Authors:
PAUL OSLINGTON
Alphacrucis College, Sydney, Australia

FREE FACTOR UNEMPLOYMENT*

ABSTRACT

It is well known that introducing various distortions into neoclassical general equilibrium models generates unemployment. This paper shows how unemployment can occur in the absence of such distortions, with particular patterns of technology, prices and factor endowments. For a technology with a labour saturation point, the marginal product of labour can fall to zero under particular market conditions, so that labour is in excess supply regardless of the wage rate. This type of unemployment can occur in the agricultural sector of developing economies, depression economies, and the rising urban underclass.

Keywords: Unemployment; General Equilibrium; Development; Zero Wages
JEL Classification: D50; F11; J64; J80

RIASSUNTO

Disoccupazione free factor

È noto che introducendo distorsioni nel modello neoclassico di equilibrio generale si crea disoccupazione. Questo articolo dimostra come si può creare disoccupazione in assenza di tali distorsioni, attraverso particolari modelli di tecnologia, prezzo e dotazione di fattori. Nelle tecnologie con un punto di saturazione dell'occupazione, il prodotto marginale del lavoro può scendere a zero in determinate condizioni di mercato, così che ci sarà un eccesso di offerta di lavoro indipendentemente dal livello dei salari. Questo tipo di disoccupazione si può verificare nel settore agricolo delle economie in via di sviluppo, delle economie in depressione e nelle classi sociali urbane.

* I thank Alan Woodland, Daehoon Nahm and Tony Bryant for comments on earlier versions with the usual caveat.

1. INTRODUCTION

It is well known that unemployment can occur in neoclassical general equilibrium trade models with distortions like wages fixed above the market clearing level (as in Drèze, 1975; Brecher, 1974; Davis, 1998; Oslington, 2006), imperfect competition in product or labour markets (for instance Weitzman, 1982; Kemp *et al.*, 1991), or types of self sustaining conjectures (as in the Non-Walrasian literature, for instance Drèze, 1997 or Hahn, 1980). Is unemployment possible under weaker conditions which involve nothing other than particular patterns of technology, endowments, and preferences? This paper gives an example of such unemployment where technology has a saturation point for the usage of a factor labour so that under certain conditions the marginal product of labour falls to zero and there is excess supply of labour no matter how low the wage falls. It can be appropriately termed free factor unemployment.

Such a possibility of unemployment was recognised by the classical economists, as part of their theory of rent, although as Kurz and Salvadori (1994, p400-403) point out it was not applied to labour except perhaps debatably by Ricardo in his discussion of machinery added to the 3rd edition of the *Principles of Political Economy and Taxation*. Such unemployment was also extensively discussed in the early neoclassical general equilibrium literature. Leon Walras (1877, pp239-240, p248-249) ruled it out by assuming

"the quantities of productive services used are equal to the quantities effectively offered" (p240),

despite the fact that his fixed input-output coefficient examples are likely to lead to factors being free and in excess supply. Pareto's (1906/1909) treatment is similar. The possibility was also discussed by Carl Menger (1871, p94-109) and a series of German language works. The Italian pioneer of general equilibrium economics Enrico Barone (1908; 2012) allows the possibility but does not pursue it. Abraham Wald made the important point that ignoring factors in excess supply when using the Walrasian equations for the scarce factors is unsatisfactory because

"whether factors are scarce or free cannot be considered, a priori, a datum of the economy; it can only be determined on the basis of the production equations" (Wald, 1951 p371).

Arrow and Debreu (1954, p45) observed that

"the view that some commodities might be free goods because supply always exceeded demand goes back to the origins of marginal utility theory"

and later in their historical note (p287-289) mention the works of Neisser, Schlesinger, Zeuthen and Wald.

After this early interest in the possibility of free factor unemployment discussion died out apart from the extreme case of fixed coefficients considered in the linear programming and activity analysis literature (for example Koopmans, 1951 ch 3,15; Dorfman *et al.,* 1958 ch 13 p357-66, or more recently Silberberg 1990, p504-506). In the main line of general equilibrium theory there is almost nothing. As noted above Arrow and Debreu were aware of the possibility, but confined their analytical attention to non-continuity of the demand functions around zero which would create problems for their existence proof. The brief discussion in Debreu (1959, p44-54) is along similar lines, as is that of Arrow and Hahn (1971, p20-24). Bryant (1997) briefly mentions the possibility in his discussion of conditions for the existence of equilibrium. Nothing in the assumptions of standard general equilibrium models rules out free goods in excess supply. One searches in vain though the standard treatments of the neoclassical general equilibrium model like Varian (1993), Mas-Colell *et al.* (1995) or Hildenbrand and Kirman (1988) for discussion of such a possibility of unemployment.

In the general equilibrium trade literature the situation is similar. In the early neoclassical trade literature the first mention seems to be Schuller (1921, pp37-378), who observed that the earlier English discussions of free trade assumed that protection would draw resources from other industries, but that this need not be so if there were idle resources, and was not so in his early 20th century Austro-German situation. He then argued that the existence of idle resources can justify a tariff to bring these resources into production. Haberler (1936, p253) called this

"one of the most profound arguments for tariffs"

but nevertheless wrote it was fallacious if Schuller meant that the factor had a negative marginal product, because bringing such a factor it into production will not increase national income. Haberler's other attempt to deal with Schuller's argument was to define away the problem by suggesting that factors must have a positive marginal product. However, this is not a good

definition of a factor because whether it has a zero or positive marginal product depends on the configuration of technology, endowments and world goods prices – changes in goods prices can switch a factor between a zero and a positive marginal product. Viner (1937, pp472-473) also believed Schuller's argument was important, and interpreted it as being about limited substitutability of factors, which in Viner's view made it only valid in the short run. Haberler mentioned the possibility again in a later paper, suggesting that when relative goods prices are changing and industries are contracting

"it is quite likely that certain factors of production will become idle; but only after their prices (imputed value) have fallen to zero" (Haberler 1950, p233).

After Haberler the possibility of free factors has usually been ignored by trade theorists. In his classic paper Samuelson commented that

"the marginal productivity of a factor may fall short of its market wage, but then it will not be used" (Samuelson 1953, p3)[1]

and does not discuss it further. In one of the other classic papers that shaped general equilibrium trade theory, Jones (1965, p558) notes that the equations of the model

"are usually presented as inequalities to allow for the existence of resources in excess supply even at a zero price" but then adds "I assume throughout that resources are fully employed".

In a later paper Jones (1971, p5) modifies this to assuming sufficient variability in the input-output coefficients to rule out unemployment. Recent standard treatments of the Heckscher-Ohlin model also neglect the possibility. Dixit and Norman (1980, p45) note that the demand for a factor may fall short of the given supply so that the factor may be a free good. Shortly afterwards they rule it out by assumption

"It is common to assume that all factors are fully employed, and this will indeed be the case if there is enough possibility of substitution in production. We will work with this assumption" (p46).

[1] Samuelson is unclear whether the factor will be used. As will be explained below, a factor with a zero price has a zero product at the margin, but not necessarily on the intra marginal units, and thus some may be used.

In another standard treatment, Woodland (1982, p42), after presenting equilibrium conditions which allow for the possibility of factors in excess supply, comments that

"excess supply is only consistent with equilibrium if the factor is free"

and does not discuss it further.

There is clearly a gap in the literature, and this paper will develop this neglected theoretical possibility in the context of a simple general equilibrium trade model. A plausible technology where it occurs will be described, and a free factor unemployment equilibrium illustrated. Comparative statics of the equilibrium will be investigated along with a free factor unemployment an argument for protection. The possibility of free factor unemployment raised by Schuller, Haberler and Viner does not deserve the complete neglect it has received in the recent general equilibrium and trade literatures.

2. Modelling framework

The possibility of unemployment will be illustrated using a standard general equilibrium trade model. While there is some loss of generality compared to an Arrow-Debreu framework, using a small general equilibrium trade model allows the exposition to be greatly simplified. Under standard assumption of these trade models (perfect competition, convex and constant returns to scale technology, no joint production, given world goods prices, and fixed factor endowments) attention can be focused on the production side of the economy. In these models output, employment and factor prices are determined by technology, endowments and goods prices, independently of consumption and trade.

Production in a such a trading economy can be represented as an optimisation problem, and this representation highlights the conditions for free factor unemployment to occur. As shown by a number of trade theorists (Woodland, 1982 ch5; Dixit and Norman, 1980 ch2) the production sector, made up of many profit maximising firms in each industry, can be represented as a problem of a hypothetical social planner choosing outputs to maximise Gross Domestic Product

(GDP), given factor endowments, world goods prices and technology[2].

This production sector optimisation problem is:

$$\text{Max}_y \sum_{j=1}^{m} p^j y^j \text{ st } y^j \in Y(v^i ..v^n) \text{ and } y^j \geq 0 \text{ for all } y^j \quad (1)$$

where p^j and y^j are prices and outputs of the j=1..m goods, $Y(v^i ..v^n)$ is the set of feasible outputs, and v^i are endowments of the n factors of production.

Kuhn-Tucker conditions for this problem are:

Zero profit conditions for each of the goods:

$$p^j - c^j(w^i..w^n) = 0 \, , \, y^j \geq 0 \quad \text{or} \quad (2)$$

$$p^j - c^j(w^i..w^n) < 0 \, , \, y^j = 0 \quad (3)$$

where production technologies for the goods are represented by minimum unit cost functions $c^j(w^i..w^n)$[3], for producing a unit of each of the j=1...m goods as a function of factor prices w^i, of which there are i=1..n. The conditions marked (2) are zero profit conditions for each of the goods, and cover the usual situation where the world price equals minimum unit cost of production and the good is produced. Condition (3) applies when minimum unit cost exceeds price and output of the good is not produced.

Utilisation conditions for each of the factors:

$$\sum_{j=1}^{m} c_i^j(w^i..w^n) \, y^j - v^i = 0 \, , \, w^i \geq 0 \quad \text{or} \quad (4)$$

$$\sum_{j=1}^{m} c_i^j(w^i..w^n) \, y^j - v^i < 0 \, , \, w^i = 0 \quad (5)$$

where the input-output coefficients or unit factor usages $c_i^j(w)$ are obtained by differentiating the unit cost function for good j with respect to the ith factor price, according to Shephard's lemma. The total usage of factor i is then the sum of the usages over the j industries, which are the unit factor usages multiplied by the outputs. Condition (4) covers the usual situation where the factor price is positive and the factor fully employed so that the total of the usages of the

[2] There is an equivalent dual problem of choosing factor prices w^i to minimise GDP (defined in terms of production cost), with given factor endowments and world goods prices, and an alternative representation of technology as the set of feasible factor prices for given goods prices. This is $\text{Min}_w \sum_{i=1}^{n} w^i v^i$ st $w^i \varepsilon W(p^j..p^j.)$ and $w^i \geq 0$ for all w^i.

[3] A technical point is that the cost functions which represent the technology must be redefined as limits of minimum cost (or infimum) functions because otherwise minimum cost may be undefined and zero factor price solutions inadmissible. This can happen even for commonly used functional forms including constant elasticity of substitution. See Shephard (1970, ch 4), Diewert (1978) or Woodland (1982, p18,42) for a discussion of the infimum interpretation of the cost function.

factor in each of industries equals the endowment. Condition (5) expresses the seldom recognised possibility of unemployment at a zero factor price, so that the total usage falls short of the endowment.

While these Kuhn-Tucker conditions are similar to the usual equilibrium conditions of the Heckscher-Ohlin model of the production sector of a small trading economy, representing the model this way highlights the neglected possibility of unemployment. Most trade theorists simplify these conditions by setting the number of goods equal to the number of factors, assuming all goods are produced and all factors are fully employed. This means conditions (3) and (5) are ignored and the model becomes one where (2) and (4) can be solved to give outputs of goods and prices of factors for the given world prices, endowments and technology. These simplifications are not always made – Samuelson (1953), Ethier (1984) and others have examined the properties of the model when numbers of goods and factors are not equal, mostly situations where (3) holds for some goods and there are more factors than goods. As discussed in the previous section the possibility that (5) holds so that a shadow factor price falls to zero and the factor is unemployed has received almost no attention. Nowhere in the general equilibrium or trade literature has this type of unemployment equilibrium been fully described, nor have the economic implications been explored.

3.TECHNOLOGY

The next step after outlining the modelling framework is to identify a particular technology that can generate free factor unemployment. The production technology must have limited substitutability.

An isoquant for such a technology a saturation point for a factor is shown in figure 1. Over the curved part of the isoquant the firm can substitute factor 2 for factor 1 but once a saturation point represented by the kink (marked e) is reached the isoquant becomes vertical; further units of factor 2 are redundant.

The dual representation of the production sector in factor price space however is more convenient than the isoquant because we are interested conditions for zero factor prices.

FIGURE 1 - *Isoquant for Saturation Technology*

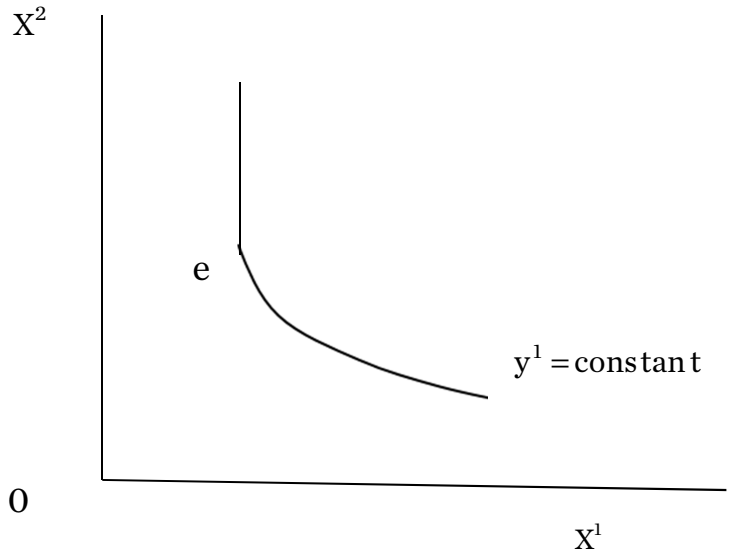


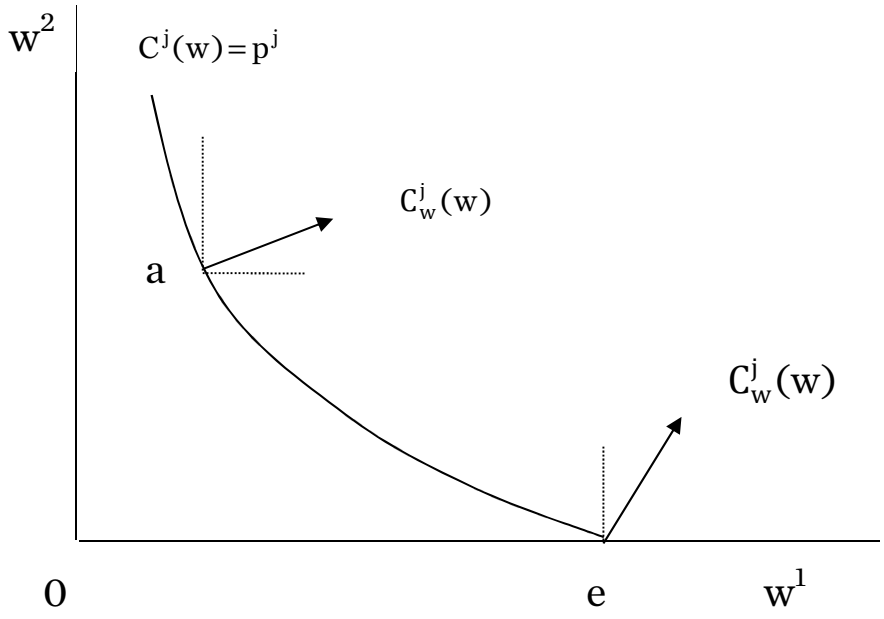
Figure 2 gives the unit cost frontier for good j showing combinations of factor prices w^1 and w^2 compatible with the given goods price p^j. The geometric interpretation of Shephard's Lemma is that a normal to the unit cost frontier drawn from equilibrium factor prices point a in factor quantity space indicates the factor proportions corresponding to those factor prices[4].

In figure 2 as we move around the smooth part of the unit cost frontier there is smooth substitutability, but at point e the production process becomes saturated with factor 2, and further falls in the price of factor 2, even to zero, fail to induce the firm to use more of it. The unit cost frontier hits the axis at e, with a positive slope, indicating that saturation occurs at a less than infinite proportion of factor 2. When saturation occurs and a factor price falls to zero, a difficulty is that there are multiple equilibrium factor usage vectors which are normal to the unit cost frontier. It is assumed that firms will not employ units of factor 2 which are unproductive even though the price of factor 2 is zero, perhaps because there are infinitesimally small costs of managing excess factors. Free disposal of factors of production is assumed. Under these assumption the factor usage vector at e is as shown in figure 2, rather than any of the other steeper possible vectors where firms would be employing unnecessary units of factor 2. Note that in figure 2 the unit cost frontier does not continue along axis, because points to the right of e

[4] A fuller explanation of the unit cost diagram may be found in Woodland (1982, ch3) and in Oslington (1999; 2006).

along the axis have the same w^2 and a higher w^1, which would give higher costs, and less than zero profits.

FIGURE 2 - *Unit Cost Frontier for Saturation Technology*



This technology with saturation satisfies all the properties of cost functions given in Shephard (1970, p.83). Shephard in fact emphasises in the introduction that

"neither the exclusion of free goods nor the requirement that the production function express the variable, substitutional, consumable character or the limitational fixed stock character of the productive factors are logically necessary for the definition of the production function" (p4) and reiterates in his discussion of the cost function that "the price vector need not be positive... free goods are allowed as inputs" (p79).

How reasonable is such a technology? Saturation seems to be a common feature of production technology. Consider the technology that links inputs to research output of an academic research centre. Adding more unskilled clerical and cleaning staff will increase output while they release academic staff from these tasks, but past this saturation point output can only be further increased by adding further specialised academic staff. Such staff may not be available even in

the long run. This is a situation just like figures 1 and 2. Factor substitution is possible in one direction from saturation point e in figures 1 and 2 but not in the other direction. Saturation seems to be most common in agricultural sector technologies, with substitutability up to a saturation point where adding unskilled labour no longer increases production.

4. Factor supply

As is common in general equilibrium trade models it is assumed that the entire labour endowment is supplied regardless of the market price of labour. While supply of labour at a zero price is taking this to an extreme, there is an analogy between the way firms supply output at zero profits (i.e. zero economic rents) in the competitive model and the way factor owners supply their endowment of factors at zero factor prices (i.e. zero economic rents).

If we move into a world where the supply of labour depends on the wage then labour supply at zero wages can be justified by workers deriving utility from labour supply, or supplying labour to maintain or acquire skills. It is conceivable that under these circumstances workers may accept jobs at zero or even at negative wages. As noted by a referee, in any situation where labour supply is a variable depending on worker utility, unemployment is conceptually impossible.

5. Free factor unemployment equilibrium

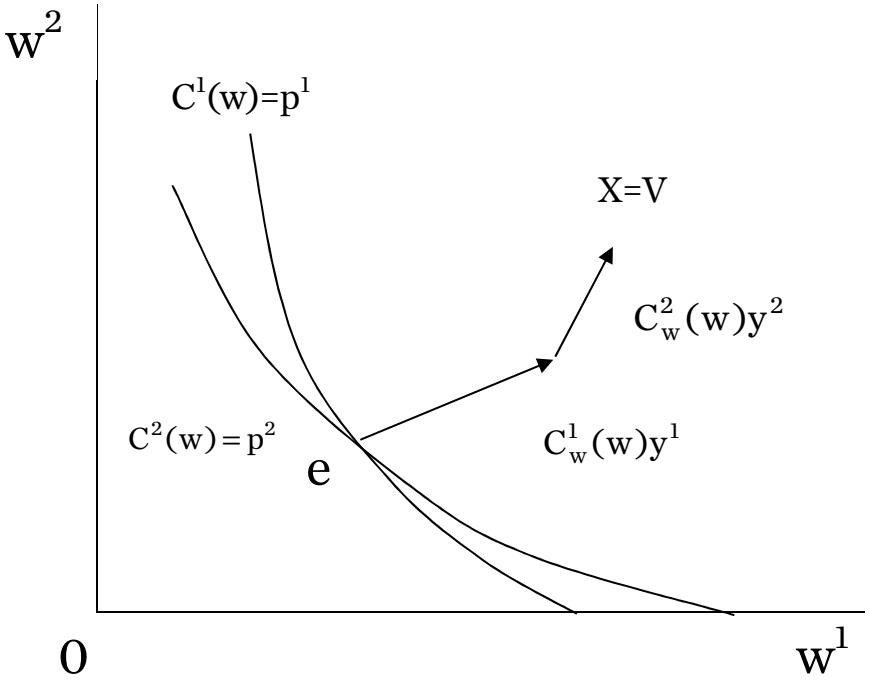
A saturation technology is not sufficient for a free factor unemployment equilibrium – there must also be a particular pattern of technology, world prices and factor endowments.

Consider the case illustrated in figure 3 where both industries technologies have saturation points, but the pattern of technology, endowments and goods prices gives full employment[5]. World goods prices are compatible with both industries operating, with factor prices given by the intersection point of the unit cost frontiers $c^1(w)=p^1$ and $c^2(w)=p^2$, marked e. This corresponds to the above equilibrium conditions (2) holding for both industries. As in figure 2 the equilibrium factor usage vectors for the industries are normal to the unit cost frontiers, drawn in factor quantity space with the origin at equilibrium factor prices. Industry 1 uses factor

[5] This figure is based on the diagram developed by Woodland (1982, ch3) and discussed in Oslington (2006).

1 relatively intensively and its factor usage vector is flatter than the factor usage vector for industry 2. The lengths of the factor usage vectors indicate outputs of the goods. The sum of the factor usage vectors $c^1_w(w)\, y^1$ and $c^2_w(w)\, y^2$, which is marked x, equals the endowment vector v. This situation corresponds where the equilibrium conditions (4) hold for both factors of production.

FIGURE 3 - *Full Employment Equilibrium*

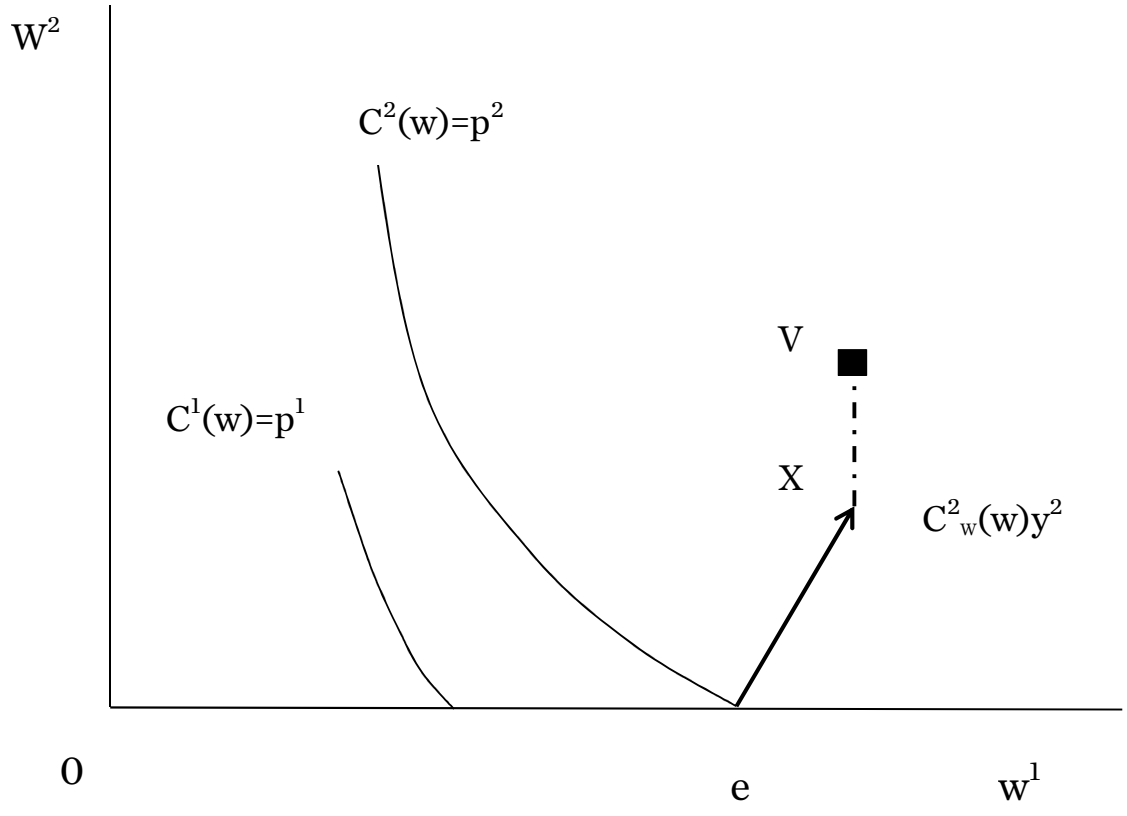


Now consider another pattern of technology, endowments and goods prices which gives the unemployment equilibrium illustrated in figure 4. This is the similar to the previous figure 3 except that the world price of good 2 is higher (or alternatively that there has been neutral technical progress in industry 2), so that the endowment vector is outside the cone of diversification[6]. In these circumstances industry 1 earns less than zero profits at the factor prices compatible with zero profits in industry 2, and so industry 1 ceases production and the economy completely specialises in good 2. Equilibrium factor prices are e, where the saturation

[6] The relationships between endowment patterns and specialisation are discussed in Oslington and Towers (2010).

point for factor 2 has been reached, and the price of factor 2 has fallen to zero. The economy specialises in the product which uses its free factor relatively intensively. This corresponds to equilibrium condition (2) holding for industry 2 and equilibrium condition (3) holding for industry 1. Equilibrium factor proportions are given by the normal $c^2_w(w)$, and output y^2 is such that the endowment of factor 1 is fully employed. Equilibrium condition (4) holds for factor 1. The equilibrium factor proportions and output are insufficient to fully employ the endowment of factor 2 and unemployment of factor 2 is indicated by the dotted distance between x and v in figure 4. Equilibrium condition (5) applies for factor 2[7].

FIGURE 4 - *Unemployment Equilibrium*



[7] The economy in the example is specialised completely in the production of one of the goods, similar to the well-known model of Brecher (1974) where a minimum wage added to a two-factor-two-good trade model causes specialisation.

6. COMPARATIVE STATICS OF FREE FACTOR EQUILIBRIUM

Let us briefly consider the comparative static properties of the free factor unemployment equilibrium in figure 4.

An increase in the endowment of the fully employed factor 1 increases output of good 2 at unchanged factor prices and factor proportions (which would be represented by lengthening the factor usage vector x in figure 4). This absorbs additional units of the free factor 2, reducing unemployment.

An increase in the endowment of the free factor 2 would merely increase unemployment.

An increase in the world price of good 1 will have no effect on the production sector as the good is not produced.

An increase in the world price of good 2 will push the relevant unit cost frontier in figure 4 to the right. As was noted in the discussion of the technology, the standard assumption of constant returns to scale (or even the weaker assumption of homotheticity) would mean that all the unit cost frontiers hit the axis at the same slope, so that factor proportions, output and employment would be unchanged. Under these circumstances the whole effect of the goods price increase will flow through to the price of factor 1.

However, the homotheticity assumption does not seem appropriate along the zero price axis; assuming that the unit cost frontier at the axis becomes steeper for higher levels of cost seems more reasonable. Higher levels of cost means higher prices of the fully employed factor, so this means that the technology uses the fully employed factor less intensively as its price rises along the axis. If this is so, an increase in the price of good 2 will cause an increase in the price of factor 1 but also make production more factor 2 intensive, reducing unemployment.

7. AN EMPLOYMENT ARGUMENT FOR PROTECTION?

In order to consider an unemployment argument for protection a consumption sector and imports and exports must be introduced into our simple small open economy model. Equilibrium conditions at the free factor unemployment equilibrium are given below.

Zero profit condition for good 2 that is produced, noting $y^1 = 0$:

$$p^2 - c^2(w^1) = 0 \quad (6)$$

Full employment condition for factor 1, noting $w^2 = 0$:

$$c_1^2(w^1)y^2 - v^1 = 0 \quad (7)$$

Relative demand, with the usual inverse relation between relative demand and relative prices:

$$y^2/z^1 = d(p^2/p^1) \quad (8)$$

Balance of trade condition for traded goods:

$$z^1 p^1 = y^2 p^2 \quad (9)$$

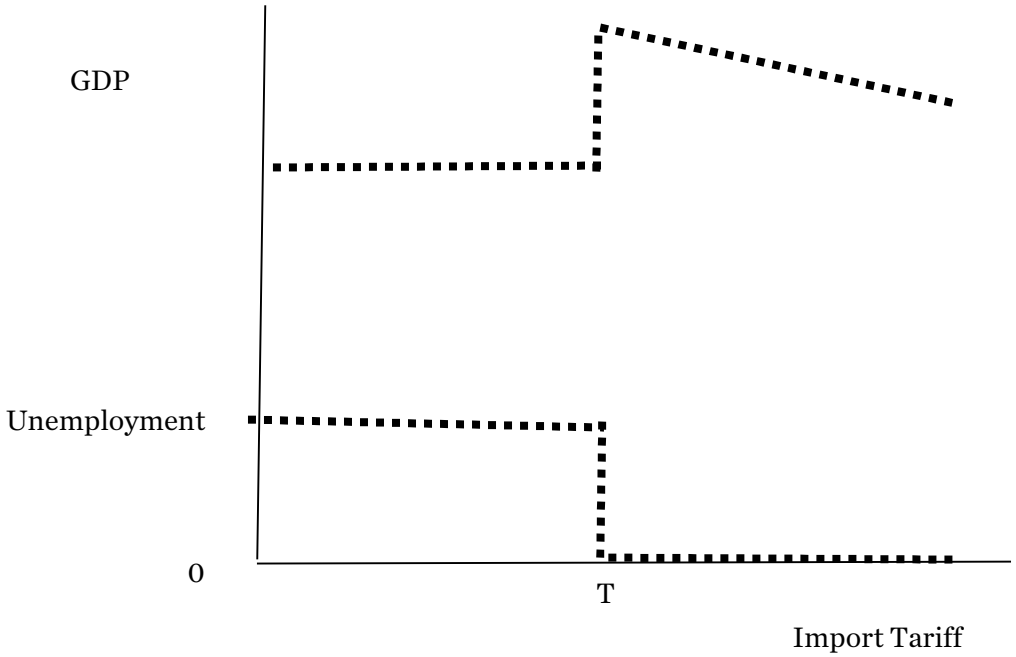
Consider the effect of an import tariff on good 1, with the revenue redistributed to domestic factor owners in the usual manner. Welfare will be measured by GDP, calculated either as the value of domestic output at world prices, or domestic factor incomes. In this simple model there will initially be no production sector effect, only a shift relative demand away from the imported good as its relative price rises. There may distributional effects from the tariff revenue flowing to owners of the unemployed factor, even though they receive no market income from supplying that factor.

This is the comparative static effect of imposing a small tariff at the specialised equilibrium, but eventually raising the import tariff will bring good 1 into production, switching the economy to the diversified full employment equilibrium.

These movements are represented in figure 5, with the tariff level T being where the endowment vector comes within the cone of diversification and the equilibrium switches. Tariff increases beyond T reduce welfare for the same resource misallocation reasons as in the standard model.

So over a range of tariff levels in this simple model we have an employment argument for protection of the type alluded to by Schuller (1921). A tariff of T increases welfare by bringing previously unemployed units into production with a positive return.

FIGURE 5 - *Welfare and Unemployment Effects of a Tariff*



8. DOES IT EXPLAIN REAL WORLD UNEMPLOYMENT?

Much of the early literature flowing from Schuller's speculations about the possibility of free factor unemployment was written in the context of developing German and Italian economies, and the authors regarded free factor unemployment as a real possibility. Similar suggestions have been made in relation to the developing economies of Africa and Asia in the 1950s – for instance Lewis' (1954) work on underemployed agricultural labour with a zero marginal product and Eckhaus' (1955) factor proportions problem. In the context of the free factor unemployment model this would be interpreted as world goods price pulling formerly free factors into production and facilitating the development process.

Besides the developing countries, some authors (Szostak, 1995; Woirol, 1996) have suggested that labour had a zero marginal product during the Great Depression. In terms of the model this would be represented as price shocks, perhaps coming from financial markets, combined with tariff changes and technological stagnation, pushing the prices of certain types of labour to zero. In both the developing countries, during the Great Depression there were few institutional

impediments to the wages of many workers falling to very low levels.

This type of equilibria could also be relevant today to developed countries facing foreign competition in low skill intensive products or experiencing technological change. Wood (1994) has argued that the growth of low skill intensive manufacturing in Asia has been pushing down the world price of the labour intensive products since the 1980s. Consider figures 3 and 4 interpreting factor 2 as unskilled labour, and industry 2 as low skill intensive manufacturing. The decline of the relative price of good 2 could shift the economy from an equilibrium like figure 3 to an equilibrium like figure 4 where factor 2 is unemployed. The disappearance of unskilled labour intensive industries and increase in the return to the factor other than unskilled labour accords with what is happening in developed countries at the moment. Others have attributed the declining fortunes of the unskilled to technological change. Neutral technical progress in skill intensive industry 1 would generate exactly the same changes in the model as a decline in the world price of labour intensive products, and generate free factor unemployment of unskilled labour. Admittedly other explanations are more likely but it is interesting that the simple general equilibrium model with free factors matches the goods and factor price movements.

In all these cases of unemployment of unskilled labour is that it is not necessary to argue that technology is changing in such a way as to create flat regions in isoquants and thus saturation points which did not previously exist. Change in goods prices (or neutral technical progress in certain industries) can trigger unemployment by pushing the economy to labour saturation points which were irrelevant at other world prices.

9. Conclusion

The purpose of this paper has been to explore the neglected possibility of free factor unemployment in a simple general equilibrium trade model – the workhorse two-factor two-good small open economy trade model. It has shown how a technology with a saturation point can generate unemployment for particular patterns of technology, endowments and world prices. It has explored some of the properties of the equilibrium, including the employment and welfare effects of a tariff. Obviously the simple general equilibrium trade model abstracts from

many important features of real world economies, but the insight about free factor unemployment emerging from the combination of limited substitutability technology and certain combinations of world prices and endowments may carry over to the real world.

In terms of the history of economics it reinforces the argument of Richard Schuler, subsequently discussed by Haberler and Jacob Viner, that there is an employment argument for protection in the presence of free factors. It also connects with arguments in the more recent development economics literature including the work by Arthur Lewis about free factors being brought into production as part of the development process in Africa, Asia and Latin America, and the literature on technological unemployment in developed economies.

REFERENCES

Arrow, K. and G. Debreu (1954), "Existence of an Equilibrium for a Competitive Economy", *Econometrica*, 22(3), 265-290.

Arrow, K. and F. Hahn (1971), General Competitive Analysis, North Holland: Amsterdam.

Barone, E. (1908), Principi di Economia Politica, G. Bertero: Rome.

Barone, E. (2012), "The Ministry of Production in the Collectivist State", *Giornale degli Economisti e Annali di Economia*, Nuova Serie, 71(2/3), 75-112, translation of "Il Ministro della Produzione nello Stato Collettivista", which originally appeared in the journal in 1908 Sept./Oct., 2, pp. 267-293, 392-414.

Brecher, R.A. (1974), "Minimum Wage Rates and the Pure Theory of International Trade", *Quarterly Journal of Economics*, 88(1), 98-116.

Bryant, W.D.A. (1997), "Conditions for the Existence of Market Equilibrium", *Journal of Economic Education*, 28(3), 230-254.

Davis, D.R. (1998), "Does European Unemployment Prop up American Wages? National Labor Markets and Global Trade", *American Economic Review*, 88(3), 478-494.

Debreu, G. (1959), Theory of Value, Yale University/Cowles Foundation: New Haven.

Diewert, W.E. (1978), *Duality Approaches to Microeconomic Theory*, in: Arrow K.J., M.D. Intriligator (Eds), "The Handbook of Mathematical Economics", North Holland: Amsterdam.

Dixit, A.K. and V. Norman (1980), The Theory of International Trade - A Dual General Equilibrium Approach, Cambridge University Press.

Dorfman, R., P.A. Samuelson and R. Solow (1958), Linear Programming and Economic Analysis, McGraw Hill Inc.: New York.

Drèze, J.H. (1975), "Existence of an Exchange Equilibrium under Price Rigidities", *International Economic Review*, 16(2), 301-320.

Drèze, J.H. (1997), "Walras-Keynes Equilibria Coordination and Macroeconomics", *European Economic Review*, 41(9), 1735-1762.

Eckhaus, R.S. (1955), "The Factor Proportions Problem in Underdeveloped Areas", *American Economic Review*,45(4), 539-565.

Ethier, W. (1984), *Higher Dimensional Issues in Trade Theory*, in: R. Jones, P. Kenen (Eds), "The Handbook of International Economics", North Holland: Amsterdam.

Haberler, G. (1936), The Theory of International Trade, William Hodge: London.

Haberler, G. (1950), "Some Problems in the Pure Theory of International Trade", *The Economic Journal*, 60(238), 223-240.

Hahn, F. (1980), "Unemployment from a Theoretical Point of View", *Economica*, 47(187), 285-298.

Hildenbrand, W. and A. Kirman (1988), Equilibrium Analysis: Variations on Themes by Edgeworth and Walras, North Holland: Amsterdam.

Jones, R.W. (1965), "The Structure of Simple General Equilibrium Models", *Journal of Political Economy*, 73(6), 557-572.

Jones, R.W. (1971, *A Three Factor Model in Theory, Trade and History*, in: J. Bhagwati, R.W. Jones, R. Mundell, J. Vanek (Eds), "Trade, Balance of Payments and Growth: Essays in Honour of Charles P. Kindleberger", North Holland: Amsterdam.

Kemp, M.C., N. van Long and K. Shimomura (1991), Labour Unions and the Theory of International Trade, North Holland: Amsterdam.

Koopmans, T.C. (Ed.) (1951), Activity Analysis of Production and Allocation, Wiley: New York.

Kurz, H. and N. Salvadori (1994), Theory of Production: A Long-Period Analysis, Cambridge University Press.

Lewis, W.A. (1954), "Economic Development with Unlimited Supplies of Labour", *The Manchester School*, 22(2), 139-191.

Mas-Colell, A., M.D. Whinston and J.R. Green (1995), Microeconomic Theory, Oxford University Press.

Menger, C. (1871), Principles of Economics, The Free Press: Illinois (1970).

Oslington, P. (1999), "Duality and the Specific Factors Model", *Economia Internazionale/International Economics*, 52(3), 373-382.

Oslington, P. (2006), The Theory of International Trade and Unemployment, Edward Elgar: Aldershot.

Oslington, P. and I. Towers (2010), "Trade and Migration in a World without Factor Price Equalization", *Review of International Economics*, 18(4), 650-662.

Pareto, V. (1906/1909), *Manual of Political Economy* – Critical and Variorum Edition, translated and edited by A. Montesano, A. Zanni, L. Bruni, J.S. Chipman and M. McLure, Oxford University Press, 2014.

Ricardo, D. (1951), On the Principles of Political Economy and Taxation, Cambridge University Press, original publication 1817.

Samuelson P.A. (1953), "Prices of Factors and Goods in General Equilibrium", *Review of Economic Studies*, 21(1), 1-20.

Schuller, R. (1921), *Effect of Imports on Domestic Production*, in: F. Taussig (Ed.), "Selected Readings in International Trade and Tariff Problems", Ginn and Co. : Boston. German original 1905.

Shephard, R.W. (1970), The Theory of Cost and Production Functions, Princeton University Press.

Silberberg, E. (1990), The Structure of Economics: A Mathematical Analysis, Second Edition, McGraw Hill: New York.

Szostack, R. (1995), Technological Innovation and the Great Depression, Westview Press: Colorado.

Varian, H. (1993), Microeconomic Analysis, 3rd edition, Norton: New York.

Viner, J. (1937), Studies in the Theory of International Trade, Allen and Unwin: London.

Wald, A. (1951), "On Some Systems of Equations of Mathematical Economic", *Econometrica*, 19(4), 368-403. German original 1936.

Walras, L. (1877), Elements of Pure Economics, translation of: Elements d'économie politique by William Jaffé, George Allen & Unwin 1954: London.

Weitzman, M.L. (1982), “Increasing Returns and the Foundations of Unemployment Theory”, *Economic Journal*, 92, 787-804.

Woirol, G.R. (1996), The Technological Unemployment and Structural Unemployment Debates, Greenwood Press: USA.

Wood, A. (1994), North-South Trade, Employment and Inequality: Changing Fortunes in a Skill-Driven World, Clarendon Press: Oxford.

Woodland, A.D. (1982), International Trade and Resource Allocation, North Holland: Amsterdam.

