Protection and Real Wages

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INTRODUCTION

Second only in political appeal to the argument that tariffs increase employment is the popular notion that the standard of living of the American worker must be protected against the ruinous competition of cheap foreign labour. Equally prevalent abroad is its counterpart that European industry cannot compete with the technically superior American system of production. Again and again economists have tried to show the falaciousness of this argument. Professor Taussig, for example, stated that " perhaps most familiar and most unfounded of all is the belief that complete freedom of trade would bring about an equalisation of money wages the world over. . . . There is no such tendency to equalisation."[1] And Professor Haberler classifies the argument that wages might suffer from international trade among those " that do not merit serious discussion. . . . An equalisation of wages comes about only if labour is mobile [between countries]"[2]

More recently, however, the writings of Ohlin seem to suggest that a re-examination of this accepted doctrine might be fruitful. It is the intention of the present paper to show that definitive statements are possible concerning the effects of international trade upon the relative remunerations of productive agencies, and more important, upon their absolute real incomes. That this is possible is surprising since the voluminous literature appears to contain only statements of possibilities and presumptions rather than of necessities. Indeed, in the beginning we expected to do no more than delineate factors which would indicate a likelihood in one direction or another, and only in the course of the investigation did we discover that unambiguous inferences were possible. It may be illuminating, therefore, to follow in the exposition our original sequence of thought rather than attempt the most direct derivation of theorems.

THE EFFECT OF TRADE UPON RELATIVE FACTOR PRICES

According to the train of thought associated with the name of Ohlin, differences in the proportions of the various productive factors between countries are important elements in explaining the course of international trade. A country will export those commodities which are produced with its relatively abundant factors of production, and will import those in the pro-

[1] F. W. Taussig, *International Trade*, p. 38. The statement might have been made equally well with respect to real wages, since in the classical formulation the prices of internationally traded goods cannot diverge in different countries by more than the cost of transfer. In his *Principles* there is a passage which might be interpreted in the opposite direction. " Under certain. contingencies, it is conceivable that protective duties will affect the process of sharing and so will influence wages otherwise than through their effect on the total product." 4th ed., p. 517. But the phrasing is not quite clear and refers probably to the share in national income rather than to the absolute size. We have not found any similar passage either in *The Tariff History of the United States*, in *International Trade*, or in *Free Trade, the Tariff, and Reciprocity*.

[2] G. Haberler, *The Theory of International Trade*, pp. 250–251, bracketed expression ours. See also the preceding sentence on p. 251 where Haberler expressly denies that movement of goods will lead to an equalisation of factor prices. However, as will be discussed below, he does in another place introduce important qualifications to this denial.

duction of which its relatively scarce factors are important.[1] And as a result of the shift towards increased production of those goods in which the abundant factors predominate, there will be a tendency—necessarily incomplete—towards an equalisation of factor prices between the two or more trading countries.[2] It is clear that the equalisation is only partial because otherwise we would be involved in the contradiction that differences in comparative cost would disappear, and there would be no trade. Although partial, the movement in the direction of equalisation is nevertheless real and can be substantial.

Assuming, as we shall throughout, that the total amounts of the factors of production remain fixed, it is clear from the Heckscher–Ohlin theorem that the introduction of trade must lower the relative share in the real or money national income going to the scarce factor of production. For the total return to a factor equals its price times the amount employed, and since we assume full employment before and after trade, the total returns to the factors are proportional to the rates per unit. This argument seems to have relevance to the American discussion of protection versus free trade. If, as is generally thought, labour is the relatively scarce factor in the American economy, it would appear that trade would necessarily lower the relative position of the labouring class as compared to owners of other factors of production. So far we have dealt only with the relative shares of the various factors and have not gone into the effect upon absolute shares. Before entering upon this latter problem, it is of considerable interest to mention the most important currently held viewpoints.

SOME EXISTING VIEWS

Nobody, of course, ever denied that the workers employed in the particular industry which loses a tariff could be hurt in the short-run, but according to the classical theory, in the long-run there would be an increased demand for those commodities in which the country had a comparative advantage, i.e. where labour is more productive.[3] Although money wages might fall, the removal of a tariff would result in a still larger reduction in price levels so that the real wage must rise. In the words of Taussig, " The question of wages is at bottom one of productivity. The greater the productivity of industry at large, the higher will be the general level of wages."[4]

How can this argument be reconciled with the Ohlin type of discussion ? If there were only one commodity produced, then indeed the marginal productivity of labour would depend simply on the relative quantities of labour

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[1] Professor Viner has shown that this line of reasoning was not unknown to the classical economists. See his *Studies in the Theory of International Trade*, pp. 500–507.

[2] B. Ohlin, *Interregional and International Trade*, Chapter II and elsewhere. This appears to be a novel theorem largely unknown to the classical economists, or at least completely unmentioned in Viner's masterful review of doctrine. Perhaps the earliest clear enunciation of this doctrine is that of E. Heckscher in a 1919 article in the *Ekonomisk Tidskrift*, cited by Ohlin. Heckscher apparently gives no prior references. Unfortunately, this important contribution is in Swedish, and we are indebted to Mr. Svend Laursen for a paraphrasing of its contents. Because of its extensive development at the hands of Ohlin, we shall refer to it as the Heckscher–Ohlin theorem.

[3] " The free-trader argues that if the duties were given up and the protected industries pushed out of the field by foreign competitors, the workmen engaged in them would find no less well-paid employment elsewhere." F. W. Taussig, *Principles of Economics*, 4th ed., Vol. I, p. 516.

[4] Ibid, p. 517.

and capital as a whole. And the same would be the case with more than one commodity if labour and capital were combined in the same proportions in the production of each. A movement of the factors of production from one employment to another would then leave the marginal productivities of labour and capital unchanged.

Now, while it is true that under the assumptions of pure competition, homogeneity, and perfect mobility of labour the value of the marginal product of labour (expressed in terms of any commodity) must be the same in each occupation, it nevertheless does not follow that this will depend simply on the proportion of labour and capital as a whole. For in so far as capital and labour are combined in different proportions in each occupation, any change from one production to another will change the " value marginal productivity " of labour (however expressed), even though it will, of course, still be equal in all occupations. In this sense the value marginal productivity of labour as a whole may be considered to depend upon a kind of weighted average of the effective demands for the various producible commodities. It is the essence of the argument of the previous section that international trade in accordance with the principle of comparative advantage so shifts production and the relative effective derived demands as to produce the Heckscher–Ohlin effect.

It is not surprising that the classical argument should not have touched upon the problem of relative and absolute shares since for most purposes the older economists implicitly assumed a one factor economy or an economy in which different factors of production were applied in a dose whose proportions never varied. It is to their credit as realists that again and again they relaxed these assumptions, but they were not always able to weld into a synthesis these excluded effects.[1]

Among more modern writers who are nevertheless in the classical tradition it has long been recognised that a small factor of production specialised for the production of a protected commodity might be harmed by the removal of tariffs.[2] This has received particular attention in connection with the problem of non-competing groups in the labour market. Certain sub-groups of the labouring class, e.g. highly skilled labourers, may benefit while others are harmed. Thus, Ohlin holds that it is quite possible under certain circumstances for free trade to reduce the standard of living of the manufacturing labouring class. " If manufacturing and agricultural labourers form two non-competing groups, high protection of manufacturing industries may raise the real wages of the workers in these industries at the expense of the other factors."[3] Similarly, Haberler remarks that " . . . in the short-run, specialised and immobile groups of workers, like the owners of specific material factors, may suffer

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[1] A good case can be made out that even Ricardo did not adhere narrowly to a labour theory of value, but this is not the place to enter into controversy on this subject. See, however, John Cassels, " A Re-interpretation of Ricardo on Value," *Quarterly Journal of Economics*, Vol. 49, pp. 518 ff.

[2] " It is perfectly clear that the imposition of a prohibitive tariff on the import of raw silk into the United States would increase the rents of the owners of land suitable for the growth of mulberry trees and the earnings of workers, if there be such, completely specialised in caring for silkworms." M. C. Samuelson, " The Australian Case for Protection Re-examined," *Quarterly Journal of Economics*, November, 1939, p. 149.

[3] Ohlin, op. cit., p. 306.

heavy reductions in income when for one reason or another they are faced with more intense foreign competition."[1] Once the principle that no factor can benefit from a tariff has been broken, one is tempted to ask whether similar results are not possible for a large factor of production even if only two factors are assumed. For the logic of the case seems the same whether two classes of labour are considered to be non-competing or whether the " non-competing " factors are labelled " capital " and " labour " respectively.

In treating this problem Haberler expresses doubt that a large and mobile factor such as labour can be harmed by unrestricted international trade. " We may conclude that in the long run the working-class as a whole has nothing to fear from international trade, since, in the long run, labour is the least specific of all factors. It will gain by the general increase in productivity due to the international division of labour, and is not likely to lose at all seriously by a change in the functional distribution of the national income."[2] This is not a dogmatic necessity, but rather regarded as the most probable situation. For lower on the same page Haberler recognises explicitly a possible qualification. If labour enters more importantly in the protected industry, it might possibly be harmed by free trade.[3]

Viner criticises Haberler's conclusion maintaining that there appears to be " no *a priori* or empirical grounds for holding this to be an improbable case."[4] In this connection Viner is concerned primarily with the *relative* share of labour in the national money income. In his discussion he introduces as an element in the problem the prices which consumers must pay for commodities, particularly imports and exports with and without protection. Thus, he says, " But even if labour on the average had low occupational mobility and were employed relatively heavily in the protected industries, its real income might still rise with the removal of tariff protection . . . if it was an important consumer of the hitherto protected commodities, and if the price of these commodities fell sufficiently as a result to offset the reduction in money wages in the new situation."[5] Ohlin and other modern writers raise this problem, but it can also be found in the older literature. Bastable, for example, in good classical fashion points out that free trade may force a food exporting country " to bring worse soils into cultivation, and to raise the value of food, thus permitting of an increase in the amount of agricultural rent. In this instance, the labourers, and possibly the capitalists, may suffer while the landlords gain."[6]

We may sum up as follows : (1) In the narrowest classical version the problem of the effect of trade upon the relative and absolute shares of various productive factors could hardly arise since only one factor is assumed. (2) Outside the confines of this rigid system it has long been recognised that the relative and possibly even the absolute share of a small specific factor of production *might* be increased by protection. This received particular attention in connection with the problem of non-competing groups. (3) With reference to large

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[1] Haberler, op. cit., p. 195.
[2] Haberler, ibid, p. 195.
[3] Similar views are attributed to Wicksell, Carver, Nicholson, and others.
[4] Viner, op. cit., p. 533.
[5] Viner, ibid, p. 533.
[6] C. F. Bastable, *The Theory of International Trade*, 4th ed., p. 105.

categories opinion is more divided. Almost all admit the possibility of a decline in the relative share of a large factor of production such as labour as a result of free trade ; many even admit the possibility of a decline in the real income of a large factor of production. But all writers consider highly improbable a decline in the absolute shares, and many believe the same with respect to the relative shares. Some take the position that no *a priori* presumption is possible in connection with the last problem. (4) The vast majority of writers take it as axiomatic that a calculation of effects upon real income must take into consideration the behaviour of prices of commodities entering into the consumer's budget. Thus, if the owners of a factor of production consume only the exported good (in Professor Pigou's terminology this is the wage good), a different result will be reached than if the wage good were imported. And since in the real world consumption is diversified so that the concept of a wage good is an oversimplification, a difficult index number problem would appear to be involved.

It is the purpose of the present investigation to show that under rather general assumptions definite conclusions can be derived concerning the absolute share of a factor (*a*) even when there is perfect physical mobility of factors of production and a complete absence of specificity, (*b*) even if we are dealing with as few as two large factors of production, and (*c*) without any recourse to the index number problem or to the concept of a wage good.

ASSUMPTIONS OF THE ANALYSIS

For purposes of the analysis we shall start out with rather simplified assumptions, considering subsequently the effect of more realistic modifications. In order to keep the number of variables down to manageable proportions we assume only two countries. This involves no loss of generality since the " rest of the world " may always be lumped together as Country II. For the sake of exposition and diagrammatic convenience, only two commodities are considered, labelled respectively " wheat," A, and " watches," B. To accord with the Ohlin assumptions the production functions of each commodity are made the same in both countries and involve only two factors of production identified for convenience as labour (L) and capital (C).[1]

Moreover, by means of a simple device it is possible to avoid detailed consideration of the second country since all of its effects upon the first operate via changes in the price ratio of the two traded commodities.[2] We shall call this price ratio of wheat to watches P_a/P_b. It is irrelevant for our argument just why the exchange ratio of the two commodities is different after international trade is established ; it is sufficient that it does change.[3]

[1] It might possibly give rise to less confusion if instead of capital the second factor were called land because of the ambiguities involved in the definition of capital. The reader who is bothered by this fact is invited to substitute mentally land for capital in all that follows.
[2] For an example of the use of this device see P. A. Samuelson, " The Gains from International Trade," *Canadian Journal of Economics and Political Science*, May, 1939.
[3] In the limiting P_a/P_b would be unchanged. Also, in the classical constant cost case of a large country facing a smaller one trade may take place, but to an extent insufficient to result in complete specialisation on the part of the large country, and hence P_a/P_b may be unchanged. This exception is touched upon later.

The effect of international trade upon the shares of the productive factors can now be analysed by varying P_a/P_b as a parameter from its value as determined in the absence of trade, or with a given amount of protection, to its new value after free trade is opened up. Throughout we follow the conventional method of comparative statics, disregarding the process of transition from the old to the new equilibrium. Full employment of both factors is assumed to be realised before and after the change, and each factor is assumed to have perfectly complete physical mobility.[1] Throughout pure competition is assumed. The following symbols are used :

The amount of labour used in producing A .. .. .. L_a
The amount of labour used in producing B .. .. .. L_b
The amount of capital used in producing A .. .. .. C_a
The amount of capital used in producing B .. .. .. C_b
The total amount of labour used in producing both A and B L
The total amount of capital used in producing both A and B C

It is assumed that regardless of trade the total amounts of each factor of production remain unchanged. Therefore, we have the following obvious identities :

$$L_a + L_b = L \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (1)$$

$$C_a + C_b = C \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (2)$$

The production functions relating each good to the inputs of the factors allocated to its production can be written respectively as :

$$A = A \ (L_a, C_a) \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (3)$$

$$B = B \ (L_b, C_b) \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (4)$$

Because we are concerned with proportions and not with the scale of the process, these functions are assumed to be homogeneous of the first order.

It is a well-known condition of equilibrium that the ratio of the marginal productivities of the two factors must be the same in each occupation, because otherwise there would be a transfer from lower to higher levels. Symbolically this can be expressed as follows :[2]

$$\frac{\dfrac{\partial A\,(L_a, C_a)}{\partial L_a}}{\dfrac{\partial A\,(L_a, C_a)}{\partial C_a}} = \frac{\dfrac{\partial B\,(L_b, C_b)}{\partial L_b}}{\dfrac{\partial B\,(L_b, C_b)}{\partial C_b}}, \dots\dots\dots\dots\dots\dots\dots\dots\dots (5)$$

where the partial derivatives stand respectively for the marginal productivities of given factors in the production of the indicated commodity.

We are still lacking one condition to make our equilibrium complete. If we add as a known parameter the value of P_a/P_b, that is, the price ratio between the two goods, wheat and watches, all our unknowns will be completely deter-

[1] We should like to emphasise that in our argument there is no dependence upon imperfections in the labour market such as form the basis for the Manoilesco type for defense of a tariff. See M. Manoilesco, *The Theory of Protection and International Trade* (1931).

[2] Of course, this holds only if something of both commodities is produced, that is, if trade does not result in complete specialisation. The effect of this qualification is treated below

mined : the amounts of each factor of production allocated to the various commodities (L_a, L_b, C_a, C_b), the amounts produced of each good (A, B), and most important for the present investigation, the marginal physical productivi-

ties of each factor in terms of each good $\left(\dfrac{\partial A}{\partial L_a}, \dfrac{\partial B}{\partial L_b}, \dfrac{\partial A}{\partial C_a}, \dfrac{\partial B}{\partial C_b}\right)$

But what is the meaning in terms of all of the above magnitudes of labour's real wage ? This is not an easy question to answer if, as is usually true, labour consumes something of both commodities. In principle it is of course possible to determine whether a given individual's real income has gone up or down if one has detailed knowledge of his (ordinal) preference field. But we cannot gather such knowledge simply from observation of the price changes which take place. Possibly an index number comparison of the type associated with the names of Pigou, Haberler, Könus, Staehle, Leontief, and others could serve to identify changes in real income. But we shall later show that this is unnecessary. At this point, purely for reasons of exposition, we shall consider the highly restrictive case where labour consumes only one of the commodities, that is, where there is a single wage good. In this case the real wage in terms of that good is an unambiguous indicator of real income[1] because of the proportionality between occupations indicated in condition (5). It is the marginal physical productivity of labour in the production of the wage good.

The effect of international trade upon the real wage (thus defined) could now be determined mathematically by varying P_a/P_b, the price ratio of the two goods, and observing how the marginal physical productivity of labour in the wage good industry is affected. One could perform this purely mathematical computation by differentiating our equilibrium equations with respect to P_a/P_b, treating as variables all the unknowns listed above. The result of this procedure, not shown here because of its purely technical character, would be found to involve a sum of terms of necessarily different sign, and without introducing further economic content into the problem, we would not be able to achieve a definite result, but would be forced, like the older writers, simply to indicate that all things are possible. However, by introducing further economic content of no less generality than theirs, we shall find that definite results can be derived.

THE ELIMINATION OF THE INDEX NUMBER PROBLEM

With the assumptions made so far it is hardly surprising that no more definite results have been reached. For no assumption has as yet been made as to which country is relatively well supplied with capital or with labour. To begin with we make two assumptions. The first is that the country in question is relatively small and has no influence on the terms of trade. Thus, any gain to the country through monopolistic or monopsonistic behaviour is excluded. Secondly, it is assumed that the removal of the duty will not destroy the formerly protected industry, but only force it to contract.

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[1] It is true that we have been talking about the real wage rate and not about the total amount of real wages, but as we have assumed full employment before and after any change and unvarying total amounts of the factors of production, it follows that the real wage sum will always be proportional to the real wage rate.

Now in equilibrium the value marginal productivity (expressed in terms of any *numéraire*) must be the same in all occupations, and so must be the wage. Therefore, whatever wage labour receives in the wage good industry it must also receive in any other employment. Moreover, any change in the value marginal productivity and, therefore, the wage rate of labour in the wage good industry must mean a corresponding change in the wage rate in all other employments. It follows that we can tell what will happen to real wages (rates as well as sums) of labour as a whole by investigating what will happen to wages in the wage good industry. Since the relevant value marginal productivity, and hence the wage of labour in the wage good industry, is in terms of the wage good, and since labour gets the same wage in all occupations, a decline of the marginal productivity of labour in the wage good industry means a fall in the real wage rate and the real wage sum of labour as a whole.

In other words, whatever will happen to wages in the wage good industry will happen to labour as a whole. And this answer is independent of whether the wage good will be imported or exported, and can be reached without any discussion of what will happen to prices of the commodities as a consequence of international trade.[1]

Assume, for example, (*a*) that the country in question is relatively well supplied with capital, and (*b*) that the proportion of labour to capital is lower in the production of wheat than in the production of watches. There is nothing restrictive about these assumptions because in terms of our previous assumptions one of the countries must be relatively well supplied with a given factor, and through our postponement of the constant cost case for later discussion the importance of labour must be greater in the production of one of the commodities. And since the names " wheat " and " watches " are arbitrary, by re-naming the variables all possible cases could be expressed in the formulation given above.

Two alternative cases must now be considered. (1) The good in whose production capital is relatively important (wheat) is also the wage good. (2) The good in whose production labour is relatively important (watches) is the wage good. Each of these possibilities must be considered in turn.

(1) The introduction of trade will shift production in the direction of the good with " comparative advantage." According to the Ohlin analysis—even though he would not employ the previous term—this will be wheat which uses much of the abundant factor. Its production will expand, and part of it will be exported, while watch production will contract, and part of the watch consumption will be satisfied by imports. This shift in production will be accompanied by a transfer of *both* labour and capital from the watch industry to the wheat industry. But by a reduction in the production of watches more labour will be set free than can be re-employed at the same rates in the production of wheat. This is because the amount of capital released, while sufficient to employ a worker in watch production, is insufficient to employ him in wheat growing at the old wage rate. Hence wage rates have to go down in wheat growing, and

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[1] In connection with a slightly different problem the same point is made by F. Benham, " Taxation and the Relative Prices of Factors of Production," *Economica*, N. S. Vol. 2, 1935, pp. 198–203.

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it follows from the changed factor proportions that the real wage must also decline. It would be clearly incorrect to argue—as one familiar with the orthodox theory of international trade would be tempted to do—that in addition to this decline in productivity due solely to changed factor proportions, there must be added a further loss to the worker *qua* consumer resulting from the inevitable price rise of the exported wage good.

(2) We turn now to the case where watches are the wage good. On the face of it this case would seem to admit only of an ambiguous answer, since any definite conclusion in the productivity sphere would have to confront a necessary fall in the (relative) price of the wage good. Fortunately, that is not so. This case admits of no less definite an answer than the previous one.

The introduction of trade will increase the production of wheat and decrease that of watches. As shown in the previous case, this will entail a movement of both labour and capital. But just as labour has less capital to work with in wheat production than formerly, so does labour have less capital to work with in the production of watches. This is brought about by the change in relative remunerations of the factors necessary to result in the reabsorption of the otherwise redundant labour supply. Therefore, regardless of the behaviour of consumer's good prices, the lowering of the proportion of capital to labour in the production of watches must adversely affect the marginal physical productivity of labour there, and hence, along now familiar lines, the real wage.

We see, therefore, that the seemingly opposite cases lead to exactly the same result. *International trade necessarily lowers the real wage of the scarce factor expressed in terms of any good*: It follows that we are now in a position to drop the assumption of a single wage good. For if the real wage declines in terms of every good, real income must suffer regardless of the tastes and expenditure patterns of the labourers as consumers. Not only can we avoid making index number comparisons, but it is also unnecessary to make the assumption of uniform tastes of all workers which such comparisons implicitly presuppose.

DIAGRAMMATICAL TREATMENT

It may be useful to illustrate the above arguments graphically. In Fig. 1 we plot the familiar substitution curve (production indifference or transformation curve) between the two commodities in the given country. Before trade, equilibrium will have taken place at M with a price ratio corresponding to the slope of the tangent there. International trade will change the price ratio of the two goods, and a new equilibrium point may be taken as N with more wheat production, less watch production, and a higher price ratio between wheat and watches. This diagram represents the result of a fairly complicated economic process by which the given fixed amounts of productive factors are optimally allocated between the two commodities in accordance with marginal productivity conditions which guarantee a maximum amount of one commodity for preassigned given amounts of the other. For many international trade problems this " short-circuiting " is an advantage ; but it omits the essential features of the present problem, and so we must go back of the substitution curve to the underlying production relations,
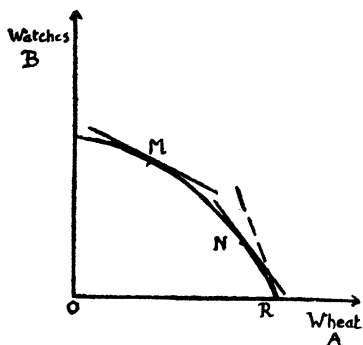
Fig. 1

This is done in Fig. 2 which consists of a modified box diagram long utilised by Edgeworth and Bowley in the study of consumers' behaviour. This rather remarkable diagram enables us to represent the relations between six variables on a two dimensional figure. On the lower horizontal axis is indicated the amount of capital used in the production of wheat. On the left-hand vertical axis is indicated the amount of labour used in the production of wheat. Because the amount of each factor which is not used in the production of wheat must be employed in the production of watches, the upper horizontal axis gives us, reading from right to left, the amount of capital used in the production of watches. Similarly, the right-hand vertical axis, reading downwards, gives us the amount of labour used in the production of watches. The dimensions of the box are, of course, simply those of the unchanging given total amounts of the two productive factors. Any point in the box represents four and capital used to things : measuring from the lower left-hand corner the amounts of labour produce wheat, and measuring from the upper right-hand corner the amounts of labour and capital used in the production of watches.

Disregarding for the moment the other commodity, watches, it is clear that every point in the box corresponds to a given production of wheat, and
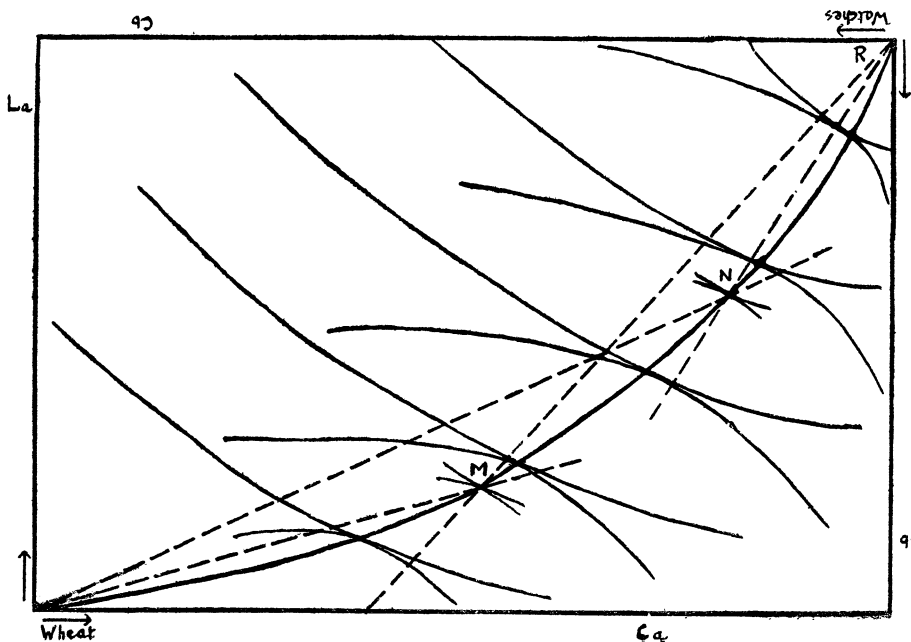

Fig. 2

hence lies on a uniquely determinable isoquant or contour line of the production surface. There is a one-parameter family of such curves with the shape as indicated by the light lines, convex to the lower left-hand corner. Turning now to the production of watches, there also exists a one-parameter family of isoquants convex to the upper right-hand corner, and indicated in the diagram by a second family of curves.

We are now in a position to derive the substitution curve. Any point in the box taken at random corresponds to given amounts of watch and wheat production, but not necessarily to a point on the substitution curve. Only those points which reflect an optimal allocation of resources according to the marginal productivity relations stated earlier correspond to points on the substitution or opportunity cost curve. The locus of points representing optimal positions is clearly given by joining all the points of tangency of the two sets of contour lines. It corresponds geometrically to Edgeworth's *contract curve*, and although the present study does not deal with bargains between contracting parties, we shall retain this descriptive title. If we hold the production of one good constant and thus move along a given isoquant, we will only stop when there is the maximum possible amount of the other good, or when we have reached the highest possible isoquant of the other family. This will be so only at a position of tangency where the ratios of the marginal productivities of the two factors are the same in each line of production.

Under the assumption of homogeneous production functions in two inputs, the contract curve must have the shape indicated in our figure. On the contract curve we have indicated points M and N corresponding to the situation before and after trade. It can now be shown graphically how the following somewhat paradoxical statement can be true : even though the proportion of total capital to total labour remains the same in both lines together, nevertheless the introduction of trade lowers the proportion of capital to labour in each line, and the prohibition of trade, as by a tariff, necessarily raises the proportion of capital to labour in each industry. Although it seems intuitively anomalous, it is graphically clear from the diagram that a movement from N to M raises the proportion of capital to labour in watches, the total proportions remaining unchanged as indicated by the box. The proportion of labour to capital in the production of wheat with trade is indicated by the slope of the angle of the dotted line going between N and the wheat origin. A similar dotted line between the same origin and M shows the proportion of labour to capital in the production of wheat after trade. Its being less steep than the other makes it clear that the ratio of capital to labour has increased. Utilising similar dotted lines between the watch origin and the points M and N, it is likewise seen that the abolition of trade increases the proportion of capital to labour in the production of watches.

How can we reconcile the graphical result with our numerical intuition which tells us that when each of two quantities goes up, an average of them cannot remain constant ? An examination of the exact relationship between the proportions of capital to labour in each line and the proportions in both at once dispels the paradox. The proportion in both is found to be not a simple

average but a weighted arithmetic mean of the proportions in each as indicated by the following identity :

$$\frac{L_a}{L}\frac{C_a}{L_a} + \frac{L_b}{L}\frac{C_b}{L_b} = \frac{C}{L} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots(6)$$

The weights are simply the proportions of the total labour supply used in the respective industries. The abolition of trade raises the proportion of capital to labour in each line, but at the same time through the reverse operation of the principle of comparative advantage automatically gives more weight to the industry which uses the lesser amount of capital to labour.

Thus, we have shown conclusively that a restriction of trade will increase the proportion of capital to labour in both lines. It follows necessarily that the real wage in terms of each commodity must increase regardless of any movements of prices of the consumer's goods. For within each industry increasing the capital which co-operates with labour raises the marginal productivity of labour expressed in physical units of that good. Not only are the labourers of that industry better off with respect to that good, but by the equivalence of real wages everywhere (expressed in terms of any good) labour in general is better off in terms of that good. If the real wage in terms of every good increases, we can definitely state that real income has increased. This is one of the few cases in economic analysis where a given change moves all relevant magnitudes in the same direction and obviates the necessity of a difficult, and often indefinite, index number comparison.

Under the assumed conditions—(a) two commodities, (b) produced by two factors of production, and (c) where trade leaves something of both commodities produced but at a new margin—it has been unequivocally demonstrated that the scarce factor must be harmed absolutely. This is in contrast to the accepted doctrine which may be fairly represented as saying that trade *might* conceivably affect adversely the relative share of a factor, but cannot be expected to harm absolutely an important factor of production. Not only is the latter possible, but under the posited conditions it follows necessarily.

THREE OR MORE COMMODITIES

If the above conclusion held only for two commodities, its interest even for theory would be limited. It is of interest to show, therefore, that the introduction of any number of commodities in no way detracts from the validity of our conclusions. Of course, no simple graphical device can be used to portray this because of the increased number of variables.

One method of approaching the problem might be to arrange the commodities in a sequence according to the relative importance of labour in each. This is not unlike the ordering of commodities long used by Mangoldt,[1] Edgeworth, and others to explain which commodities will be imported and which exported when more than two commodities are introduced into the classical theory of comparative advantage. In our case, however, costs are not constant and are not expressible in a single homogeneous unit of a factor or in a given composite factor.

For the present purpose one need not rely upon such a construction, but

need only realise that the introduction of trade will increase the production of those commodities which use relatively much of the abundant factor, and will lower the production of the commodities using relatively little of the abundant factor. Accompanying this, there will be the familiar Heckscher–Ohlin tendency towards partial equalisation of factor prices in the two countries, the price of the scarce factor falling in relationship to the price of the abundant factor. By itself this tells us nothing concerning the absolute burden or benefit from trade, but deals only with the effect upon relative shares. We cannot simply infer from this anything concerning the behaviour of absolute shares. For it is not as if international trade leaves the total amount of real national income unchanged so that the more one factor receives, the less there will be left for the other. On the contrary, it has been shown elsewhere that trade must increase the national income under the conditions here postulated.

It is nevertheless true that the introduction of trade will harm absolutely the scarce factor of production. To demonstrate this we must recall the fact that at the new higher relative price of capital to labour there will inevitably be a *relative* substitution of labour for capital *in each line* of production. In exactly the same way a restriction upon trade will raise the price of the scarce factor, labour, relative to the abundant factor, capital. There is nothing paradoxical in the fact that the ratio of capital to labour can increase in every line, while the ratio of total capital to total labour remains constant. The explanation given in the two commodity case whereby the weights in the arithmetic mean change in an appropriate fashion holds without modification when there are any number of commodities.

It is now a simple matter to show that the physical marginal productivity of labour in each line must increase, and because of the equalisation of wages in all lines, expressed in terms of any commodity, it immediately follows that restriction of trade increases the real wage of workers expressed in terms of each and every commodity. This obviates the necessity for any index number comparison or for any consideration of the worsening of the terms of trade.

THE CASE OF COMPLETE SPECIALISATION

The reader of the above argument will have realised that its remarkable simplicity springs from the fact that we may infer the real wage of workers in terms of a given good from the real marginal physical productivity of those workers who produce that good. This requires that before and after trade some finite amount, however small, be produced of every good. In a world where technological conditions are conducive towards the maintenance of the state of pure competition implicit in all our previous argument, this is perhaps not too unrealistic an assumption. However, it is still desirable to see what remains of the argument when this assumption is dropped. This is even more so because in the course of the argument it will be shown that the classical theory was not so much incorrect as limited in scope.

Provided that costs are not constant, and that something of both goods was previously consumed, at first price changes brought about by international trade will shift the margin of production, but will still leave some production of

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[1] J. Viner, op. cit., p. 458 ; G. Haberler, op. cit., pp. 136–140.

both commodities. At one crucial price ratio corresponding to the slope of the tangent at R in Fig. 1 the production of one of the commodities will cease completely, and further changes will not alter the specialisation. Up until the critical price ratio is reached, the introduction of trade worsens the position of labour according to the previous arguments. But what happens after this critical price ratio ?

There is no essential loss of generality in considering the two commodity case. For the commodity which is still produced the real wage is determined as before by the physical productivity of the workers in that line. Up until the critical price ratio at which complete specialisation takes place, the scarce labour factors have been shown to lose. Beyond this critical price ratio their physical productivities remain unchanged. It is clear, therefore, that the real wage in terms of the good using little labour is necessarily harmed by the introduction of trade.

With respect to the other commodity the matter is more complicated, and the final result is indeterminate. Up to the critical price ratio we know that the real wage in terms of this commodity must fall. But after specialisation, the level of real wages cannot be determined by the productivity of workers in this line since there are no such workers. One cannot avoid bringing into the analysis the price ratio between the two consumers' goods, that is, the terms of trade. Given this price ratio, it is possible to convert real wages in terms of one commodity into real wages in terms of the other. It becomes apparent that beyond the critical point the real wage in terms of the non-produced, imported good must begin to increase. This is to be balanced against the loss of real wages in terms of this good which took place before the critical point was reached. Whether the result will be on balance favourable or unfavourable cannot possibly be determined on *a priori* grounds, but rests upon the technological and economic features of the countries in question. Even if in a limited number of cases we could determine that the real wage in terms of the imported good would increase, there would still be involved a problem of weighing against this the demonstrated loss in real wages expressed in terms of the good in which the country has a comparative advantage. Here again the final result would be indeterminate, although in favourable cases an index number comparison might be decisive.

Applying this same line of reasoning to the constant cost case of the classical theory of international trade, it is seen that theirs is one of the special unambiguous cases. Either a single factor of production or a never varying composite dose of factors is assumed. Because of constant costs the slightest change in the price ratio of the goods will lead instantaneously to complete specialisation. There results no shifting of the proportions of the factors, and hence no deterioration of wages in terms of either good. On the contrary, in terms of the imported good there must be an improvement in real wages with a consequent increase in real income. This is made intuitively obvious from the consideration that trade necessarily increases the real income of a country, and in the classical case the proportion of income going to the respective factors cannot be changed by trade. It is the latter feature of the classical theory which constitutes one of its important short-comings.

MORE THAN TWO FACTORS

One by one we have been able to drop our various restrictive assumptions with only slight modifications of results. Still there remains the problem of introducing into the analysis more than two productive factors. Unfortunately, this entails more serious consequences.

In the first place, the definiteness of the Heckscher–Ohlin theorem begins to fade. With three or more factors of production it is certainly not necessary that the result of trade is to make the ratios of factor prices in the respective countries more closely approach unity. Some may do so, but others may diverge depending upon complicated patterns of complementarity and competitiveness.[1] Whether on balance the movement towards equalisation exceeds the tendency towards diversification is not a meaningful question until a non-arbitrary method of weighting these changes is specified. Furthermore, even the concepts of scarce and abundant factors lose their sharpness of definition.

The fact that the Heckscher–Ohlin theorem breaks down when many factors of production are involved affords an explanation of its failure to account for the facts *if the production functions in the two countries differ, or if the factors of production of different countries are not identical.* By appropriate terminological conventions it is always possible to attribute differences in the production functions to differences in amounts of some factors of production (knowledge, available free factors, etc.). Similarly, if the factors of production of different countries are regarded as non-comparable and incommensurable,[2] this can be classified as an extreme case of factor disproportionality, but there must be more than two factors. We conclude, therefore, that the Heckscher–Ohlin theorem does not necessarily hold in the case of constant costs or multiple factors of production.

It does not follow that our results stand and fall with the Heckscher–Ohlin theorem. Our analysis neglected the other country completely. If factors of production are not comparable between countries, or if production functions differ, nevertheless, so long as the country has only two factors, international trade would necessarily affect the real wage of a factor in the same direction as its relative remuneration.[3] The only loss to our analysis would be the possibility of labelling the factor which is harmed as the " scarce " (relative to the other country) one.

However, we must admit that three or more factors of production within a single country do seriously modify the inevitability of our conclusions. It is not only that the relatively scarce factor can be defined only circularly as the one whose price falls most after trade, but even if we do know the behaviour

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[1] See Ohlin, op. cit., pp. 96–105 and parsim.

[2] If the extreme classical assumption of immobility of labour between countries were valid, then over time the working populations of the various countries would become differentiated culturally, genetically, and in the limit cease to be of the same species. But those in the narrower classical tradition are least in a position to bring this up as an argument against the Heckscher–Ohlin theory, for in expositing the comparative cost doctrine they repeatedly (and sometimes unnecessarily) compare labour (costs, productivities, hierarchies, etc.) in various countries.

[3] This is in contrast to the problem of the effect of a technological innovation to which Professor Haberler (op. cit., p. 195) has compared the effects of trade. Technological change shifts the production function, and no inferences concerning the new marginal productivity relationships are possible. As we have shown, trade leads to definite effects.

of relative factor prices, i.e. relative shares in the national income, it seems that we cannot infer unambiguously that the physical marginal productivities move in the same direction. Even though these continue to depend only upon the proportions of the factors in the respective industry, diverse patterns of complementarity and competitiveness emerge as possibilities. It is outside the scope of the present paper to attempt a catalogue of the various conceivable permutations and combinations.

This lack of definiteness in the more complex case is typical of attempts to go beyond the level of abstraction current in economic theory. We have resisted the temptation to lump together diverse factors into two composite factors and thereby achieve the appearance of versimilitude, although others may care to do so for some purpose.

CONCLUSION

We have shown that there is a grain of truth in the pauper labour type of argument for protection. Thus, in Australia, where land may perhaps be said to be abundant relative to labour, protection might possibly raise the real income of labour.[1] The same may have been true in colonial America. It does not follow that the American working man to-day would be better off if trade with, say, the tropics were cut off, because land suitable for growing coffee, rubber, and bananas is ever scarcer in America than is labour. The bearing of the many factor case will be obvious.

We are anxious to point out that even in the two factor case our argument provides no political ammunition for the protectionist. For if effects on the terms of trade can be disregarded, it has been shown that the harm which free trade inflicts upon one factor of production is necessarily less than the gain to the other. Hence, it is always possible to bribe the suffering factor by subsidy or other redistributive devices so as to leave all factors better off as a result of trade.[2]

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[1] See D. B. Copland, " A Neglected Phase of Tariff Controversy," *Quarterly Journal of Economics*, 1931, pp. 289–308 ; K. L. Anderson, " Protection and the Historical Situation : Australia," *Quarterly Journal of Economics*, November, 1938, pp. 86–104 ; M. C. Samuelson, op. cit., pp. 143–149.
[2] Viner, op. cit., p. 534 ; P. A. Samuelson, op. cit., p. 204.