)}$, the price level inside a non-member country. Disregarding, as before, the second-order terms in the weights, we have

$$(4.5) \qquad p_{(u)} = \frac{1}{N}\left\{np_u + mp_s\,(1+t)\right\}$$

$$(4.6) \qquad p_{(s)} = \frac{1}{N}\left\{np_u\,(1+t) + (m-1)\,p_s\,(1+t) + p_s\right\}.$$

The first of these equations expresses the fact that a member country gets the products of all member countries duty-free, whereas the second states that a non-member gets only its own product in that way.

Calculating total production, we may also use the concepts p_u, p_s, $p_{(u)}$ and $p_{(s)}$ to write it as follows (*cf.* 2.3):

$$v_{00} = \frac{1}{N}\sum_k\left(\bar\sigma - \sigma\frac{p_{(k)}}{p_k}\right) = \frac{1}{N}\left(N\bar\sigma - n\sigma\frac{p_{(u)}}{p_u} - m\sigma\frac{p_{(s)}}{p_s}\right) =$$

$$= \bar\sigma - \frac{\sigma}{N^2}\left\{n\frac{np_u + mp_s(1+t)}{p_u} + m\frac{np_u\,(1+t) + (m-1)\,p_s\,(1+t) + p_s}{p_s}\right\}$$

$$= \bar\sigma - \frac{\sigma}{N^2}\left\{n^2 + mn\,(1+t)\left(\pi + \frac{1}{\pi}\right) + m\,(m-1)\,(1+t) + m\right\}.$$

Since, according to (4.4), $\pi = 1 - a$, and, approximately $1/\pi = 1 + a$, the a-terms vanish and we obtain:

$$(4.7) \qquad v_{00} = \bar\sigma - \sigma - \frac{\sigma t}{N^2}\,(N + n - 1)\,(N - n).$$

Real income of a union member is:

$$w_u = \frac{1}{N}\,\frac{\bar\sigma\,p_u - \sigma\,p_{(u)}}{p} = \frac{\bar\sigma - \dfrac{\sigma}{N}\,(N + mt - ma)}{N - ma},$$

where p stands for the duty-free average of prices. For small values of t and a we may approximate this by

$$\frac{1}{N}\left(\bar\sigma - \sigma - \frac{\dot\sigma m}{N}\,t + \frac{\dot\sigma m}{N}\,a\right) \text{ or:}$$

$$(4.8) \qquad w_u = \frac{1}{N}\left\{\bar\sigma - \dot\sigma - \frac{\dot\sigma m}{N}\,t + \frac{m\,(n-1)}{N^2}\,\frac{\bar\sigma t}{\bar\sigma + \varphi}\,(\varphi - \dot\sigma)\right\}.$$

Similarly, we obtain for non-members:

$$(4.9) \qquad w_s = \frac{1}{N}\left\{\bar{\sigma} - \sigma - \frac{\dot{\sigma}\,(N-1)}{N}\,t - \frac{n\,(n-1)}{N^2}\,\frac{\bar{\sigma}\,t}{\bar{\sigma}+\varphi}\,(\varphi - \dot{\sigma})\right\}.$$

5. SOME CONCLUSIONS

The process can now be summarized as follows. Writing for (4.7):

$$(5.1) \qquad v_{00} = \bar{\sigma} - \sigma + \dot{\sigma}\,t\left\{-1 + \frac{1}{N} + \frac{n\,(n-1)}{N^2}\right\}$$

we observe that in the initial state I, without union, production is at the level (taking $n = 1$):

$$v_{00}^{I} = \bar{\sigma} - \sigma + \dot{\sigma}\,t\left(-1 + \frac{1}{N}\right)$$

and that in the final state III of free trade (where either $t = 0$ or $n = N$)

$$(5.3) \qquad v_{00}^{III} = \bar{\sigma} - \sigma$$

representing a total gain of $\sigma t\ (1 - 1/N)$, which for large N is practically σt.

The *process of change from I to III* is expressed by the last term in (5.1): $\sigma t\ [n\ (n-1)/N^2]$ and appears to be accelerated. For $N = 6$ the consecutive values are (after multiplication by 36):

2 6 12 20 30,

implying that the progress achieved with each additional member of the union, is:

2 4 6 8 10.

It is interesting to note that *these figures are equal* to the number of elements in the T-matrix (in which, with each new member the value of $1 + t$ is reduced to 1) or, *to the number of tariff walls eliminated.*

This economic gain is *not equally shared between members and non-members.* The exact distribution depends on the value of $\varphi - \sigma$ in particular. If $\varphi > \sigma$ we see from (4.8) and (4.9) that members are in a more advantageous situation than if $\varphi < \sigma$, and the reverse is true for the non-members. Assuming, at first, that $\varphi = \sigma$, we find that non-members are not affected at all by the process of integration: they remain at what was the pre-integration income level for all countries.

Accordingly, the advantages, in comparison to the pre-union stage, are shared equally by the members. This implies that late-comers experience a substantial welfare increase upon entering the union.

If $\varphi > \sigma$, that is, *if the substitution elasticity in demand values* (*cf.* section 2), *is relatively large with regard to supply elasticity, non-members may even suffer losses from the integration process.* Inversely, if $\varphi < \sigma$, the non-members will share somewhat in the advantages; and consequently the members will then have smaller advantages. *The members will, however, never suffer a setback below the pre-union state,* as is shown by the following transformation for w_u:

$$(5.4)\quad Nw_u = \bar{\sigma} - \dot{\sigma} - \frac{N-1}{N}\,\frac{\bar{\sigma}}{\bar{\sigma}+\varphi}\,\sigma t + \frac{m\{(n-1)\,\bar{\sigma} - \sigma\}}{N^2\,(\bar{\sigma}+\varphi)}\,\varphi t + \frac{n\,(n-1)}{N^2}\,\frac{\bar{\sigma}}{\bar{\sigma}+\varphi}\,\dot{\sigma}t.$$

Here the third (negative) term is still a little bit less than $-(N-1/N)\,\sigma t$: meaning that the first three terms are a little bit higher than pre-

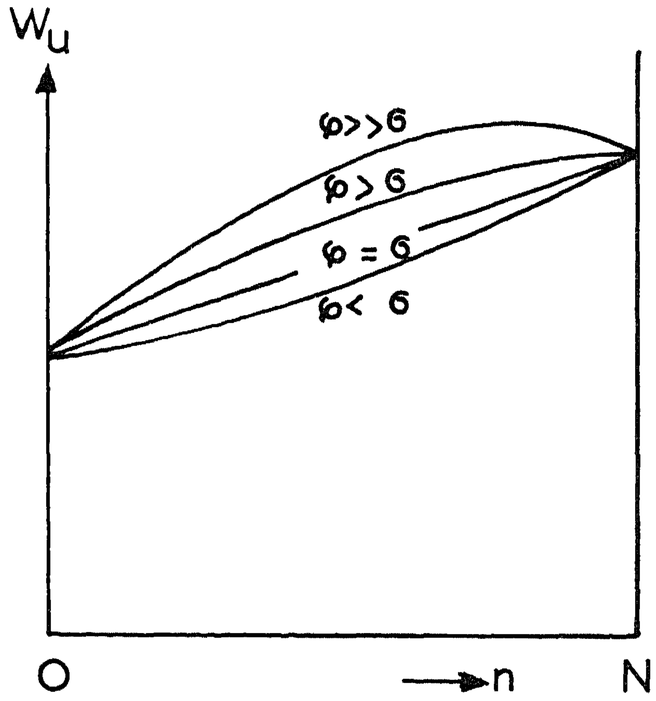

Fig. 1

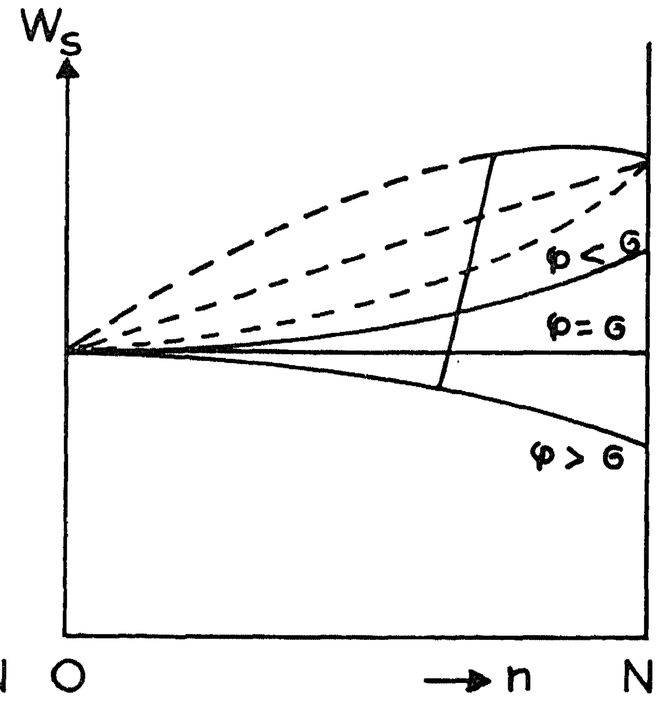

Fig. 2

Fig. 1: Real income w_u of union members as a function of the number n of union members.

Fig. 2: Real income w_s of non-members of the union as a function of the number n of members (———), compared with real income (– – –) of members. Heavy line represents real income of any single country, jump indicates transition to union.

nion total production. And the last two terms are positive. The ›urth term is positive because we have to assume that $\bar{\sigma} > \sigma$; other-ise there would not be a positive production level under any circum-:ances. Consequently, the real income of a member country never ılls below the initial level.

This does not mean, however, that each step of the integration rocess, will always improve the situation of the member countries. .s is shown by the third term of (5.4), as well as by the last term in 4.8), there are forces tending to diminish a member country's real ıcome, since m appears as a factor in an otherwise positive term. *f member countries have gained substantially in the earlier phases of in-:gration, there may be reductions in real income in the later stages of ntegration if the value of φ is high.* As an illustration we may take the ollowing numerical values:

$$\bar{\sigma} = 1\tfrac{1}{3} \qquad \sigma = \tfrac{1}{3} \qquad \varphi = 2.$$

The development of real income of a member country is now (multi-lied by 3240):

$n = 1$	$w_u = 525$
2	532
3	538
4	540
5	541
6	540

It can also be shown that a *member's real income is always higher han a non-member's*. From (4.8) and (4.9) it follows that $N\,(w_u - w_s)$ $= \dfrac{n-1}{N}\,\dfrac{\bar{\sigma}+\sigma}{\bar{\sigma}+\varphi}\,\varphi t$ and this is positive irrespective of the value of $) - \sigma$.

The situation may be described in a general way by Figs. 1 and 2, /hich represent the development over time—due to a regular increase f the size of the union—of the real income of a member country and of non-member country respectively. The former's real income develops long a straight line for $\varphi = \sigma$ and along a parabolic curve for other

relative values of φ and σ. From Fig. 1, it will be clear that retrogressive movements may occur for $\varphi >> \sigma$ (much larger than σ) in the latter phases of integration. Real income of a non-member country develops along a horizontal line for $\varphi = \sigma$ and along the parabolae indicated in Fig. 2 for other values. Since in the process considered every non-member country is bound to become a member country at some time, the development will first occur along one of the light, fulldrawn curves and then jump to one of the dotted lines (which are a replica of the curves of Fig. 1). Especially for the higher values of φ the jump will be considerable (see heavy line).

For those readers who prefer to have some further explanation of the occurrence of the retrogressive movements in real income (which are true also for member countries), it seems useful to calculate the relative price and production levels for each phase of integration.

With regard to relative prices, equation (4.4) discloses that producers' (duty-free) prices of non-member countries in comparison to the same prices for members, are either gradually falling (when $\varphi > \sigma$) or gradually rising (when $\varphi < \sigma$) up to the point where only one non-member is left. With the inclusion of the last country in the union, price levels again become equal. The price ratio will be falling if demand elasticity (as defined above) surpasses supply elasticity, because then duties are affecting demand more than supply. In other words, *union members experience, from the extension of the union, a price-raising demand influence for $\varphi > \sigma$, which surpasses the cost-reducing supply influence*. When, on the other hand, $\varphi < \sigma$, price-reducing influences surpass price-raising influences.

The influences exerted by these relative price changes on each country's real income are the following:

(1) With each increase in the number of members of the union n, the quantity produced

$$\frac{\bar{\sigma}}{N} - \frac{\sigma\{np_u + m(1+t)p_s\}}{N^2 p_u} = \frac{\sigma}{N} - \frac{\bar{\sigma}}{N^2}\left\{n + m(1+t)\frac{p_s}{p_u}\right\}$$

changes because, first of all, in the expression {} (the cost-to-price-ratio), one term $(1+t)p_s/p_u$ is replaced by a term 1. Goods previously imported from an outside country are now obtained from the new member country.

(II) The quantity produced is, in addition, influenced by the change in p_s/p_u as a consequence of the increase in union membership.

(III) Similarly, the "terms of trade" factor in real income

$$\frac{Np_u}{np_u + mp_s} = \frac{N}{n + m\dfrac{p_s}{p_u}}$$

is affected, first, because a term p_s/p_u is replaced by a term 1 and second, because p_s/p_u changes in value.

Closer consideration shows that the nature of the changes depends in the following way on the size of σ:

Influences	$\sigma > \varphi$	$\sigma = \varphi$	$\varphi > \sigma > \varphi - (\bar{\sigma} + \varphi)\dfrac{N}{n-1}$
(I)	rise	rise	rise
(III)	rise	0	fall
(II) and (IV)	rise	0	fall

From this Table it appears that an increase in union membership always raises the members' real income when $\sigma \geq \varphi$, but may reduce it when $\sigma < \varphi$, because of influences (II), (III) and (IV). Values for σ below $\varphi - (\bar{\sigma} + \varphi)\, N/(n-1)$ are very improbable, since for $\varphi > 0$ they are negative.

Since, as we saw, in the somewhat longer run φ surpasses σ in most cases, the possibility that member countries will suffer a reduction in real income in the later phases of integration, is not merely theoretical. This is not the only example of somewhat unexpected consequences of changes in the terms-of-trade.

It seems useful, at this moment, to remember that real income is a rather rough measure of welfare. The distribution of consumption among the various goods becomes more equal in the later phases of integration and this, as a rule, is a favourable element in welfare. Our present model does not permit us to estimate its influence.

6. SUMMARY

A set of countries is considered, each of which produces one commodity, with identical supply functions showing elasticities σ. Demand

functions are identical for these countries and symmetrical with regard to the various goods. Expenditure on each commodity shows a price elasticity of substitution of $-\varphi$. Initially all countries levy import duties t on all imports. Then a customs union is formed between two countries and gradually expanded until all countries are members. Total production appears to increase in an accelerated way, in proportion to the number of tariff walls eliminated. For $\varphi = \sigma$, the real income of member countries rises according to a straight line, while the real income of non-member countries remains constant as long as they do not join the union. For $\varphi \neq \sigma$, the time path is parabolic (*cf.* Figs. 1 and 2), implying that real incomes may sometimes even fall: if $\varphi > \sigma$, income falls continuously in the non-member countries; in the later phases, in the member countries as well. Each country except the pioneers of the union will at a certain moment make the jump from the "non-member curve" to the "member curve". (Heavy line in Fig. 2.)