
Notes (1) on a Thermodynamic Theory of Economics

Copyright © VOCAT International Ltd 2007

John Bryant

VOCAT International Ltd, 10 Falconers Field, Harpenden, AL5 3ES, United Kingdom.

E-mail: john.bryant@vocat.co.uk

Abstract: This paper re-visits two points of a paper by the author, published earlier in 2007. Additional analyses are set out first, on the issue of the boundary between products of economic value and flows of value between them, and second, on the structure of the Cobb Douglas function derived from thermodynamic theory.

1. Introduction

This paper re-visits two points of a paper of the author, published earlier in 2007 in the International Journal of Exergy¹, to provide additional analysis. It should be read in conjunction with the original paper.

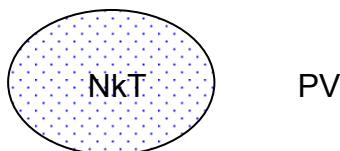
2. The Boundary

The original paper postulates a system involving a number N of 'monetary carriers or holders of value', equivalent in size to units of currency. Each carrier or holder can carry or hold a constant amount of embodied value k (the monetary equivalent of the Boltzmann constant) *not* dependent on price or volume, and usually given the numerical value 1 if a currency. The relationship of the system with the outside world is that the value held by the *carriers or holders of value* can be exchanged for goods and services at the boundary of the system at price P and volume V over a period of time, according to an *Index (or a degree of a scale) of Trading Value T* with which they can do this over that period. If they can increase their index of trading value T over the same period, then the number of times the monetary units are recycled and used again goes up, and they can increase the value of exchange of goods over the period. Thus the relationship of the variables is given by the ideal economic equation:

$$PV = NkT \dots\dots\dots 2.1$$

A boundary so described exists around each and every item of economic value, whether solid, liquid or service. Some people have difficulty accepting this analogy. In particular, in a thermodynamic world a system is often depicted as a container (non-flow) or pipe (flow) of some indeterminate shape with gas molecules vibrating inside:

Figure 1



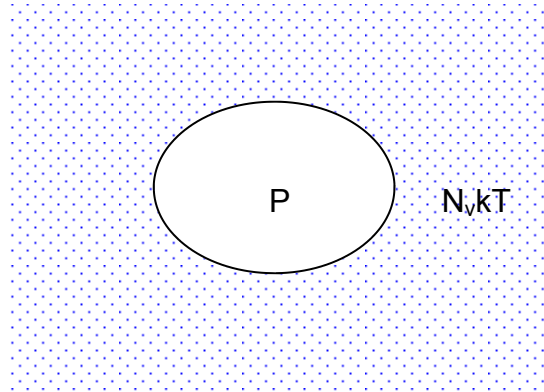
Thus the level of the kinetic energy of the gas molecules inside results in a pressure P being exerted on the walls of the container of volume V , and the total energy inside the container is PV , equal to kinetic energy NkT , where N is the number of gas molecules, k the Boltzmann constant and T the absolute temperature.

Equally, however, the walls of the container are exerting a force on the gas to contain it within the volume; rather easily illustrated by a child's balloon being burst by a pin, breaking the elastic tensile force of the balloon rubber. Thus the

energy level of the gas inside the container is being met by an equal and opposite energy of the container itself, equal in value to PV .

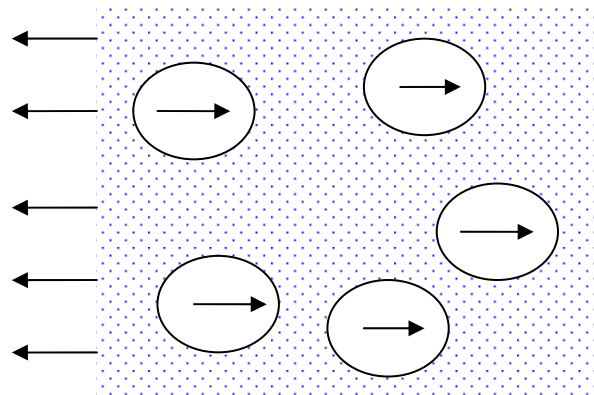
A solution to the economic analogue is just to view this process inside out, with the molecules or *carriers of value* on the outside of the boundary wall and the product flow at price P on the inside. Figure 2 illustrates the position for one product with one wall:

Figure 2



Where N_v represents the number of carriers of value required to fund the flow of one product at price P . Further, imagine several products of volume V and the pictorial representation becomes as in figure 3:

Figure 3



Where $N = VN_v$, is the number of carriers of value required to fund a flow of V products at price P . Thence the equation becomes $PV = NkT$, where T is, as before, the Index of Trading Value (velocity of circulation for a whole economy). Thus in general there are many boundaries, each around a product item of whatever form or makeup, all served by the monetary and accounting link between them. The same process will apply to a product being assembled and produced in a factory. It will have a boundary, which changes as more parts are added to it to make the whole. The monetary aspect of this will be reflected in the accounting process accompanying it, reflecting the costs and profit being built up, and the supply of money to fund the operation.

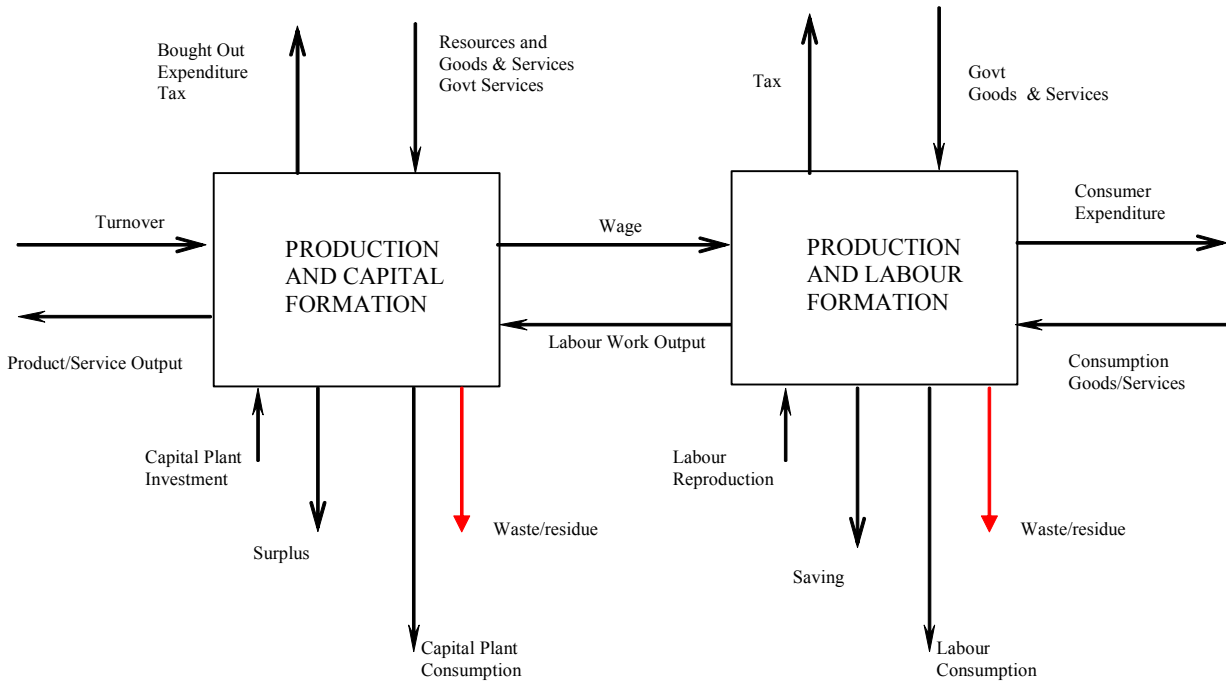
Thus the important differences between gas and economic thermodynamic systems are:

- A gas system mostly comprises a boundary (such as a chamber or pipe flow or other description) with the gas on the inside and a force on the outside holding the gas within the system; whereas an economic system has a reverse boundary polarity with monetary/accounting movements on the outside and the product value on the inside.
- In general, while a gas system may only involve one boundary, an economic system may comprise many products, with a boundary surrounding each product, with the monetary comparator linking them all.

3. Equilibrium & disequilibrium

The original paper set out a diagram illustrating a simple economic system, with capital and labour formation separated out. This presentation omitted to indicate flows of waste and residue, and figure 4 corrects this omission:

Figure 4 A simple economic system



There followed a discourse to show the link between economic systems and the Le Chatelier Principle. An initial equation was set out, whereby to form x units of a particular output product G (*not including capital plant replacement/investment*), required a units of capital stock K (depreciation), b units of labour L (wage) and c units of resource B (bought out goods and services, government services), with y units of residue D and z units of capital replacement/investment K being produced. The equation was set out as:

$$aK + bL + cB \Leftrightarrow xG + yD + zK \dots\dots\dots 3.1$$

The author believes that the above equation unnecessarily complicates the issue, in that it had been assumed that a part of the product xG had been separated out for capital plant replacement/investment zK , and assumed to be fixed. The author regarded this assumption as not a very good one to make, and in these notes the assumption is dropped.

The above may be greatly simplified by allowing product xG to include capital plant replacement/investment, with no fixed proportions between net output value and investment. Decision makers decide what to do with output sales value received in the light of the equilibrium position they perceive. Thus the equation is modified as:

$$aK + bL + cB \Leftrightarrow xG + yD \dots\dots\dots 3.2$$

Thence, for example, if a slowdown in output is perceived, resulting first in a reduction of surplus, decision makers will act to reduce inputs of labour and materials, and may also slow down investment if there is excess plant capacity.

The rest of the analysis proceeds as set out in the original paper but with the final equation for output volume being:

$$V_G = \psi \left[e^{-\Delta F/xNkT} \right] (V_K^\alpha V_L^\beta V_B^\delta) (V_D^{-\rho}) \dots\dots\dots 3.3$$

4. Conclusion

The above amplifications and adjustments do not result in any significant changes to the concepts and results of the original paper. These notes should however be read in conjunction with the original paper, to set the presentation in context.

5. Reference

1. Bryant, J. (2007) 'A thermodynamic theory of economics', Int. J. Exergy, Vol 4, No. 3, pp.302-337.