PRODUCTION BY LABOUR ALONE

An Essay on Capital, Production and Price in the Classical Tradition

by

S. Bose

Economic Research Unit

Indian Statistical Institute, Kolkata

and

P.Gajapathi

Macmillan India Ltd., Bangalore

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No, we do not mean to say that labour produces something out of nothing, simply out of nature dispensing all so-called produced means of production. We mean the term ``production by labour alone'' (PLA) as a contradistinction from ``production by means of commodities'' (PMC) with its implicit reference to Sraffa's famous **Production of Commodities by Means of Commodities**. This is where the contradistinction is complete. ``Commodity production'' is common to both PLA and PMC, i.e., it is a ``commodity'' that is taken to be produced in both cases. Distinctive feature of PLA is that all the produced means of producing a *given commodity* are themselves turned out or produced within the production process of *that commodity*. They are the *internal products* of that process (IP), not commodities in the economy. To be explicit, they are produced for *use*, not *sale*. Stated more precisely, they are produced for *internal* and not *external* use. ``Sale'' is simply a criterion of external use.

Our PLA then is no different from so-called ``vertical integration of production'' -- with a difference in orientation to become clearer as we go on. Leaving this aside, we have to say that we do not really *borrow* this concept. We build it up step by step starting from scratch. Bulk of the paper is devoted precisely to this task (secs. i-xiv). Starting point for this purpose is simply the idea of a ``production process''. We go about this concept is a way of our own. Our conception runs in terms of *stocks* and *flows* and something *prior* that we leave unstated at this point (see § **2**) -- away from ``time streams'', ``dated quantities'' and such. It is felt that this is what reflects correctly the ideas of ``old classical economists'' to use the word of Sraffa though contrary evidence is also there. But ``classical'' or not, the ideas must stand on their own. Reader to judge. Our object then is a certain fulfillment of certain classical ideas, thought to be ``correct''.

Let us pause, quietly, to state what put us on this path thereby acknowledging a debt going deep. Literally nothing of this paper would have been written had not Georgescue-Roegen written his magnificent **Analytical Economics: Issues and Problems**. He made us aware of certain issues and problems in the area mentioned. We follow them up -- ``resolve" if you like -- in a way of our own, now running close to him, now away, as the discerning reader will easily see. The whole writing is replete with expressions very much his own without further reference or acknowledgment. However, nothing is taken literally or verbatim as the discerning reader will again see. It is GR who first directed our attention to the storehouse that is classical economic writings, which we read with the hindsight of his connections. Only then did we find our ``contradistinction" from Sraffa to cover much the same ground as he in a different framework -- a distant second. So, we end with certain Sraffa themes as we may put it (sec. xv - xix). This in brief is the genesis of the paper.

Let us take out a few words on the actual writing of the paper, its history. It is clear from what we have said so far that the paper is very much dated. The books mentioned were published in 1960 and 1966. Substance of the paper -- most of its diagrams and equations -- was worked out long back, roughly in the years 1976-78, when the second author was doing his research for a Ph.D degree under the first's guidance. Unfortunately the thesis proved too difficult and unweildy to write at that time. We didn't know where to begin, how to proceed. That is where the whole thing stayed -- in our heads -- till we got down to this writing sometime back.

Of course, this passage of time has meant a difference. Things have somehow been made to fall in their place. A basic simplification has been boldly effected. (This is breifly alluded at the beginning of sec. *ix*). Many refinements and embellishments are given to the older ideas. One is to be specially mentioned. In secs *ii* and *iii*, we solve a problem that long bothered us, though not quite in this form and context. The solution emerged only in the course of this writing, i.e., very recently. But as made clear in sec. *v* (§ **19**), the rest of the argument can go on completely bypassing this problem -- it can stand on coarser grounds, as it did earlier. Continuity of the arguments is not lost if the detailed analysis of these sections, which one may find rather abstruse, is glossed over. However, the *concepts* have to be noted. Incidentally, if one has no taste for *concepts* as such -- or for *pure theory* -- then, well, this is not quite the paper for him or her. (Last section of the paper is also substantially new).

Before ending, we have to return once again to the substantive fold. Our concept of PLA is completed by *two further attributes* or *assumptions*, both of a purely institutional nature, as the whole concept is. One, ``labour" in PLA is understood as *labour hired on the basis of wage payment* (or ``wage labour"). So, the ``production" in PLA in not just commodity production. It is *capitalist production* in the relational sense of the term. PLA is simply an analytical tool meant to throw light upon certain aspects of such production free from the clutters of PMC thought to be irrelevant for this purpose. Two, let us get down to the bottom of all production: *nature*. Bottomline of our notion of PLA is simply that ``nature" lies beyond the realm of *private property.* It follows that there is no ``rent" in the economy discussed.

Page references to the writings of Adam Smith and Ricardo are respectively to the ML edition of **The Wealth of Nations** and the EML edition of **The Principles**.

Part One

THE PIN FACTORY PRODUCTION PROCESS OF ADAM SMITH

I

1 The pin factory production process of Adam Smith (pfpp) is our *key reference* for the whole paper. It gives us *all* the concepts we need and is to stay with us for this purpose all the way up to Part Four. With this word of introduction, we go and visit the pin factory. We see

> ``One man draws out the wire, another straights it, a third cuts it, a fourth points it, a fifth grinds it on the top…." (p 4)

and so on and so forth till pins are finally made, ready for sale (``put into paper"), in fact *sold*.

Obviously, wire comes from outside. We can presume that it is in fact *bought*. So, pins-as-sold and wire-as-bought are both *commodities*, and this is PMC. PLA is a long way off.

So much is clear from outside. Going inside, we see all the works going on as stated. Clearly, these works divide up the process in to a number of distinct stages through which the raw material, ``wire", is given the successive shapes of ``wire drawn", ``wire straightened", ``wire cut into pieces" or ``cut pieces of wire", ``pointed such pieces" and so on. We have in short a process made up of *successive stages of production* in the sense of material transformation.

We now note that each of the objects just mentioned, barring pins-put-into-paper, are *both* produced and used within the process and so can indeed be considered its IPs. We shall look into this question later (sec. *vii*). Till then, we proceed *without* this notion. We do not need another common denominator for these objects besides the one already given (successive transforms of the raw material).

2 Let us not now turn to something *analytical*. What we see in the pin factory -- the ``happenings" we see -- is obviously a *going process*. The point to really see is that this ``goingness" is underlined by *self-repetitions*. It is not just or even that wire is dawn in front of our eyes all the time we see. ``Drawer" remains fixed in his position, does not move away with the wire drawn. When we fix our attention properly, we see that arm's length *after* arm's length of wire is drawn, straightened, cut into pieces........ or, to say the same thing over again starting from here, piece *after* piece of wire is cut out, pointed, grinded and so on. We thus come to see these *elementary unit operations* (euo) in the process, as we may call them,[1] *taking place in their own self-repetition, happening over and over again*. This is our fundamental observational datum and we build own whole picture or idea of a ``production process" on this basis. This is the ``prior" left unstated earlier. We mention that this reference point of self-repetition seems to have far reaching analytical significance going beyond the terms of this paper. This is not the place to talk of that.

It is necessary to take one more step to *complete* the notion of self-repetition. Obviously, the notion is defined only *in time*. Let us now see it *explicitly* in time. We see that it *takes time* to perform any of our euo's. So, given ``self repetition" in the sense understood so far, we have a *sequence* of ``times taken" for any given euo. There are now two related points to make. One, this is a completely *open-ended* sequence, ``open" on both sides, for there is neither a ``first" nor a ``last" performance so far as self-repetition is concerned. Two, this is not an *arbitrary* sequence. Arbitrariness of this sort does not simply go with the idea of a ``process''[2] and ``self-repetition" is nothing if not a process. There must be *some regularity* or *orderliness* in the sequence to justify the notion of self-repetition. The precise content of these terms depends upon the context. At present, we simply keep to the context introduced. Later, we meet essentially the same problem in another context (§ **55**). Since no other context is so far specified, we mention that all our euo's are but ``happenings", and there are ``happenings" and ``happenings" happening over and over again.

[1] ``Drawing", ``straighting", ``cutting" etc. are all taken to be ``elementary operations". (However, see fn. 41 below) Drawing *an arm's length* of wire, cutting out *one* piece of wire etc. are elementary *unit* operations. These are quantitative notions.

[2] There is no ``process" without some law, rule, principle or whatever to it. These very ideas are violated by the ``arbitrariness" talked.

Completeness of the notion of self-repetition then comes from the regularity condition. The simplest, also the strictest, regularity condition in the present context is simply that the *same* time is taken in each successive performance of an euo. Note how clearly the notion of self-repetition stands out here in time. We can put successive performances of an euo in a one-one correspondence with a succession of time-intervals of equal length and see the euo performed in *each* interval.

Let us now weaken the condition. Once we take out the condition, we have ``time taken'' as a variable varying from one performance of an ueo to another. Clearly, this cannot be *arbitrary* variation, for that is to be back to square one. We solve this problem by thinking of the variations as *fluctuations around a mean or average*. Obviously, for this to be true, the ``average'' must first *exist*. This is our weaker regularity condition in the present context. Obviously, the condition is very weak. The ``fluctuations'' themselves are left in the open. Perhaps we should call it simply a non-arbitrariness condition instead of a regularity condition. Be that as it may, the condition suffices for the very limited purpose we keep in view. Substantively, we think of the ``average'' as a *norm* established through practice[3]. The very idea subsumes the idea of regularity and orderliness.

3 Let us move on to see the notion of self-repetition on a purely *quantitative* plane. The steps for this purpose are already taken. We simply put them in a *form* that is going to be our *principal analytical tool* in this paper.

Let us keep to the context introduced. Consider any of our euo's, say cutting out a piece of wire. Suppose, to begin with, that it is performed according to the strict regularity condition. Time taken to cut out each successive piece of wire is the *same* all over, say 40 secs. Reciprocal of this number gives us the *rate* at which the ``happening'' happens in or through or over time, the *rate per unit of time* (p.u.t.) This is the ``form'' just referred.

But a ``rate p.u.t.'' (or ``time-rate'') is above all a *descriptive* measure of a ``happening'' (with explicit reference to ``time''). As such, it is defined in purely *observational* terms. It is not privy to ``technical conditions''. Let us follow this out in the given context. Let us have ``minute'' as

[3] So, the average time taken to perform an ueo is also called the *normal* time. We also speak of our weaker regularity condition as allowing *deviations from the norm*.

unit of time and count successive minutes from immediately after one of our ``cuttings''. Now we observe. We observe that 1 piece (unit) is cut out in the 1st min. and again in the 2nd min., 2 units are cut out in the 3rd min, 1 unit is again cut out in the 4th and 5th min., and so on. Taking *average* of all those observations, we find that 2/3 units are cut out *per min*. -- this is the ``rate''. The ``rate'' is a *time-average*. Note, the ``average'' is defined over an open-ended or indefinite sequence. This means in turn that we observe *open-endedly in time.* This is essential. Without it, we may miss out the whole element of self-repetition, on the basis of which we have the notion of rate p.u.t. (See also § **5**).

Let us now replace the strict regularity condition by the weaker one. The rate of cutting, to use a short expression, is then given by the reciprocal of time taken *on the average* (or the *normal* time) to cut a piece of wire, all this being defined within the self-repletion of the ``happening''. Observational basis of the notion remains the same as above, but now a ``statistical'' average gets *superimposed* upon the earlier time-average. The ``rate'' is in this sense a *double average.* When all this is understood, we may as well *define* the notion w.r.t. a ``large lot'' of cut out pieces of wire. The rate of cutting is simply the size of this lot divided by the time taken to cut it out.

4 We take off a little time to put this notion across some familiar ones going by the same name. This may help one see it in a perspective and grasp its basic significance. On one side, we have the notion of a rate p.u.t. defined w.r.t. a *given* time-interval, where the notion appears simply as the quantity happened in the interval divided by the length of the interval. This says nothing about the nature of the ``happening''. It may well be a ``happening'' happened once-and-for-all in that interval. Obviously, this is way out of our notion. There is nothing in common between the two concepts except the dimensionality.

Diametrically opposite stands the notion of a rate p.u.t. defined w.r.t. a presumed *proportional* relation between the quantity happened in a time-interval and the length of the interval, where the notion appears simply as the factor of proportionality. In this notion, the ``happening'' is supposed to happen *continuously* in time whereas all the ``happenings'' we talk occur *discretly* in time. The two notions are therefore defined in two different *frameworks*. This apart, they stand very *close together*. Indeed, the concept here can be taken as a *general* *benchmark of reference* in the whole field. At this benchmark, it is simply not *necessary* to talk of any ``average''. Our concept then *generalises* this concept in this direction[4]. Alternately, we can say that this concept is a *limiting case* of ours where it is no longer necessary to talk of ``averages''.

5 Let us wind up this part of the discussion. As already mentioned, the notion of rate p.u.t. is going to be our principal analytical tool in this essay. Essence of the tool-sense of the notion is simply its presumed association with the idea of self-repetition. Granted the presumption, the moment we speak of something happening at a rate in or through or over time - and what is that but a rate p.u.t. ? -- we imply the self-repletion of that ``thing'', the ``happening'' under reference. This is all that matters for our purpose.

Perhaps this is where we could have left off. Nevertheless, we give a defense of our ``presumption'' for all that it is worth. The opening point is this. When one speaks of something happening at a rate in or through or over time, one does take an open-ended view of things in time. One describes a *state*.

But what ``state''? Let us start from square one. ``Time'' is very unlike weight, volume etc. So, ``per unit of time'' is also unlike per unit of weight, volume etc. A notion of *sequence* comes in which is nothing other than the *passage of time*. The very notion ``per unit of time'' brings with it the idea of unit *after* unit of time passing by. More correctly, we should say ``time interval of unit length after such interval passing by''. Enter now the ``happening'', of which the ``rate''. A notion of ``quantity happened'' is automatically granted, for ``rate'' is a quantitative notion. The ``happening'' happens in time. When one says that it happens at such or such rate p.u.t., one views it explicitly in time. In fact, one sums up or represents the whole sequence of quantities happened in the successive time-intervals in a *single* number, the ``rate''. As we see, this is possible only if the ``happening'' is subject to self-repetition in some form or other -- some ``sameness'' is there in the sequence in a suitable form. So, the ``state'' *is* characterised by self-repetition. It is a *stationary* state.

[4] We mention that such generalisation is also possible within the framework of continuous happenings.

Let us put the point in another way. Let us think of the sequence under reference as an infinite time-series[5]. Our point is that it is possible to ``sum it up" in a single number only if it has a *stationary trend*. The rate p.u.t. is simply a measure of the ``constant" defining the stationary trend. One sees this very simply by positing the proportional relation just spoken as the trend-equation. By definition, all fluctuations - whether ``cyclical", ``seasonal" or ``irregular" - are eliminated in the trend so defined.

6 Let us now move in another direction. We said that we conceive a production process in terms of stocks and flows -- away from time-streams, dated quantities and such. Gist of this ``away" lies in the tool just introduced[6]. ``Stock" will come into the picture later (§ **12**). ``Flows" are already there though the word is not used. Let us get it in.

Wire is bought. Pins are sold. Both are a *reciprocal pair of flows*. Wire *flows in*, money *flows out* while pins *flow out*, money *flows in*. ``Flow" is a *directional* notion, the *crossing of a boundary* from one side to the other if this needs be said[7] -- here the boundary of pfpp. The term is also used in the related quantitative sense (quantity flown).

Let us proceed on. Let us leave money flows out of account. ``Wire flows in, pins flow out" is then all we see of our process from outside on the material plane. Going inside, we see the whole material transformation as stated. The point to note is that the connection between successive stages in this transformation is again a *flow*. One can also use the word ``pass" (and ``passage") in this context. Wire drawn *flows* or *passes* from hands of the drawer to hands of the straightener, wire straightened passes from hands of straightener to hands of cutter and so on[8]. The whole

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[5] This is not quite correct. But let that go.

[6] The reason is that all ``dates" and ``sequences" are simply obliterated in a time rate. A relation between these ``rates" is a plain temporal relation, not an ``intertemporal" relation.

[7] How else does one cross a boundary?

[8] So, to count each of ``wire drawn", ``wire straightened", ``cut pieces of wire'' etc. as IP of the process is really to follow a *flow-criterion* of identification of IPs of a process. This criterion is discussed later (§ **29**). Precisely because of this, we keep the notion in abeyance.

process thus appears as a process of material flow through successive stages effecting successive transformations of the ``material''.

7 Before ending, we take a close look at the flows or passages just talked. We distinguish *two alternatives* to play a significant role in our arguments later[9]. In the first, everything passes *straight, hand to hand*. Workers stand in a *row* or *line*. Drawer passes wire drawn to straightener who passes wire straightened to cutter who passes cut pieces of wire to pointer and so on -- hand to hand, as just stated. We call this the *hand-to-hand process* (a variant of pfpp to be sure).

Now, in the very nature of things described, wire drawn *must* pass straight, hand to hand from drawer to straightener, wire straightened must again pass likewise from straightener to cutter, but cut piece of wire *need not* pass like this from cutter to pointer. We may as well suppose that a *bin* or *basket* is conveniently placed between cutter and pointer for the first to *drop in* the cut pieces and the second to *pick up*, which they do. This is the *bin/basket process* (another variant of pfpp). It is assumed that the arrangement holds good for suitable successive pairs of workers like pointer-grinder and so on.

Note, what appears as *just* a flow from cutter to pointer in the hand-to-hand process appears as a *pair of flows* in the bin/basket process -- one from cutter to the bin or basket, one from there to pointer. More briefly, it is now a flow *via* the bin. Note, though we speak *a* flow, there are really *two* distinct flows.

II

8 Let us now introduce the notion of *rate of flow*. We go from the statement, wire flows in, pins flow out, to that wire flows in at a certain *rate* p.u.t., pins flow out at a certain *rate* p.u.t. This,

[9] There may be other alternatives, which we do not consider. Note, the moment we start talking of ``alternatives'', the analysis turns *speculative* or *hypothetical*. The *actuality* -- what we ``see'' when we visit the pin factory -- gets left in the open, which can be properly closed only by definite *analysis*.

we assume, is true of the process we talk[10]. Subject to a provision presently stated, the two rates are connected in a straightforward material or physical sense. Suppose 1 cm of wire ``goes into'' a pin. Stated simply, pins are 1cm long each. Then, for every metre of wire flown in per hour, 100 pins flow out per hour. This is assuming that their is no *loss* or *waste* of the material at any stage (the ``proviso"). We keep to this assumption all through. We then have so to say a string of ``material equations'' -- for every metre of wire flown in per hour, 1m. of wire is both drawn and straightened per hour, 100 pieces of wire are cut out, pointed, grinded and so on per hour. The *actual* number -- how many metres or pieces -- depends upon the *number of workers* and their *work-hours*. We shall assume that all workers have the same work hours, say 8 a.m. to 6 p.m. (with breaks as allowed) each working day. This enables us so to say to get off the ground -- to focus upon a *problem* which seems to get ``lost" otherwise. Stated in a word, the problem is that the same question of *waste* appears at the level of work and workers conditioning the ``dependence" just talked. We refer to the possibility of *idleness* or *loss of time* that is not purely ``volitional" or ``intentional" on the part of workers but is in some way endemic to the very ``process" in which they participate, a question of *organisation*. This is where the two a alternatives just spoken (§ **7**) come in.

9 First, we get something out of our way. Suppose that all works are done strictly according to norm, no deviations. For the sake of argument, we *provisionally assume* that time taken in performing any of our euo's is defined *independently* of its self-repetition, i.e., in ``isolation". This is really a self-contradiction but, as just stated, the assumption is provisional, made for argument's sake. How it affects the argument, if at all, is discussed later (§ **16**).

Suppose it takes 1 min. to draw an arm's length of wire (=1 m. say) but 2 mins. to straighten it. Drawer is then perforce *idle* for 1 min. between each successive round of drawing. Say he just holds the wire an hand, unable to pass it on, for straightener is still straightening the wire previously passed on to him. Perhaps two straighteners can be employed, the drawer passing on the wire drawn alternately to each. It becomes a little difficult to visualise the precise arrangement to

[10] This is based on the following important assumptions lying hidden behind. Our process, pfpp, is not an ``isolated'' process, whatever that may really mean. It is *connected to the outside* by the fact of wire flowing in, pins flowing out. For these flows to at all take place, certain *outside conditions* must be satisfied. And for the flows to take place at certain *rates p.u.t.*, there must be some *stationarity* to the outside. We simply assume these conditions.

overcome this sort of idleness or loss of time, if that is at all possible[11]. We shall not bother about this problem any more. We shall simply assume that all instances of idleness under the idealised condition of all works done strictly according to norm can be removed by a *proper distribution of work-force*; further, that the actual distribution in pfpp *is* ``proper'' in this sense.

All this is simply ground clearance for our purpose. Unfortunately, there is a little more to do of that. We note, to begin with, that there is an ``inversion'' --- putting thing upside down -- in Adam Smith's ``one man for each job'' description of the process. Granting proper distribution, the description means that *equal* time is taken to draw as well as straighten 1 m. of wire, that *equal* time is again taken to either cut out or point, grind one piece of wire etc., these being all a hundredth part of the time taken to draw or straighten 1 m. of wire. We will simply continue with Adam Smith's description with the tacit assumption that these technical conditions are satisfied. *And* we go on to the case where things do not work strictly according to norm, -- surely a fact of life, and so this is the ``real'' case of interest -- by simply taking these ``equalities'' to apply to the *normal* or *average* time taken in the different euo's of the process. Thus the normal time taken to either cut out or point one piece of wire is a hundredth of the normal time taken to either draw or straighten 1 m. of wire and so on.

10 We can now settle down to our problem area. The first question is simply whether there is ``idleness'' in the ``real'' case under the ``hand to hand'' process, given that the technical conditions just stated are satisfied i.e., given that the assumed ``one man for each job'' description of the whole process reflects a ``proper'' distribution of work force. It suffices to consider deviations from norm at any *one* of the successive stages or works of the process. We take that to be ``cutting''. Consequences of dropping this special assumption are noted in the due course.

Let us begin at the beginning. Wire drawn and straightened is passed on to cutter at a certain pace, which be keeps cutting, taking *on the average but not always* the normal time to cut out a piece of wire. Note, this ``normal time'' equals the (constant) time taken to point a piece of

[11] Perhaps this particular problem is simply our own making. ``Straightening'' may well be a more difficult operation than ``drawing''. What time it takes to draw 1m. of wire to no purpose is an idle thought, inconsequential. The real task of the drawer here is to draw wire at a pace *suitable* for straightening. This then is the real problem, not the one talked here. Nothing of this however stands in the way of the *analysis* given below.

wire[12]. It follows that every time the cutter finishes *early*, which he does sometime or other, he remains *idle* for some time. He simply *waits upon* the pointer to finish his pointing on hand and receive the piece just cut out -- *relieve* cutter of that piece; he cannot begin on the next cutting till so relieved. And every time cutter finishes *late*, which again he does sometime or other, he keeps *pointer* waiting upon him to hand in a piece to point. Thus the answer to our question is ``yes". We are back to idleness or loss of time in the form of these ``waitings" and that is simply endemic to the hand-to-hand process[13].

11 Let us a dwell a little on this conclusion. Recall that time taken on the average to cut out a piece of wire equals time taken to point a piece of wire. Durations of the ``waitings'' just talked -- cutter's or pointer's as the case way be -- are by definition equal to deviations from the ``average'' on one side or the other. It follows that their respective *average waiting times* -- time waited on the average between successive performances of the respective euo's – are *equal*. Following the arguments given in the last footnote, we see that this proposition holds for *all* workers in the process.

Let us see what this means in terms of the *rates* at which the works get done. Let ``$a$'' denote the common value of the normal time taken in cutting out a piece of wire on the one hand and pointing a piece of wire on the other. In the ``unreal'' case of no deviations, $1/a$ pieces of wire are both cut out and pointed p.u.t. This sets a *standard*, and we call the rates by this name. In the ``real'' case, the rates are again *equal*[14], but they are equal at a *lower* level or value. The common value now is $1/(a+e)$ where ``e'' denotes the common value of the average waiting time of cutter and pointer. For reasons already stated, this is a general result holding everywhere in the process, which is in some sense only ``compounded'' if our special assumption is dropped. Thus the fact of

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[12] Nevertheless, we can speak of the ``constant'' also as an ``average''. This is just a linguistic convenience.

[13] The ``waitings'' are in fact a *general* phenomenon, not confined to cutter and pointer. Every time cutter waits -- note this means that his hands are not ``free'', he is holding a piece of wire -- straightener is rendered idle or waiting. This in turn renders drawer waiting. Similarly, every time pointer waits, grinder waits; that in turn means that the top-maker waits and so on. In short, the waitings or idlenesses get transmitted in either direction as the case may be. Our special assumption simply locates the source of the phenomenon at a particular point in the process. This is of no consequence in itself.

[14] This follows at once from the assumption of no material waste.

life distinguishing the ``real'' from the ``unreal'' ultimately drives the rate at which pins flow out of the process *below* the standard with a corresponding lowering of the rate of material flow all through *for the same properly distributed workforce working the same hours per day*. This completes our characterisation of the hand-to-hand process.

III

12 The bin/basket process now. Cutter drops his cut pieces of wire into the bin. Clearly, he drops them just *as and when* he finishes the cuttings. There cannot by definition be any ``waiting'' in this. Pointer does not simply come in the cutter's work any more. To repeat, *cutter-waitings talked earlier are simply cut out in toto*. The rate at which wire is cut into pieces is back to the standard, $1/a$.

Pointer-waiting is however by no means cut out or eliminated. It occurs every time pointer finds *nothing* in the bin to pick up. We can restate the condition, the ``nothing'', as *stockout*, for once dropped in, the cut pieces simply *stay* there -- *accumulate into a stock* – till picked up. The stock at any moment is made up of pieces dropped in so far minus the pieces already picked up or taken out[15]. So, we now have ``stock'' in the picture, albeit only in a *potential* sense.

Suppose now that there *is* pointer-waiting as some sort of a *recurrent phenomenon*. Time waited on the average between successive pointings gets into the rate at which cut pieces are pointed in the same way as before, in the denominator. So, the rate is now *below* the standard. By the same token, it is *smaller* than the rate at which pieces of wire are now cut out. But to cut out a piece of wire is now to drop it into the basket, and to point it is to first pick it up from there. If the first rate is greater than the second -- the case here -- then the stock there must obviously *grow*[16].

[15] The general concept underlying this statement is that a stock is but an *accumulation of flows*. By definition, the ``flows'' are flows into the location of the stock, ``inflows'' in this sense. Netting out of ``outflows'' -- ``minus the pieces already picked up'' as just stated -- follows from the very notion of ``accumulation''. Note, just as the word ``flow'' is used also in the quantitative sense (amount flown), so is the word ``stock'' (amount in stock).

[16] So, if it was zero to begin with, it becomes positive in the due course.

Say $a = 1$ min. and so 60 pieces are on the average dropped in an hour's time but only 59 pieces are on the average picked up. The remaining piece simply gets *added* to the pre-existing stock. The stock *grows* on the average by one piece an hour.

All this stands on the assumption of pointer-waiting as some sort of a recurrent phenomenon. But pointer-waiting is simply *equivalent* to stockout[17]. So, we end up in a state characterised by *recurrent stockout* on the one hand and a definite *upward trend in stock* on the other. Since this does not appear possible, we conclude -- ``surmise'' is perhaps the word -- that the process has a built-in mechanism whereby enough -- just enough[18] -- stock is accumulated to prevent subsequent stockout. The process reaches a state where *pointer-waiting too is eliminated*. The rate of pointing too is back to the standard, $1/a$.

13 The argument is admittedly sketchy. We end with a ``surmise'' and no more. We do not bother overmuch on this, for *what really matters for our purpose is the ``state'' just described* -- further described below (next sec.) -- *not how it is reached*. If not reached internally (the ``surmise''), the prior accumulation of stock presumed in this ``state'' is simply presumed to be accomplished by some *other* process, which we need not go into. *Henceforth we assume this ``state'' to be the actuality, what we ``see'' when we visit the pin-factory*. This can be seen as a logical culmination of our assumption of proper distribution of work-force, for while that cuts out idleness in the ``ideal'' case, this cuts out idleness in the ``real'' case as well. We build up our whole remaining picture of the process on this basis. It is so to say the second step in this build-up, the first being self-repetition.

Let us end by updating the notion of ``flow via the bin''. In the state under reference, there is a *stock* in the bin. So, the notion now appears as *flow via a stock*. This is a most convenient expression for our purpose and we often use it. We mention again that though we speak of ``a'' flow via a stock, there are really two flows, which are simply disconnected in a physical sense by the very fact of the stock coming in between. Any formal or conceptual connection between the two

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[17] This is obvious, for pointer waits not only *if* but also *only if* he finds nothing in the bin or basket.

[18] Proof given in the text section.

flows must be thought of in a ``whole" manner covering the stock as well. This brings us to the subject of the next section.

IV

14 Cut pieces of wire before and after pointing are surely very different objects in themselves. Nevertheless, we can compare their numbers as we have been doing. Let us now recapitulate that wire is cut into pieces at the rate $1/a$ in the bin/basket process as such. In its *state* now presumed, cut pieces of wire are also pointed at *this* rate. But, as just stated, to cut a piece of wire is simply to drop it into the bin and to point it is to first pick if up from there. Further, these ``droppings" and ``pickings" are now but *flows into and out of a stock*. It follows -- follows from the equality of these two rates -- that the *stock is maintained intact*[19]. This is the essence of our ``further description" of the state. The rest is basically clarifications and elaborations.

15 First, we justify the word ``just enough" in the last section. It is assumed that the bin/basket process comes on its own to the state under reference. This means, among other things, that the stock that is maintained intact in this state is reached from *below*. Hence it is the *minimum* stock compatible with such a state. Hence the word.

Let us now come to the notion of ``stock maintained intact". Careful reading of the argument so far will show that in the present context the notion means simply that (a) *the earlier-noticed trend in stock is eliminated*, and (b) *the opposite trend does not emerge*. ``Fluctuations" are not ruled out. In fact, they are a *fact* in our case[20]. We presume that the conditions presumed so far

[19] A minute's reflection shows that in the framework of self-repetitions, the equality between these two rates is not only a *sufficient condition* but also a *necessary condition* for the stock to be maintained intact.

[20] This is as simple as that the stock goes *up* with every ``dropping'', *down* with every ``picking''. True, there are no ``ups'' and ``downs'' if the droppings and pickings are *perfectly synchronised* or *exactly matched*. Such is the case, under our assumption, in the ``ideal'' or ``unreal'' case left behind. In that case, there would simply be no stock in the bin, ever. So there goes the talk about the meaning of the stock maintained intact.

-- in particular, the self-repetition of flows -- ensure that the fluctuations take place around a *mean* or *average*. This ``average'' defines the *level* at which the stock is maintained intact. This in turn gives us a single-magnitude measure or representation of the stock in the state under reference, parallel in some sense to the ``rate" measure or representation of flows[21]. Both are *state characteristics*. The state itself is represented fundamentally by these two characteristics.

We give two more related characterisations of the state. The characterisation given so far runs in purely quantitative terms. The underlying qualitative statement is that the state is characterised by flows subject to self-repetition or stationary flows[22] on the one hand *and* stocks maintained intact on the other. This ``and" can be replaced by something more ``connected", for the flows under reference are connected to the stocks as epitomised in the notion of ``flow via a stock". So, we can say simply that the stock is maintained intact *through* stationary flows.

All these characterisations are purely *descriptive* in nature. The *logical* statement is that the flows spoken -- flows occurring at *standard* rates -- occur only with the *support* of stocks maintained at certain *minimum* levels, which are precisely the stocks spoken. This is the other characterisation.

Let us change track, marginally. All this time, we have been speaking of a ``state". But ``state" and ``process'' are not exclusive terms. The fact that the state under reference is a possible state of the bin/basket process does not mean that it is not a process *in itself*. It is. This process is simply the bin/basket process with two further properties: (a) there is a stock in the bin, and (b) the stock is maintained intact through or in or by the process. Of course, this process is conditional upon a prior accumulation of stock. Every process has its preconditions. We call such a process in

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By the way, ``perfect synchronisation'' or ``exact matching'' has (obviously) *nothing to do* with ``self repetition''. If one so likes, one can make this assumption, unmake the other, undo the stock and go ahead (good luck). Not our line of thinking or reasoning in this paper.

[21] Because of this, we can use the words ``stock'' and ``flow'' as shorthands for the ``level at which the stock is maintained intact'' and the ``rate of the flow'' while speaking of the state referred. This greatly simplifies the language but it can also be source of much confusion. We shall therefore use this language sparingly, only when the urge for linguistic simplicity is strong and the state reference is clear.

[22] Another convenient expression for our purpose, to be used whenever necessary or convenient.

general a *stock-flow process* (SFP). In the background stands the hand-to-hand process, which is self-evidently a *pure flow process* (PFP). Note, the ``flows" in either case are stationary flows.

16 It remains to remove the assumption that time taken in performing our euo's is independent of their self-repetition. The precise nature of these self-repetitions is different in the hand-to-hand process on the one hand and the bin/basket process in its state assumed on the other. So, the normal time taken say to cut a piece of wire is also different under the two processes. Let the respective values be a_1 and a_2. In the hand-to-hand process, the self-repetitions are punctuated by some waitings, some times. No such thing in the other process. As we see -- and we think we have Adam Smith behind us -- this implies that ``dexterity" of workers is *greater* in the other process and so $a_2 < a_1$. Obviously, this only strengthens the case of the bin/basket process, *our* case.

V

17 We have come a long way from Adam Smith's ``one man draws the wire, ...". We owe some explanation of the path traversed, *why* this way. We also have a long way to go from here. Some preparations -- purely conceptual developments out of beginnings already made -- are necessary for this purpose. These two things cut out the present two sections of the paper, after which we resume the mainline of our arguments.

18 Path traversed so far is summed up in one word. We have got *stocks* into the picture. Reason we traversed this path is also stated in one word. *No stocks, no classical economics*. Read, please read, is all we can say on this general point.

Let us now come down to a very ``particular" and pass back immediately to the ``broad" or ``general". We refer to Adam Smith's careful listing of

> ``materials, whether altogether rude or more of less manufactured ... not yet made up ... still in the hands of growers, manufacturers, mercers.. (p 266)

as elements of his ``circulating capital'', one of the two ``divisions'' of his ``capital'' and capital, to begin with, was *stock* -- a ``division of stock'' to use the word of Adam Smith (p 262) -- whence the general classical expression, ``profits of stock''. Back to pfpp, we can see wire as ``material altogether rude'' and cut pieces of wire, pointed pieces of wire,..., pins not yet put into paper as ``materials more or less manufactured, not yet made up''. These being all elements of capital, a *stock* of each is clearly presumed to exist in the process as per Smith's listing.

But *why* these stocks – *what for*?[23] We gave, we think, the most ``elementary'' answer to this question, no matter how ```particular'' and ``abstruse'' that tended to be. This way, we simply took the earliest opportunity of grounding the classical conceptions just noted (see also below) remaining within the precincts of pfpp. In view of the very particular nature of our argument, we give a few ``general'' or rather ``generalist'' ones. As we see, a process of material flow with stocks at suitable points is altogether *more flexible, more easily adapted to exogenous shocks and changes, less burdened with strains of coordination* than otherwise[24].

19 Let us know say in all candor that the precise *rationale* of these stocks is beside the point for the purpose of the essay. One may as well start straight from the *fact* of these stocks -- where one earth is there a pin factory *without* these stocks? -- and argue backwards. First, the stocks must play a role in the production process. Otherwise, why are they there? *Ipso facto*, they must be maintained intact. Otherwise, how do they continue to play those roles? *Ipso facto* again, they must be the minimum stocks for these ``roles''. Otherwise why are they maintained intact, not cut down? Finally, the stocks must be related to the flows. Otherwise what ``role''?

This is all that really gets into the following analysis. We simply substituted something definite and hard (sorry) for such reasoned empiricism or whatever.

20 Let us change track. We have come a long way from Adam Smith's statements. Let us round them off with his *first*, very categorical, words on ``profits of stock''.

[23] We do not talk of the stock of wire here. We leave it out of the following discussion as well (till § **32**).

[24] However, the hand-to-hand arrangement of pfpp -- no ``stocks'' in that -- may have an advantage in terms of ``labour discipline''!

> ``The profits of stock, it may perhaps be thought, are only a different name for the wages of a particular sort of labour, the labour of inspection and direction. They are, however, *altogether different*, are *regulated by quite different principles*, and bear no proportion to the quantity, the hardship and the ingenuity of this supposed labour of inspection and direction. They are *regulated altogether by the value of the stock employed*.'' (p 48, italics added)

This is for future reference.

Let us end with a few *curiosms*. Adam Smith introduced pfpp as tool to argue the ``advantages'' of division of labour. Using the same words, we can say that we used pfpp as tool to argue a certain advantage of organising production on the basis of appropriate stocks of his ``materials, more or less manufactured, not yet made up''. And what is that advantage but his ``second advantage'' of division of labour, the avoidance of certain ``losses of time'' that world otherwise occur (p)? Between this particular and the general or generalist now stated, we can certainly say that SFP is ``naturally the case''. Where one earth etc. So, PFP is but a fiction brought up for argument's sake. This way, we simply come back to Adam Smith's proposition, ``accumulation of stock must in the nature of things be previous to division of labour'' (p 260). Wild transgressions indeed. But who knows what the elementary beginnings of these ideas really were.

VI

21 We described our observational datum -- what we ``see'' when we visit the site or place -- as a *state*. This ``state'' defines the *present* for our purpose. Thus we conceive the ``present'' as a *state*, not a ``date''. The concept is *these days*, a sum total of conditions. This is an *analytical* notion as distinct from the empirical ``today'' or the legalistic ``this day, today, the....''

The state we described is based upon a prior accumulation of stocks. Obviously, the accumulation took place in the *past*. How precisely it took place -- over what time, through what precise inflows and outflows etc. -- are all irrelevant and essentially arbitrary from our point of view. The ``present" is the present, no matter how reached.

22 In the ``state" of our reference, stocks are maintained intact. Let us belabour the point. These stocks are not ``frozen conglomerates" that remain intact no matter what happens in the phenomenal domain of reference. The concept is *maintained* intact. The question of maintenance arises because there are flows out of the stock. Let us put the point as follows. The outflow *depletes* the stock. So, ``stock maintained intact" means that the inflow *makes good* the depletion. It is in this sense a *replacement flow* -- the most useful of our expressions so far[25]. The very term connotes the idea of a stock maintained intact. So, we have a fresh statement of this idea.

Suppose now we start *directly* from stock-depletion as a fact of life. We do not speak of ``outflows". Clearly, the notion of replacement flow remains. Thus it carries the seeds of a clear generalisation of the framework of stocks and flows so far. *A stock is by definition maintained intact by replacement flows into it, no matter what the mechanism of stock depletion*.

23 Let us now see the *level* at which a stock is maintained intact in relation to the *rate* of replacement flow into it. Obviously, this is purely quantitative. For simplicity, we assume that this ``rate" is simply a time-average, no ``superimpositions". Consequently, the stock is of a *constant* magnitude, no ``fluctuations". Say, the ``level" is 12 units and the ``rate'' is 4 units per day. This means that a third part of the stock is on the average replaced every day and so , the *whole stock* comes to be replaced in 3 days. Note, this is only a manner of speaking, speaking ``notionally", for the ``whole stock" may never come up for replacement[26]. For the same reason, the ``3 days'' just talked is a *pure length of time*, not to be confused with the notion of ``duration" in the sense of the length of an ``interval" defined on the so-called real time-axis. We cannot read it off the calendar, or clock-calendar if that be the case (e.g., the ``number" turns out to be 3 days 4 hours).

[25] The full expression is ``replacement flow into a stock''.

[26] The obvious exception is that all 12 units are replaced at one and the same time, again and again. We simply disregard this case in the present discussion.

There is another, a more ``inside" way of looking at the length of time just talked. We retain the notion of outflow for this purpose. We also assume that the substance under reference, of which the stock and flows, comes in discrete units like our pieces of wire. Let us now look at the replacements just talked. A replacement occurs when one or more unit of the substance exits from or leaves the stock (outflow). Fresh units, equal in number, move in or enter (inflow). This is what ``replacement" means. The point to note is that the unit that left must have *first entered* the stock. In between, it *stayed* in the stock -- stayed for some *time*. One now sees that the time over which the whole stock comes to replaced (a notional entity, as just pointed out) is once and the same as *time stayed on the average by one unit of the substance in stock* (a ``duration" in the proper sense).

We shall not give a proper name to this ``time". We shall call it simply by what brought us there, viz., the ratio of the level at which a stock is maintained intact to the rate of replacement flow into it (which is in fact what maintains the stock intact). For brevity, we shall call this simply the *stock-flow ratio*. Note, the term has a very particular meaning in our usage. It is not just the ratio of a stock to a flow, whatever that may mean.

24 Let us look a little further into the notion of ``time stayed". We are concerned with a stock with inflows and outflows. This is purely physical. As we see, the rigorous physical conception of this matter is that a unit of the substance simply *losses itself* in the stock as it enters there -- gets ``mixed up'' with pre-existing units -- *whence the outflow*. Clearly, we cannot keep track of the unit from entry to exit[27]. We cannot therefore find out how long it stayed in the stock by pure observations and measurements[28]. But if we do not know how long a particular unit stays in the stock, we cannot say whether different unit stay the *same* time -- equal times -- or not. Hence the necessity of speaking of time stayed ``on the average". This is a *notional* average, not to be confused with an actual average, averaged out of different observations. It is borne out of our *ignorance*, not out of *facts* we know.

[27] Except by some special device like putting an indelible identification mark upon each unit at the entry-point recording relevant informations.

[28] We may however find it by the experiment just sketched (last fn.). We do not however envisage such ``experiments'' for our purpose. Hence we simply disregard this point in the following discussion.

One more clarification is perhaps in order. However ``found", time stayed by a unit of the substance in stock is a physical fact defined under all circumstances, given that there are flows into and out of the stock. But our stock-flow ratio in defined only under stringent conditions: the flows are stationary and the stock is maintained intact. It is only under these conditions that we speak of ``finding" the time stayed.

VII

25 We return finally to the notion of IP. The object is in some sense to ``fix" it -- to be able to precisely identify the IPs of a production process. For this purpose, we first set out a *general scheme* of the internal structure of a production process, which we simply keep to all through. The main thing after that is simply to guard against its *vacuity* or *emptiness*. This roughly is the agenda.

Let us start from square one. The notion of IP is defined w.r.t. a *given commodity*. An IP is both produced and used within the process of production of that commodity. Perhaps the simplest way to conceptualise this in the abstract is to suppose that an IP is produced in a *subprocess* of the whole process (SP) -- for use in *other* SPs [29]. This in a word is the scheme.

26 There are *three underlying assumptions* of the scheme. The first is implicit in the word ``for use in other SPs", for this tacitly rules out the use of an IP in the SP where it is produced, i.e., in its own production (however, see below). This is the assumption[30] Note, the assumption does not rule out the following possibility. Let us take an IP as point of reference. Consider now the IPs produced in SPs where this IP is used. It is possibile that these IPs in turn may be used in the SP producing the IP under reference and so on. In other words, our assumption rules out only the

[29] Let us provisionally count each of ``wire drawn'', ``wire straightened''… ``pins not yet put into paper'' as IPs of pfpp. Its SPs are then simply ``drawing (wire)'', ``straightening''... ``putting pins into paper''. Note, in this case, an IP is used in only *one* SP, placed *next*, and so all the IPs and SPs are ``ordered'' this way. All this is very special. No such restrictions are there in our scheme as such. More importantly, precise nature of the ``use'' of an IP in any SP is left in the open in this scheme.

[30] We shall re-open this whole point at the end of the paper (§ **92**) in a somewhat different form and context and for a different purpose.

``direct use" of an IP in its own production, not ``indirect use". The other two assumptions are stated a little later.

27 For the scheme to be non-empty, it is necessary that there is *at least one* IP. This in turn implies that there are at *least two* SPs, one where the IP is produced, one where it is used.

The question arises, what does the second SP do besides ``using" the IP, given that there are only two SPs. The answer is that it produces the *commodity* begun with. There is no contradiction in the fact that the commodity is produced both in the whole process and in one of its SPs. In one case, we view the process from *outside* and see the object come out of it. In the other case, we go *inside* the process and see the object come out of one of its SPs.

The SP that produces the commodity is by definition the *final* SP[31]. *It is served in one way or another by all the other SPs*. This is only another way of saying that these ``other SPs" produce IPs and IPs are but ``means" of producing the given commodity. Thus the whole set of SPs divide into two subsets, {final SP} and {other SPs} (or {pre-final SPs}), connected ``logically" as stated. This defines the basic logical structure of the whole process viewed as a collection of SPs, i.e., as per our ``scheme".

28 Let us pass on to a consideration of *products* produced in the process. Obviously, the notion must cover its IPs as much as the commodity produced. The difference is that one serves *inside needs*, the other serves *outside needs*. Now that we have used this word (``need"), we may as well divest the ``commodity" of its institutional specification and see it simply as product *of* the process[32] -- what originates in the process, crosses its boundary to serve a ``need" defined outside and thereby realises the very ``purpose" of the production (or of the process) in the social sense of this term[33].

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[31] ``Putting pins into paper'' in pfpp.

[32] Note, the stress is on the word ``of''. ``Product of'' and ``produced in'' are not the same or equivalent notions. IPs of a process are produced ``in " it, but they are not products ``of'' it. They are the products of the respective SPs.

[33] Obviously, the institutional specification now divested (``sale") simply specifies a mechanism of the ``crossing" talked.

All this is defined from outside the process. Going inside, we can see the same object as the *final product* of the process in a sense running parallel to the notion of the final SP[34]. One provides the rationale of all *other* SPs, the other provides the rationale of all *other* products, viz. its IPs. Thus the ``product" form of statement of the logical structure of the process is that the set of products produced in the process divides into the two subsets {final product} and {IPs} (or {other products}), which are connected by the very definition of IP.

Let us now state the two other underliying assumptions of our scheme. We assume a one-one correspondence between products produced in a process and its SPs, in the sense that each product is produced in *one* SP and conversely, each SP produces *one* product. Thus we rule out both ``alternative methods of production ‘’ (for producing the same product) and ``joint production".

29 Let us pass on to a second round of logical examination of the scheme. Let us focus attention upon the two sets, {pre-final SPs} and {IPs}. There is a one-one correspondence between the two sets saying that an IP is produced in a (pre-final) SP and that a (pre-final) SP produces an IP. The point to state is simply that this *goes in a circle*. We end up by defining an IP w.r.t. an SP and an SP w.r.t. an IP. Nothing gets ``fixed" by this. The scheme again turns empty or vacuous.

Clearly, something must come from outside -- outside the scheme -- to cut the circle and fix the notions[35]. This sets the stage for reviewing the *flow criterion* for identifying IPs.

The outside element here is simply the ``flow". The criterion is that an IP is identified by its flow from an SP (where it is ``produced") to one or more SPs (where it is ``used"). Granting the implicit assertions[36], we have to say that this does *not* cut the circle. All that this criterion says is

[34] Thus we have three alternative designations of the same object -- commodity produced, product of the process and final product -- which we use simply according to context, purpose and convenience.

[35] A little reflection will show that the ``outside element" underlying our ``provisional countings" in pfpp is *division of labour* as epitomised in Adam Smith's ``one man for each job" description of the process. Yes, a ``job’’ is a job here because ``one man’’ does it. This is what fixes the ``elementary operations" of pfpp, which we just saw as its SPs. On this view, SPs are ``fixed" *first*. IPs are *then* defined w.r.t. these SPs.

[36] viz., an IP (a) *flows out* of the SP where it is produced, and (b) *flows into* the SP(s) where it is used. We have already granted (a) as inherent in the very notion of a ``product". (b) is a disputed area.

that an IP flows out of an SP (pre-final) and conversely that an SP (pre-final) is the source of such a flow. The circularity remains.

Let us proceed through a different way of putting essentially the same problem. In the abstract, one can ``cut" a process *wherever one likes* and conceive a ``flow" from one part to the other. This simply makes the whole notion of IPs and SPs vanish into a thin air of abstractions. The scheme gets drained of its content.

But there is nothing *abstract* about a ``stock". Very location of stocks in a process tells us where to ``cut". This does cut the circle. Existence of stocks cannot be tricked out of the picture. Accordingly, we now adopt the stronger *stock-criterion* for identifying IPs of a process, i.e., we identify them simply by the existence of their stocks in the process. Note, this means that it is IPs that are now *first* fixed or identified. SPs are *then* defined w.r.t. IPs already identified by the stock-criterion[37].

30 We have now completed one big lap of the analysis in this essay. The next lap begins in Part Two. The next section (the last of this Part) acts as a link. Let us briefly review the lap covered. This section comes straight out of the introduction to the paper bypassing the rest till we got to the identification criterion of IP. In that -- in the stock-criterion finally adopted -- we have the confluence of two streams. One stream gave us the substantive framework of stocks and flows -- of rates of flow and stocks maintained intact. The other stream gave us the abstract framework of IPs and SPs. Rest of our analysis flows in the combined stream -- on the boat of pfpp till Part Four.

VIII

31 This section simply gives a formal shape to pfpp as discussed so far in term of the notions of IP and SP. This is to serve as framework for the analysis of Part Two of the essay. We

[37] Back to pfpp, this means that cut pieces of wire now appear as its *first* IP. It is produced in the SP, ``drawing *cum* straightening *cum* cutting''. This is just *one* SP, not three as earlier.

say ``as discussed so far'', for additions are made later (Part Three). For brevity, we simply write pfpp for ``pfpp as discussed so far".

32 Recall Adam Smith's ``materials altogether rude" in the context of circulating capital. A *stock* of ``wire'' was clearly presumed to exist in pfpp. He was more emphatic about

> ``the work which is made up and completed, but which is still in the hands of the merchant or manufacturer, ... not yet distributed to the proper consumers "(p 266).

in the same context. A *stock* of ``pins'' (put into paper) was thus also presumed to exist in pfpp. We now carry on with these specifications[38]. This means that the wire that flows into the process flows in into a stock of wire inside the process, from which it flows into an SP (the first). Similarly, pins flow out of the last or final SP first into a stock of pins inside the process and thence out of the whole process. In brief, we again have the phenomenon of ``flow via a stock" at the two endpoints of the process.

33 Fig. 1 below gives a visual depiction of the whole process. Its two *vertical bars* represent the process boundary as crossed by wire (G_0) on the one hand and pins (G_{n+1}) on the other. These (and other) crossings or flows are depicted by *arrows* suitably bent to depict the phenomenon of ``flow via a stock". Strictly speaking, the ``bendings" are not necessary. Stocks and SPs are depicted respectively by *circles* and *rectangles*, which could as well be arranged in a line. The two-line arrangement simply enhances the contrast. Besides, it is faithful to the idea of ``dropping" and ``picking".

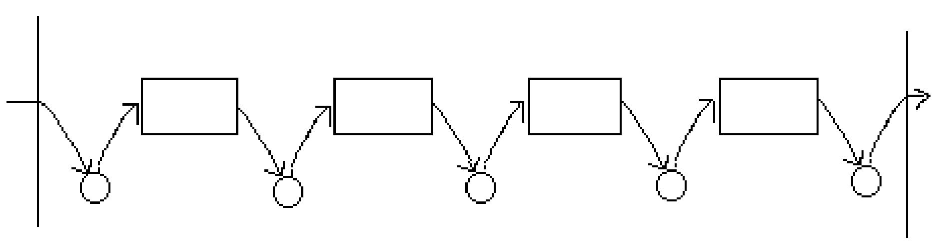

Fig 1

Internal Structure of pfpp *qua* SFP

[38] We do this simply because the stock of wire and pins facilitates the statement of certain *principles* discussed later (§ **39**). Once they have served this purpose, they may as well be *abstracted*. This point applies eventually only to the stock of pins in our scheme, for wire in the sense understood here (commodity bought) simply disappears under PLA. Note, we simply dodge the question why the stocks are there in the process in the fist place. (However, see § **97**).

34 Let us now put in the rest of (algebraic) symbols or notations for describing the process and simultaneously describe the process in these terms. In between G_0 and G_{n+1}, we have a whole series of IPs denoted $G_1,\cdots,G_n$. So, there are in all (a) $(n+1)$ *products*, $G_1,\cdots,G_{n+1}$ and as may *SPs* producing them, denoted $P_1,\cdots,P_{n+1}$; (b) $(n+2)$ *stocks*, one for each G_k, $k=0,\cdots,n+1$, denoted $S_0,\cdots,S_{n+1}$, and (c) $2(n+2)$ *flows*, for each G_k flows both *into* S_k (one flow) and *out of* S_k (another flow), the notations for which are stated below.

We shall define the flow-notation from the *process point of view*, not the ``goods"[39] or stock point of view. $Z$'s will denote *inflows* and $X$'s will denote *outflows* as seen from this standpoint. Consider $P_k$. There is a flow into it, denoted $Z_k$, and a flow out of it denoted $X_k$[40]. Note, the ``substance" in Z_k -- of which the flow -- is G_{k-1}, not G_k. The substance in X_k is of course G_k. Note also that Z_k and X_k are simultaneously the flow out of S_{k-1} and flow into S_k respectively.

Finally, we denote the flow into and flow out of the whole process by Z and X respectively (no subscripts). By definition, Z is a flow of G_0, simultaneously the flow into S_0 while X is a flow of G_{n+1}, simultaneously the flow out of S_{n+1}.

We can now take a total view of the process. G_0 flows in from outside (this is Z). Inside, it flows into S_0 (this too is Z) and then out of S_0 into P_1 (this is Z_1) where it gets transformed into G_1. G_1 in turn flows out of P_1 into S_1 (this is X_1) and then out of S_1 into P_2 (this is Z_2) where it gets transformed into G_2 and so on. G_{n+1} flow out of P_{n+1} into S_{n+1} (this is X_{n+1}) and then out of S_{n+1}, out of the whole process (this is X).

35 So much is purely qualitative. Quantitative statement of the process runs in turns of *rates* of flow and *levels* at which stocks are maintained intact. Without batting an eyelid, we let the stock and flow notations just introduced denote these magnitudes as well. Thus depending upon the

[39] The word is used as a common denominator for commodities and IPs in the present context.

[40] The X's are called the *rates of production*.

context (qualitative/quantitative) the S 's will denote either stocks or levels at which the stocks are maintained intact and similarly the Z 's and X 's will denote either flows or rates of the flows. It is hoped that these double interpretations do not cause any confusion. The economy of notation is simply enormous.

Algebraic statement of the process is completed by setting down a set of equations expressing the inter-linkages running though the process. These are simply the equations equating the rates of flow *into* and *out of* each stock. The inter-linkages follow at once from recognising the *source* of the first set of flows and *destination* of the second set of flows. As already noted, these equations are both necessary and sufficient for the condition that stocks are maintained intact. So, we call them the *stock-maintenance conditions* of the process.

The equations are

$$\left.\begin{aligned} X_k &= Z_{k+1} \quad k = 1, \cdots n \\ Z &= Z_1 \\ X_{n+1} &= X \end{aligned}\right\} \qquad (i)$$

Taken together, the equations constitute a set of *chain-relations* and are to be so referred.

Part Two

CAPITAL

IX

36 ``Capital'' is our *central concept* in this essay. Everything discussed so far is preparatory to it. So is the whole discussion of the next Part of the essay. At this point, we simply discuss the concept in the background of the statement of pfpp just given[41], for that serves to bring out certain *principles* with the least clutter, given the reference point of pfpp.

At the very outset, we have to state a *basic limitation* of our handling of the concept of capital. We left ``money flows'' out of our account of pfpp. We simply continue with this abstraction. Consequently, we miss out the ``circuit'' defined by these flows, which in turn *blots out* a significant aspect of the classical notion of capital. We stop short of their *organic* notion and concern ourselves with essentially a *logical* notion reflecting ultimately a certain programme or project culled out of their writings that we keep in view. In the ultimate analysis, the ``logical'' should flow out of the ``organic''. We miss this out simply because we leave out the organic.

Let us state the limitation in another way. So far, we have viewed pfpp simply as a piece of *technology*. Now, we see it as an instance of *capitalist production* focussing upon the word ``capital''. But we do not go the whole ``classical'' way with this. We stop short of their specific notion of a *capitalist* process of production as classically enunciated by Adam Smith with the words, ``As soon as stock is accumulated in the hand of particular persons, …'' (p 48), later elaborated by Marx in his notion of the capitalist *mode* of production. In our account, ``technology'' and ``institutions'' are initially kept separate and then merely combined, not integrated as in these statements.

[41] It is tacitly assumed that this is a *complete* statemnt of pfpp so far at least as stocks are concerned.

37 Our programme or project is a reconstruction of certain strands of the classical theory of value and distribution, referred at the outset as ``Sraffa themes". At this point, we simply note *two basic propositions* underlying these strands -- (a) mechanism-wise, profits are governed or regulated by *forces of free competition*, and (b) these forces always tend to *equalise rates of profit*[42] *across board*.

38 Let us now pick up the notion of capital from where are had left it off, courtesy Adam Smith. We begin from the statement, profits are ``regulated altogether by the value of stocks employed". In that context, the statement meant no more than that the greater the stock employed as capital, the greater the profit earned. A person with greater capital earns greater profits. ``Value" of stock means in this context simply ``amount" or ``magnitude"[43]. All this remains essentially within a *physical* notion of capital.

Set now the same statement in the fuller background of the classical theory just given. ``Capital" here is a *value-notion* on par with ``profits". How else to conceive the rates of profit that are to get *equalised* by forces of free competition? We are thus back to Smith's statement with this specific sense of the term ``value". Capital is not simply stock employed for the purpose of making profits. It is the *value* of such stock or *stock-value* in short.

39 Let us get back to pfpp. Seen from the above standpoint, *two stocks* in this process at once stand out, for, for these two, and them only, do we have a *price* to value the stock. We refer of course to S_0 and S_{n+1}, stock of ``wire'' on the one hand and ``pins'' on the other.

The rub is that wire is *bought* but pins are *sold* in pfpp and the ``selling" means *profit*. By definition, the price of pins *includes* profit. It follows that *this price cannot just come into the notion of capital*. Capital is the very base and basis of profits. As such, it must be defined independently of and prior to profits. This is possible only if the ```valuation" in this notion is done

---

[42] ``Rate of profit'' is simply profit per unit of capital.

[43] Cf. the very next statement of Adam Smith: ``(profits) are greater or smaller in proportion to the extent of this stock " (p 48).

from the *cost-side*, excluding profits[44]. So, in sum, the price of wire is ``in" -- for it obviously gets into the cost of wire in pfpp -- but the price of pins is ``out" -- it does not get into the cost of pins in pfpp -- so far as this valuation and therefore the whole notion of capital in pfpp, the capital *invested* to use a modern expression, is concerned. We thus proceed from just a value-notion of capital to a *cost*-value or value-at-*cost* notion of capital.

40 Rest of the section is concerned with capital in pfpp in the form of wire or G_0. Capital in the remaining forms, $G_1, \cdots, G_{n+1}$, is taken up in the next section.

Let us start from square one. In the project of programme we keep in view, ``capital" derives it significance from being the base or denominator of rate of profit to be played upon by the forces of free competition. The point to note is that ``free" or not, *competition knows only the ``present"*. The ``past" is simply disregarded[45]. It follows that the ``cost-value of the stock of G_0" defining our capital is simply the value of the stock at the price at which G_0 is *presently* or *currently* bought. This means in turn that this is really a *hypothetical* value as distinct from the *actual*. It is given by the cost that *would have been* incurred in accumulating stock *had* G_0 been always bought at its present price, not the cost actually incurred in this accumulation[46].

[44] A very simple way of putting all this is that profit is but return upon the money *put in.* ``Interest"?. That needs another paper. We keep entirely within the two basic institutions of ``commodity production'' and ``wage labour'' in this essay.

[45] Thus we again come back to the proposition that the ``past'' *is irrelevant* for the purpose of this paper.

[46] Obviously, the two notions coincide if the present price had always ruled in the past, i.e., in a world of *unchanging* or *constant* price. The cost actually incurred in accumulating the stock is in this case simply the stock valued at this ``one'' price. Notwithstanding this obvious convenience of this assumption, we do *not* in fact make it, for it has no logical status in our conceptual scheme.

It may be worth bringing out one implication of *not* making the assumption though this is not directly relevant to our purpose. Let us start off from the stock of G_0 as it exists in our process at a given point of time. *Suppose* we have the complete record of dates and quantities of past flows, in and out of the stock i.e., it whole ``history''. *Suppose* we also have the complete record of prices paid in these purchases (inflows). Can we find the cost *actually* incurred in accumulating the stock? The answer is in general *no*. Reason for this follows at once from the argument of § **24**. We have no way of finding out *what part of which past inflow is still in stock*. So, we have noting -- no ``age distribution'' of the stock -- to match the price data. The ``actual'' cost-value of the stock is thus just undecipherable. This comes full circle. The ``irrelevant'' is also ``undefined''.

41 Let us now pass on to a consideration of the *cost incurred in the purchase of* G_0 in our process. In the background, we have G_0 flowing into the process at a certain *rate p.u.t*. This does not however mean that the corresponding money flow, .i.e., the cost under reference, also occurs as a *rate p.u.t.*. Yes, this is so *if* the price concerned is a constant. But as just stated, we do not make this assumption. We now repeat a point just made. Competition knows only the ``present''. Hence it is the *present* price of $G_0$ that matters for our purpose. This does convert the rate of flow of $G_0$ into a rate of money-flow out of the process, and that is the relevant ``cost'' for our purpose. This ``cost'' too is a hypothetical notion defined parametrically w.r.t. the present price -- the cost that would have been incurred p.u.t. had this been the price all through -- just as much as capital (in the given form) is[47].

42 Let us now set down our notions in symbols. Let q denote the *present price* of G_0 and K_0 and C_0 denote respectively capital in pfpp in the from of G_0 and the cost incurred on the purchase of G_0 per unit of time in pfpp. According to the arguments just given, we have the following definitions

$$K_0 = qS_0 \qquad (i)^{48}$$
$$C_0 = qZ$$

We now give a *transformation* of the expression of capital, which is to play an exceedingly important role in the subsequent analysis. We can write

$$\begin{aligned} K_0 &= qS_0 \\ &= (qZ)(S_0 / Z) \\ &= C_0\theta_0 \qquad (ii) \end{aligned}$$

[47] Henceforth, we take these clarifications as understood and speak simply of ``cost value of stocks'' and ``costs incurred per unit of time'' in the hypothetical and parametric sense as just explained without explicit statements to this effect.

[48] Note, capital defined here is a *state* notion. This is to be distinguished from the notion of capital *at a given point of time* in the strict sense of this term. In fact, the notion of ``point of time'' does not simply enter our substantive analysis.

where

$$\theta_0 = S_0 / Z .$$

θ_0 represents precisely a *stock-flow ratio* in our sense of this term (see § **19**). As such, it represents a pure length of time -- so many ``days" say, precisely those many days for which one unit of G_0 stays, on the average, in the stock S_0. Turning this around, we can say that the stock S_0 is simply *these many days' replacement flow of* G_0. By the same token, the capital K_0 is the *cost* of these replacement flows -- the rate of replacement cost C_0 lies *invested* in capital for θ_0 days. This is precisely what (ii) says. We can say that this gives us a *time-form of expression* of capital as distinct from its *stock-form of expression* given in (i)[49]. In a deeper sense, (i) gives a *material* form of expression of capital while (ii) gives a pure *value* form of expression, for C_0 denotes a pure value with a time-dimension, and the time-dimension cancels out in the product $C_0\theta_0$.

X

43 We are concerned here with capital in pfpp as a whole, in all the forms $G_0, \cdots, G_{n+1}$ together. This capital is by definition the sum in value or value-sum of all stocks in the process where ``value" is understood in a cost sense and ``cost" is understood to be defined as per present cost conditions ignoring past changes. All this is already explained.

We can write the definition as

$$\begin{aligned} K &= c_0 S_0 + c_1 S_0 + \cdots + c_{n+1} S_{n+1} \\ &= K_0 + K_1 + \cdots + K_{n+1} \end{aligned}$$

[49] Need we say that the notion of form of *expression* of capital is not to be confused with the notion of form of *capital* as such?

The notation is self-explanatory. c's denote *unit costs* of respective G's, also called ``cost coefficients'' (see below) while K's denote *capital* in the form of respective G's; K (unsubscripted) denotes *total capital*. Obviously, c_0 is only new notation for q. It is introduced simply to put things on par. The difference remains that G_0 being *bought*, its unit cost is simply the *price paid*, while the remaining G's being each *produced* in pfpp, their unit costs are the respective *unit costs of production* which in turn are to be *derived* ultimately form *costs actually incurred in the process*. There are several steps in this matter.

44 We assume that the only cost incurred in pfpp besides the cost of purchasing wire or G_0 is the *wages paid*, denoted W. This W is the sum total of wages paid to all workers, each of which is conceived as a rate p.u.t. defined w.r.t. present terms and conditions of employment. This is a rather intricate matter, but we do not have to go very deep into it. For our purpose, the ``terms and conditions'' boil down to the *wage system* in operation. Whatever the system -- e.g., the piece-wage system, the time-wage system and their variants -- it will have its own procedure of measurement of ``labour'' or ``work'' and its own definition of ``wage rate'' understood in the sense of wage paid per unit of work done. Linking this up with the internal structure of the process, we see that W is the sum of $(n+1)$ individual terms, $W_1, \cdots, W_{n+1}$ representing the wages paid for the work done in the respective SPs, $P_1, \cdots, P_{n+1}$ [50], where each of these W's is the product of a *physical term* (``work done'') and a *value* or *remuneration term* (``wage rate''). This important decomposition is simply to be kept in mind. We do not explicitly write it in our equations or formulae anywhere.

45 We now pass to the subject of *cost of production*. We conceive cost of production to be one and the same as cost incurred in the process of production. In the present context, this is defined only for pfpp as a whole. Let us keep to that for the time.

Let us first adjust our notions and notations to this ``whole'' view, which is also the view from ``outside''. The point of this observation will become clear as we go on. Let C denote the total cost incurred in pfpp per unit of time. By definition

[50] We can also say that the total wage W is *distributed* over the SPs in the stated amounts.

$$C = C_0 + W$$

This C is by definition the cost of production of pins in a certain amout p.u.t. (X). We should *not* denote ``pins'' in this context by $G_{n+1}$. This notation is defined only as endpoint of a sequence defined inside the process. At present, we are viewing ``pins'' simply as the *commodity* produced, not as the ``final product'' of the process. If we want to have a symbol for it, that should be, say, G.

Let us now get back to the point that C is the cost of producing G at the rate X. From here, we get to the notion of the *unit cost of production* of G, which we denote by c. By definition

$$c = \frac{C}{X}.$$

Note, C and X are both visible from *outside* the process - one is the rate at which money flows out of the process, the other is the rate at which G flows out. Hence c is also visible or at any rate definable from outside. It is in this sense comparable to q which is obviously visible and defined outside.

Let us now come to a deeper point. We have just divided C by X thereby *cancelling out* their time dimension. By this very cancellation, we can see the ratio as *detached* from the underlying process. This step too puts c on par with q[51]. This is the basic idea of calling c a ``cost coefficient''.

46 Let us now proceed *inside* the process. We see a whole series of SPs, $P_1, P_2, \cdots$ producing the respective products, $G_1, G_2, \cdots$. No cost is separately incurred in an SP in the sense of money payments. We avoid confusion by speaking instead of costs *associated* with SPs. The cost of

[51] In fact, q is also detached from its underlying process of buying-selling. ``Price'' is not just a money-commodity ratio thrown up by a motley collection of such transactions. A *non-price* transaction as e.g., in all-or-none bargaining, will also throw up a like ratio. The very notion of price embodies a rule or principle. By that very rule, price appears as *parameter* in particular transactions, governing them from outside.

production of these products are the costs associated with SPs producing them. They are *internal costs* or *notional costs* as distinct from the actual cost C visible from outside.

Note, we again meet P_{n+1} and G_{n+1} as endpoints of the above sequences. Since G_{n+1} is simply ``pins", this gives us an ``inside view" of the cost of production of ``pins" which must obviously coincide with its ``outside view" just given. This is to be seen[52].

Let $C_1, C_2, \cdots$ be the respective cost of production of $G_1, G_2, \cdots$ equivalently the costs associated with $P_1, P_2, \cdots$[53]. All these C's are again made up of a *labour cost* and *material cost*. The labour cost in P_k is simply W_k. The material cost in P_1 is C_0, for the raw material in P_1 is simply G_0 and the whole amount bought of G_0 serves simply this purpose[54]. The material cost in P_k, $k = 2,3,\cdots$ is C_{k-1}, for the raw material in P_k is simply G_{k-1} which in turn is simply the product of P_{k-1} and the whole of this production serves simply this purpose.

These relations at once *define* the C's, the *actual values* of which in terms of the *given data* of our problem, $C_0, W_1, W_2, \cdots, W_{n+1}$, are then also worked out at once by a process of back-substitution starting with C_0. All this is set out below.

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[52] Taking this coincidence for granted, one sees that we are in some sense ``closing in " on our capital K from its two ends. We have already got a complete view of capital in our process in the form of G_0. Granted the coincidence, we now also have a complete view of capital in this process in the form of G_{n+1} viz.

$$K_{n+1} = c_{n+1} S_{n+1} = c S_{n+1}$$

Thus, what remains to be seen or rather ``resolved" is only capital in the remaining, ``intermediate'', forms of $G_1, \cdots, G_n$, i.e., in the form of IPs.

[53] Obviously, $C_1, C_2, \cdots$ are the costs of producing $G_1, G_2, \cdots$ at the respective rates, $X_1, X_2, \cdots$.

[54] This is to be understood in the *indirect* sense of ``flow via a stock''. What serves the ``purpose'' under reference in the *direct* sense is simply the *flow out of the stock* but this in turn *equals* the flow *into* it (in the ``rate'' sense) *because* the stock is maintained intact. Taking all this as understood, we speak of this ``inflow'', which *is* the ``amount bought of $G_0$", as serving the stated purpose. The same clarifications apply to the expression ``serving simply this purpose" used below.

$$
\begin{aligned}
C_1 &= C_0 + W_1 \\
C_2 &= C_1 + W_2 = C_0 + W_1 + W_2 \\
&\vdots \\
C_k &= C_{k-1} + W_k = C_0 + W_1 + W_2 + \cdots + W_k \\
&\vdots \\
C_{n+1} &= C_n + W_{n+1} = C_0 + W_1 + W_2 + \cdots + W_k + \cdots + W_{n+1}
\end{aligned}
$$

Note, the RS of the last equation is nothing but C. This establishes the identity of the ``inside" and ``outside" views of the cost of production of ``pins".

47 Let us now *interpret*. The back-substitution just employed to solve our cost equations[55] boils down simply to resolving the material cost at any stage of our production process into the constituent elements of the cost of production of the ``material" or ``raw material" concerned. Stated in *analytical* terms, this is the same as resolving certain ``direct costs" into ``indirect costs". Because of the clear sequential nature of the production process, there is a clear ``beginning" for this process of ``resolutions". At this ``beginning", there are only direct costs: C_1 is made up of C_0 and W_1 both of which are direct costs in the production of G_1 [56]. At the next stage, we have C_1 and W_2 as direct costs, of which the first resolves into components just mentioned, which are, in this case, simply C_0 and W_1. And so on. When this whole process is worked out, we have each C_k resolved into a direct cost, W_k, and a *series* of indirect costs, $W_{k-1},\cdots,W_0$ and C_0. This way, C_0 appears as indirect cost in every C_k, $k = 1,2,\cdots$ while W_i appears as indirect cost in every C_k for $k > i$. Note, each of these elements is a *cost actually incurred* in pfpp. So, each C is made up ultimately of a series of costs incurred, incurred directly or indirectly. This is what comes to the foreground of the following analysis. The fact that these C's are notional costs recedes into the background.

[55] We use this term to denote the equations *defining* the costs of productions. Later, the term is also used to denote the equations defining *unit* costs of production (§ **69**).

[56] They are also primary data for our problem. Hence there is noting to ``solve'' so far as our first cost-equation is concerned.

48 We can now pass on to capital via the unit costs, $c_1, c_2, \cdots$ which are obviously defined by

$$c_k = C_k / X_k, \quad k = 1, \cdots, n+1.$$

Note, we again have the ``cancellation of time-dimension" talked earlier and the resultant interpretation of these $c$'s as ``cost coefficients" detached from the underlying processes[57].

The material form of expression of capital in pfpp as a whole and also in its various constituent forms was stated at the outset (§ **43**). The cost coefficients appearing in these expressions or formulae are now worked out, though not explicitly written down as such. We do not take out any time on this matter but pass directly to the pure value form of expression of these capitals.

49 The starting point for this purpose is the fact that in our process the whole production of G_k is but a replacement flow into its stock. So, the associated *stock-flow ratio* in our sense of the term, which we denote by θ_k, is given by:

$$\theta_k = S_k / X_k, \quad k = 1, \cdots, n+1.$$

So,

$$\begin{aligned} K_k &= c_k S_k \\ &= (c_k X_k)(S_k / X_k) \\ &= C_k \theta_k \end{aligned}$$

---

[57] We give here important *derivation* to be used later. Just now, we started out from a set of cost equations and solved them. Grant now the notion of cost-coefficients in the sense understood. Recall that G_k flows into P_{k+1} at the rate Z_{k+1} p.u.t., this being the only flow into P_{k+1}. It follows that the material cost component of P_{k+1} is $c_k Z_{k+1}$. Hence

$$\begin{aligned} C_{k+1} &= c_k Z_{k+1} + W_{k+1} \\ &= c_k X_k + W_{k+1} \qquad (\textit{from eq.}(i), \sec.\ \textit{viii}) \\ &= C_k + W_{k+1} \end{aligned}$$

Thus, we now *derive* the cost equation we earlier *started from*.

We can now argue the rest. We have just got K_k as θ_k days' cost of production of G_k, meaning that the (daily) cost C_k lies ``invested'' in this capital for θ_k days. And, we saw before that this cost C_k is made up of a direct cost W_k and a whole series of indirect costs which we can write backwards as $W_{k-1}, W_{k-2}, \cdots, W_0$. Let us now consider capital in *all forms together upto* G_k. We see at once that while W_k lies invested in it for θ_k days, W_{k-1} lies invested *first* through K_{k-1} for θ_{k-1} days and *then* through K_k for θ_k days, i.e., for a total of $(\theta_{k-1} + \theta_k)$ days. This kind of *cumulations* goes on all through. C_0 lies invested through each of $K_0, K_1, \cdots, K_k$ for $\theta_0, \theta_1, \cdots, \theta_k$ day respectively, i.e., for a total of $(\theta_0 + \cdots + \theta_k)$ days. So, when we take a *total* view of capital in our process -- we *sum* over all the K's -- we find that C_0 lies invested for $(\theta_0 + \theta_1 + \cdots + \theta_{n+1})$ days, W_1 for $(\theta_1 + \theta_2 + \cdots + \theta_{n+1})$ days and so on, W_{n+1} for θ_{n+1} days.

Let us interpret this result. Our ``goods'' $G_0, G_1, \cdots$ are ordered by the fact that $G_0$ produces $G_1$, $G_1$ produces $G_2$ and so on. In other words, they come in a line[58]. By this very fact, each of these different forms of capital can be seen as constituting a ``layer'' of capital falling in a clear *succession*. The deepest layer is made up of G_0, the next deepest of G_1 and so on. The ``topsoil'' is made up of G_{n+1}.

So much is preliminary to our purpose. Let us now move on to *capital* thereby moving from the physical to the value-plane. We just saw that C_0 lies ``invested'' in capital for $(\theta_0 + \cdots + \theta_{n+1})$ days. We can say now that the corresponding ``layer'' of capital -- the ``deepest'' as just seen -- has *depth* of $(\theta_0 + \cdots + \theta_{n+1})$ days. Similar interpretation applies to all the other terms in capital. So, we see capital as *formed of successive layers with ``depths'' just indicated*[59].

A diagrammatic representation of this ``formation'' is given in fig.2. Before that, we give the algebraic derivation of the results just stated.

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[58] Because of this, we say that the production process here has a ``linear structure''. This is of course very special.
[59] Needless to say, this is specific to the linear structure of the process.

$$K = C_0\theta_0 + C_1\theta_1 + \cdots + C_{n+1}\theta_{n+1}$$
$$= C_0\theta_0 + (C_0 + W_1)\theta_1 + \cdots + (C_0 + W_1 + \cdots + W_{n+1})\theta_{n+1}$$

Rearranging terms, we can write

$$\begin{aligned} K = {} & C_0(\theta_0 + \theta_1 + \cdots\cdots\cdots\cdots\cdots\cdots\cdots + \theta_{n+1}) \\ & + W_1(\theta_1 + \theta_2 + \cdots\cdots\cdots\cdots\cdots\cdots + \theta_{n+1}) \\ & + \cdots \\ & + W_{n+1}\theta_{n+1} \qquad (i) \end{aligned}$$

This upside-down pyramid is made upside-up in the diagram.

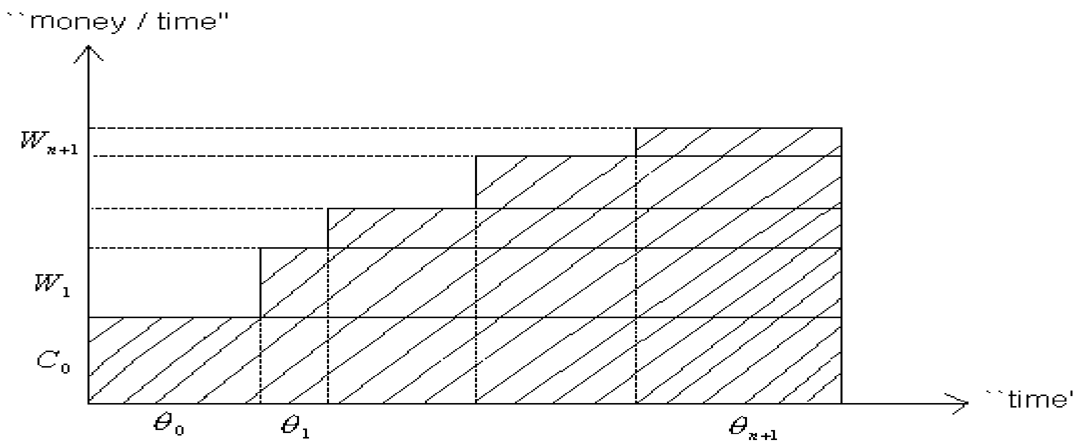

Fig 2

Structure of capital in pfpp
(Shaded area represents capital. Slabs in the shaded area represent successive layers of capital. Axis-designations denote simply units of measurement along respective axes).

XI

50 Here we simply take the earliest opportunity of entering the domain of PLA, given the beginning made with pfpp. This is going to be a brief, transient visit. We have still some ground to cover remaining within the precincts of PMC (Part Three).

We enter the domain of PLA by a simple trick. Our notion of PLA precludes private property over ``natural things''. They are simply *free* gifts of nature in the sense of coming *gratis* to all concerend. We now simply assume that ``wire'' is a ``natural thing''! This is the trick.

51 Algebraically, this means that $q = 0$. This simply takes out the bottom layer of capital just talked and reduces the whole notion to an innate simplicity:

$$K = W_1(\theta_1 + \cdots + \theta_{n+1}) + W_2(\theta_2 + \cdots + \theta_{n+1}) + \cdots + W_{n+1}\theta_{n+1}$$

We can write the formula compactly as:

$$K = W\theta \qquad (i)$$

where,

$$\theta = \delta_1(\theta_1 + \cdots + \theta_{n+1}) + \delta_2(\theta_2 + \cdots + \theta_{n+1}) + \cdots + \delta_{n+1}\theta_{n+1}$$

and

$$\delta_k = W_k / W, k = 1, \cdots, n+1.$$

Clearly, the δ's represent the *proportions* of total wage W accounted by the respective SPs while θ can be said to measure the *overall depth* of capital in our process, for it is simply a weighted average of partial sums of θ's, which we just saw as measures of the depths of ``successive layers'', of which capital is made up in the present case. (Note, the ``weights'' come from *within* the notion of capital).

The innate simplicity of this formula of capital is that it expresses capital simply as *so many days' wages paid* (θ days'). These many days' wages lies ``invested'' in capital, and that is *all* there is to ``capital''. The proposition comes out entirely through the *valuation* of stocks constituting capital. So, we can say that we now have a *wage-valued notion of capital*. This is our basic proposition on PLA. The rest are essentially corollaries to it.

The proposition is intuitively obvious. Capital is the cost-value of stocks engaged in a capitalist activity, activity of making money (profit) out of money (capital). When this ``activity'' is PLA in the sense understood, the ``cost'' is simply wage. So, capital under PLA *must* be wage-valued. We have simply articulated this proposition in a particular set-up.

52 Let us turn to θ. As just seen, it gives us a measure of the overall depth of capital in our process. As such, it also stands as a measure of the *capital intensity* of the process. We can bolster up this interpretation as follows.

By definition,

$$\theta = K / W.$$

Now, both W and K are value-magnitudes, one with, one without a time-dimension. The value dimension cancels out on division leaving us with a ``pure length of time'', which is nothing but $\theta$. Let us now *suppose* that this ``cancellation'' leaves us with a *physical* term in each of the numerator and the denominator. The two terms correspoind respectively to a *physical* measure of stocks of produced means of production and an equally *physical* measure of labour or work. This way, we come to see θ as a ``capital-labour ratio'' in a purely physical sense of this term.

53 Before ending, we pick up a suggestion made earlier, that we abstract from the stock of pins in the process[60]. It has already served its ``purpose'' for our purpose. This means that S_{n+1} and hence θ_{n+1} are now simply *undefined*. Supose we simply set $\theta_{n+1} = 0$. θ is then *less than* a weighted average of θ's. Consequently, it underestimates the overall depth of capital in the process or its capital-intensity. To retrieve these notions we have to write the formula of capital as

$$K = (1 - \delta_{n+1}) W \theta' \qquad (ii)$$

[60] The assumption is not perhaps devoid of interest from the standpoint of the later course of economic theory. Substantively, the assumption means that the commodity produced can be sold exactly as and when it gets produced -- pins are put into paper -- precisely in those amounts. This is perhaps what the assumption of ``unlimited market'' of ``perfect competition'' means.

where

$$\theta' = \frac{1}{1-\delta_{n+1}}[\delta_1(\theta_1 + \cdots + \theta_n) + \delta_2(\theta_1 + \cdots + \theta_n) + \cdots + \delta_n\theta_n]$$

θ' -- a weighted average of θ's -- is the measure of capital intensity of production when there is no stock of the final product in the process of production. The interpretetion of capital as ``so many days' wages paid'' remains intact. ``Wages paid'' in this expression now stands for wages paid in the production of IPs, for they alone make up capital, and that is given by $(\delta_1 + \cdots + \delta_n)W$ or $(1-\delta_{n+1})W$. Consequently, the ``number of days'' is given by θ'.

Part Three

``TOOLS"

XII

54 So far, we have considered pfpp exactly as written by Adam Smith. We now consider an obvious unwritten. ``One man draws out the wire, ... ". Wire, we take, is both drawn and straightened by hand. But cut, *no*. A cutter is needed, not to be confused with the person so named. Pair of scissors may be, may be hammer and something -- a *tool*. In the process as a whole, there are just *tools and tools*. We simplify this down to *so many tool-units of the same kind used by all tool-using workers* -- a ``versatile" kind of tool[61]. It is assumed that the tool, like wire, is *bought*. We are back to PMC, on both counts.

We visualise the tool-using nature of the process a follows. There is a *pool* or *pile* of tool-units in the factory from which each tool-using worker takes out a unit when he needs it, returning it there when he no longer needs it for the time. So, another worker can use it during that time. The maximum number of units used at one and the same time sets the *stock* of the tool in the process[62]. These times, the stock lies empty. Other times, some units lie unused in the stock.

Clearly, for the process to go on as described -- we assume it does -- the stock must be *maintained intact*[63]. This is ensured the appropriate *replacements*. The underlying assumption is

[61] The case of *specialised* tools is discussed later (§ **62**).

[62] This is the *minimum* stock required for the process to work. This should be obvious from the description just given. Focus of the description remains the avoidance of ``loss of time" or ``idleness" (here, of tool-units) as before. This does not mean that the two descriptions can in any sense go together. Surely, workers lose time in all these fetchings and returings we talk here. While there is no harm in thinking that each tool-using worker picks up a tool-unit from its ``pool'' at daybreak and returns it there at the end of the day (provided the unit is still useable), it is better to simply part company with pfpp at this point. This does not prevent us from using its *formal* structure developed so far as a convenenient point of reference to develope some further points, as we do in this Part the essay.

[63] We tacitly assume that there is no qualitative deterioration of tool-units through use or simply over time. So, there arises no question about the ``stock'' that is maintained intact. It is a stock of qualitatively equal tool-units.

that tool-units *do not last forever* (in a useable condition). The full picture is this. Any unit of the tool is simply thrown out or discarded when found no longer useable[64]. This does happen sometime or other for each unit. When this happens, the discarded unit is replaced by a new unit.

Obviously, ``replaced by a new unit" means a *fresh purchase* -- a ``flow", in fact a ``replacement flow" in our sense of these terms. According to the assumptions just made, these flows occur precisely when one or more tool-unit is found no longer useable, in that amount. The sequence of flows so defined defines one of our *two primary observational data* in the present context. The other is the number of units in stock at any moment, which is already assumed to be a constant, and that in turn defines the level at which the stock is maintained intact.

55 We now come to our *last* assumption in the present context. We assume that the replacement flows are subject to *self-repetition*[65]. This is familiar territory. However, the context is quite different, and that does require some fresh thinking. The analogue to our previous ``euo" in the present context is replacement of *one unit at a time*. This is very arbitrary. How many units come up for replacement at what times is related, perhaps in an obscure way, to the past history of accumulation, which we have considered ``arbitrary" for our purpose. So, the relevant case is simply an *arbitrary pattern of replacements*.

Care. Arbitrariness of the *pattern* of replacements is not to be confused with arbitrariness of the sequence of replacements begun with. Whatever the ``pattern", it is *defined* by its self-repetition. The ``sequence" is simply this pattern repeating itself over and over. So, the notion of ``pattern ``comes to the same as *cycle.* This is far removed from arbitrariness.

Let us proceed on. Our ``pattern" is simply a well-defined part of the whole sequence of replacements. Any element of this sequence is defined at bottom by a pair of elements, one giving the *number of units replaced together*, the other giving the *time elapsed since the last replacement*. By addition, we get to (a) the total number of units replaced, and (b) the total time elapsed *for any*

[64] Obviously, only two distinct states of a tool-unit are assumed, one ``useable'', one ``unuseable''.
[65] *Some* notion of self-repetition is already there in the assumption of ``goingness''. The new unit replacing a discarded unit is itself replaced when found no longer useable and so on. The reference here is to a more *complete* notion of self repetition just as earlier (§ **2**).

given finite part of the sequence and hence for our ``pattern''. From here, we get to the notion of *rate* of replacements p.u.t.. This ``rate'' is simply the ratio of (a) to (b) as defined for our ``pattern'' or ``cycle''[66]. Dividing the stock of tools in the process by this rate -- note, this is a stock-flow ratio in our sense of the term -- we get to know the time stayed on the average by one unit of the tool in the stock, which is the same as its (average) *lifetime* in the process.

56 Care again. The ``average'' qualification in the above statement is borne, not out of ``facts'' we know, but simply out of our *ignorance* (see § **24**). The facts gone into the very conception of ``pattern of replacements'' in fact *makes the qualification redundant*. We have here really the case of *same* lifetime of all units of the tool. Consequently, the earlier guarded statement that the replacements are related ``perhaps in an obscure way'' to the past history of accumulation also loses its point. The relation here is perfectly rigid or mechanical.

Proof of these propositions goes as flows. Consider the case where *all* units in the stock come up for replacement *together*. What exactly do we *observe* in time? We observe, on the one hand, that all these units, say 20 units, are bought together some time; that they are again bought together after some time, say 100 days; that they are again bought together after 100 days and so on. We also observe that all these flows are flows into a stock and that there are 20 units in the stock all through. We now *see* -- infer, if you like -- that each unit must last the *same* time in the process, for otherwise surely some units would fall due for replacement earlier, some later, and that is decidedly not the case here. The same conclusion is obtained by a perusal of ther cases. Consider for example the case of one unit replaced at a time, each time after the lapse of the same time (5 days to be consistent with the above example). Why should this be the case unless each unit lasts the same time in the process.?[67]

Looking back, one sees at once that because we have a rigid notion of ``pattern'' (or ``cycle'',), we also have rigid connection of the ``present'' to the ``past''. Under these rigid notions, the rate of replacement flow is *simply* a time-average, without any super-impositions. Once this

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[66] All this is simply an elaboration of the notion of time-average.

[67] These two cases correspond to *two extreme distributions* of 20 units over 100 days. Looking back, one sees that the ``pattern'' talked earlier corresponds to *any* distribution of the same number of units over the same number of days. ``Any'', therefore arbitrary.

condition is suitably generalised, we can get a ``variable'' lifetime into the picture[68]. We leave that out of our discussion.

Before leaving this discussion, we stress one point made silently through it. There is in general *no* way of finding out the lifetime of a tool-unit in a process *except* by means of the stock-flow ratio[69], which *is* the lifetime referred. This is simply the *one* correct way of thinking or conceiving this notion in a rigorous framework of stocks and flows. How does one keep track of a unit of the tool in the pool or pile talked earlier -- through all the take-outs and returns -- from its original inflow to the final outflow or throw-out?

57 Let us wind up. We have just completed our basic modelling of ``tools'' running parallel to the modelling of ``raw materials'' given in Part One. Both are preparatory to the notion of capital, to which return in the next section. The goal is to see both these categories of produced means of production as elements of capital in a single integrated analytical framework. This is not an easy task. Our path is admittedly strewn with various incongruities as already noted in the passing. ``Tool-units'', we said earlier, ``do not last forever''. Forever! What more incongruous with the ``minutes'' talked earlier?

Let us end with a reference to Adam Smith. Our ``tool'' is only another name of his ``useful machines and instruments of trade'' which was his leading example of his ``fixed capital'', the other ``division'' of his ``capital'' (p 265). Nowhere did he however talk about their ``replacement''. Instead, he talked of the necessity of keeping these items in ``constant repair'' -- by means of ``circulating capital'' (p 267).

This is a very different modelling of ``tools''. Let us follow this out a little. The whole idea of repair (or repair-maintenance) is to restore tool-units to a previous level of efficiency. Suppose by this process the stock of tool-units is maintained at a certan level of efficiency. There is then no fresh purchase of tool-units -- no replacement flow into this stock. This does not however mean

[68] The term is meant in the sense of lifetime varying from one unit of the tool to another.

[69] An obvious exception is the case of only *one* unit a total in the process. Its lifetime is simply the time lapsed between successive purchases of the tool in a stationary framework like ours.

that we do away with the notion of replament flow as such in this connection. Recall the word ``circulating capital'' in the present model. We can visualise this as a stock of ``parts and spares'' to effect Smith's ``constant repair''. Obviously these stocks must themselves be maintained intact through the process, and that is possible only by replament flows into them. We are thus back to our general framework of stocks *and* flows[70].

XIII

58 The ``tool'' as just discussed brings in nothing new so far as the *definition* of capital is concerned. Let us introduce a new subscript ``*t*'' to denote the tool and carry on with the earlier notation with obvious adaptations as necessary[71]. We can write

$$\begin{aligned} K_t &= q_t S_t \\ &= (q_t Z_t)(S_t / Z_t) \\ &= C_t \theta_t \end{aligned}$$

thus going from material form of expression of capital in the form of the tool (or G_t) to its pure value form of expression.

However, we cannot proceed to an *integral* view of capital as given in eq. *(i)* of sec. *xi* just on the basis of these equations. Such view is our basic task here. For this, we have to first *redefine* and then *solve* (and interpret) the cost equations of G's. The new equations must reflect the actual *use* of G_t in each P_k in a precise way. We solve this problem as follows.

59 Bottomline for this purpose is simply the tool-using nature of the process begun with. To recapitulate, each tool-using worker takes out a tool-unit from its pool or pile when he needs it and returns it there after each such use, when he no longer needs it for the time being. Piecing together

[70] What this means for ``capital'' is however left in the open.
[71] Obviously, ``*t*'' is purely alphabetic – not to be confused into the numerically valued indices *i,j,k* etc.

these informations (or observations), we can at once find out the *extent* to which G_t is used in each SP in the sense (and form) of its *tool-hours per day* in the SP (number of hours for which G_t is used in the SP in a day[72]). This is the basic *new physical data* to enter the picture now, besides S_t and Z_t.

Given these data, we can *distribute* the replacement flow of G_t, i.e., Z_t -- and hence also the *cost* of this flow, i.e., C_t or $q_t Z_t$ -- over the SPs *in proportion to these ``extents*''. We then simply enter the *share* of $P_k$ in $C_t$ as per this ``distribution'' as *new element* in the cost of production of G_k or cost associated with P_k, i.e., C_k. This is the ``solution''. Obviously, we can say that the part of C_t allocated to P_k by this procedure is *due to* or *accounted by* the actual use of G_t in P_k. There is nothing arbitrary about this piece of cost-accountancy through which we proceed to extend the earlier integral view of capital.

For the formal analysis, it is necessary to take account of the *unused* hours of our tool-units. We simply distribute the unused hour per day over different SPs in proportion of their extent of tool-use and then *redefine* these ``extents'' by *including* the respective shares of SPs in the unused tool-hours per day. Let us call these redefined ``extents'' the *tool-intensities* of the SPs and denote them by $\lambda_1, \lambda_2, \cdots, \lambda_{n+1}$. By definition, the λ's add up to 1.

$$\lambda_1 + \cdots + \lambda_{n+1} = 1, \qquad \lambda_k \geq 0, \textit{ all } k.$$ [73]

60 According to the arguments just given, $\lambda_k C_t$ enters as new element in C_k besides those given in the earlier cost-equations. So, we now have the following definition (or re-definition) of C_k

$$\begin{aligned} C_k &= C_{k-1} + W_k + \lambda_k C_t \\ &= C_{k-1} + \delta_k W + \lambda_k C_t, \quad k = 1, \cdots, n+1 \end{aligned}$$

[72] This is to be taken as an ``average'' if necessary.

[73] $\lambda_k = 0$ simply means that G_t is not used in P_k. This is a pure convention to be used in other contexts as well.

Solving these equations -- the cost-equations in the present set up -- we get

$$\begin{aligned} C_k &= [C_0 + (\delta_1 W + \lambda_1 C_t) + \cdots + (\delta_{k-1} W + \lambda_{k-1} C_t)] + \delta_k W + \lambda_k C_t \\ &= C_0 + (\delta_1 + \cdots + \delta_k) W + (\lambda_1 + \cdots + \lambda_k) C_t, \quad k = 1, \cdots, n+1. \end{aligned}$$

Note the parallelism between $\delta_i W$ and $\lambda_i C_t$. We will pick this up in a minute.

Following steps given in § **49**, we now have the following integral view of capital

$$\begin{aligned} K &= C_t \theta_t + C_0(\theta_0 + \cdots + \theta_{n+1}) + (\delta_1 W + \lambda_1 C_t)(\theta_1 + \cdots + \theta_{n+1}) \\ &\quad + (\delta_2 W + \lambda_2 C_t)(\theta_2 + \cdots + \theta_{n+1}) + \cdots + (\delta_{n+1} W + \lambda_{n+1} C_t)\theta_{n+1} \end{aligned}$$

Rearranging terms, we can write

$$K = C_0 \theta_0 + C_t \theta_t + \sum_{k=1}^{n+1} (C_0 + \delta_k W + \lambda_k C_t)(\theta_k + \cdots + \theta_{n+1})$$

61 This sets the stage for a *comparative view* of all the elements or forms of K. Since alternative classifications run through the elements, there is more than one set of comparison to make. First, we note a clear parallelism between the two *commodities* bought, G_0 and G_t. Both enter K *first* on their own (first two terms on the RS) and *then again* through the cost-value of stocks of $G_1, G_2, \cdots$ (remaining terms). The parallelism ends at this point. The cost-values under reference reflect the respective *costs of production* $C_1, C_2, \cdots$. Here, the *whole* of C_0 is simply carried over from one stage (SP) of the process to the next sage starting from the very beginning (P_1) and thus *recurs* in each C_k [74]. There is nothing like this so far as C_t is concerned. On the contrary, we are simply back to the parallelism between $\delta_k W$ and $\lambda_k C_t$ noted earlier. The starting point here is simply W and C. Both are first *distributed* over SPs. The ``parts'' so defined then

[74] Again, this proposition is specific to the linear structure of pfpp. It certainly does not apply to ``raw materials'' as such and have nothing to do with the raw-material-tool distinction as such.

appear as *direct costs* in the respective C's from where they are carried over to the following C's as *indirect cost*[75]. The difference of course is that the distribution of W is an *actual* distribution, this being only another way of expressing a ``sum" originally defined. There is nothing like this in case of C_t. C_t is the *one* prior entity, which is then distributed by *us* in the manner explained. This is a *notional* distribution pure and simply.

62 Let us now take up the case of *specialised tools*. This is altogether simple. Suppose each of our SPs requires the use of a specialised tool. Call these $G_{t_1}, G_{t_2}, \cdots$. Like G_t so par, each of these G_{t_k}'s enter K first on its own contributing terms like $C_{t_j}\theta_{t_j}$ and then again through the cost-values of the stocks of G_k's, $k \geq 1$. This is where the parallelism ends. C_{t_j} appears as direct cost *only* in the cost of production of G_j, i.e., in C_j, from where it is carried over to C_i for $i > j$, as indirect cost. No notion of ``distribution", whether actual or notional, simply enters the matter. This is the simplicity.

63 We end by introducing a *term* that greatly facilitates the remaining discussion. We start from the case of specialised tools. Consider Z_{t_j}, the (rate of) replacement flow of G_{t_j} into its stock in the process. Since G_{t_j} is specialised (or specific) to P_j, we may as well consider this stock S_{t_j} as ``lying inside" $P_j$. $Z_{t_j}$ then appears as a *flow into* $P_j$ serving the purpose as stated. Note, this ``lying inside" is only a *notional device deployed by us* -- *we* draw or re-draw the boundary of P_j to this effect[76]. So, Z_{t_j} is a *notional flow* into P_j. This is the term.

Let us go on to the case of a versatile tool as begun with. Recall the λ's by which we distributed Z_t, the replacement flow of G_t, over the SPs of our process. This has been our very

[75] Of course, the ``recurrences'' just talked are also instances of indirect cost.

[76] G_k is also specific to P_{k+1} (used only there). But we saw S_k as lying ``between'' $P_k$ and $P_{k+1}$, not ``inside" P_{k+1}. Of course, we can now re-draw the boundary of P_{k+1} to this effect. By the same principle, the boundary of P_k also gets re-drawn in a similar fashion. However, this serves no purpose, for here we already have the notion of flow of

purposive use of these ratios so far, the ``purpose" being to define the costs associated with these SPs. A moment's reflection shows that the idea of ``distribution according λ's" applies to the *stock* of G_t as well. Indeed, we can consider this to be a *logical prior* in the sense that once we associate a certain fraction of S_t to P_k, we can agree that the same fraction of Z_t (and C_t) be associated with P_k.

Let us now go one step further and think of the stock of G_t just associated with P_k, i.e., $\lambda_k S_t$, as a *stock in itself*[77]. This stock is then by definition ``attached" to $P_k$. This notional device at once makes room for the other. We end up by seeing $\lambda_k S_t$ as ``stock lying inside P_k" with the corollary that the replacement flow into this stock -- already equated to the magnitude $\lambda_k Z_t$ -- is simultaneously a *flow into* P_k. Purely ``notional". No question about that. The point is simply that the term ``notional flow" applies in both cases with supports as stated.

The great facility or convenience afforded by this term, admittedly a rather twisted one, is that we can so to day speak the *uniform language* of ``flow into an SP" in respect of both raw materials and tools with *just the right discrimination* thrown in by the distinction between ``actual" and ``notional" flows. Recall that G_{k-1} flows into P_k at the rate Z_k. This is an *actual flow*. We now also say that G_{t_k} and G_t flow into P_k at the respective rates Z_{t_k} and $\lambda_k Z_t$. These are *notional flows*.

G_k into P_{k+1} whereas we do not have any a priori notion of flow of G_t into any P_k, and that is precisely the point at issue.

[77] Another way of saying the same thing is that the think the whole stock S_t to be divided into so many distinct stocks, $\lambda_1 S_t, \lambda_2 S_t, \cdots,$.

Part Four

PRODUCTION BY LABOUR ALONE

XIV

64 We now permanently enter the zone of PLA. The reference point is no longer pfpp but the general scheme of IPs and SPs set out in sec. *vii*[78]. However, this is purely formal. Substantively, our conceptual fremwork here is simply a carry over from pfpp. Let us get going by spelling this out.

Recall that nothing is stated about the *precise nature of use of an IP in an SP* in our general scheme. This very substantive notion has come into our analysis entirely through pfpp. We began with ``raw materials'' and ended with ``tools'' or ``instruments''. We will simply keep to these two categories as per the ``visualisations'' given.

Let us briefly review this matter. The essence of these visualisations is simply that *an IP is used from its stock existing inside the process*. This is true of both raw materials and tools. The difference goes as follows. For a raw material, the ``use'' means a *flow* out of the stock *into* the SP or SPs where it is used. This defines a complete mechanism of stock-depletion. The stock-depletion is simply the *sum* of all these flows. For a tool, on the other hand, we start directly from the fact of stock-depletion bypassing the question of its precise mechanism. This very fact entails the notion of replacement flow into the stock. Only at this point do we have the notion of a flow of the IP *into* an SP and that only in the sense of a ``notional flow'' as just explained. As a result of this device,

[78] Let us make a parting reference to pfpp. We now do away with the earlier ``trick'' to see it as instance of PLA. This means that ``wire'' is now considered an IP of the process. Now, wire is generally used in the production of many other commodities. So, in a world of PLA, it is separately produced inside so many production processes, in amounts equal to the respective stock-depletions. This is true for all produced means of production, which are not specific to a particular commodity. The picture is somewhat bizarre. Our tool of PLA cetainly exacts a price.

we again have the equality of stock-depletion and the sum of (notional) flows of the IP concerned into the relevant SPs. This is all that matters for our purpose.

65 Let us now come to a point of *detail.* There is nothing in our scheme to preclude the possibility that the final product or commodity produced is not only sold *but also* used (or ``used back") in the production of one or more IPs. *We shall rule out this posibility for simplicity.* So, there is no flow (or flow back) of the final product into any SP inside our production process. This apart, we go back again to the assumption that *there is no stock of the final product in the process*[79] so that the present model is a true generalisation of our earlier model of PLA (sec. *xi*) *as modified in* § **53**, not as set out in § **51**. Both these assumptions considerably simplify our equations or formulae here without affecting the substance of our arguments. In short, they are just ``simplifying assumptions".

66 We can now begin the formal analysis. First, some words on notation. Now on, we will write G_f, not G_{n+1}, for the final product with appropriate adjustment of other notations, e.g., the final SP is now denoted P_f. This `` $f$ `` , like the `` $t$ " earlier, is purely alphabetic. However, we no longer need `` t ". IPs are denoted simply $G_1, \cdots, G_n$ regardless of the precise nature of their use in any SP. All other notations are retained in their original meanings which will generally be taken as understood. We need only one new notation. Z_{ij} will denote the *flow of* G_i *into* P_j, $i = 1, \cdots n, \quad j = 1, \cdots, n, f$, this being either an *actual flow* or a *notional flow* as the case may be as already explained. If G_i is not used in P_j, and consequently there is no flow of G_i into P_j, we will write $Z_{ij} = 0$. So, in particular, $Z_{ii} = 0$. This is a pure convention already adopted in another context (see fn. 73).

[79] We give a ``logical" defense (or clarification) of this assumption. IPs of our process are defined ultimately by their *stocks* inside the process. But the final product is already defined by its *sale* (*qua* ``commodity produced"). So, we *need not* assume its ``stock" inside the process on ``logical" grounds.

As before, relevant internal relations of the production process for our purpose are summed up in a set of *stock-maintenance conditions*. These conditions are simply:

$$X_i = \sum_{j=1}^{n} Z_{ij} + Z_{if} \qquad (i)$$

67 We have now reached a familiar point. The set of product-flows described in *(i)* is the same as that underlying the well-known *input-output (IO) model of production*[80] -- *except that* there are no ``notional flows'' in the IO model. More fundamentally, there are only flows, no stocks, in the IO model -- our stock maintenance equations appear here simply as a set of flow-balance or flow-distribution equations -- whereas *nothing* in our model, not even the G's, are defined without reference to stocks. Seen from this standpoint, it makes no sense to think of stocks as *afterthoughts* to go from a ``static'' to a ``dynamic'' model (*sic*). Neverthless, the similarity of the *formal structure* of the two models opens the road to our using certain techniques of IO analysis -- for *our* purpose. The precise nature of our ``use'' will be clear as we go on.

Let us take this occasion to give two related clarifications. Seen from the standpoint of IO model, our Z_{if} appear as ``final uses'', to be taken as ``given'' to ``solve for'' the levels of output or production. This whole programme is simply beside the point for our purpose. Our whole frame of reference so far as ``production'' is concerned is given by a set of *observed data,* both stocks and flows, describing a *given* state of production. There is simply nothing to ``solve'' in this. Secondly, our $Z_{if}$ do not really represent ``final uses'' in the subsantive sense of this term. They represenet *internal uses* of IPs in our production process just as much as Z_{ij} do, the difference being simply that they are used in different places (SPs). Substance of the notion of ``final use'' applies in our case only to the flow of the final product out of the whole process, which is simply not represented in the equations. We come to that later on (next section).

68 Let us resume the substantive analysis. The crucial property of *(i)* for our purpose is that *at least one* Z_{if} *is positive*. This follows from the fact that $G_1, \cdots, G_n$ are but IPs, necessary for the

[80] This should not come as a surprise. The underlying assumptions of our scheme are already a pointer in this direction. The moot point is simply the general system of ``two-way flows'' -- as distinct from or generalised out of the ``one-way flows'' of pfpp -- characteristic alike of our model and the IO model.

production of G_f. So, at least one G_i must be ``directly'' necessary for the production of $G_f$, as stated in this condition. The rest are ``indirectly'' necessary. The total condition boils down to the following. For any given i, $1 \le i \le n$, there is a *positive* sequence $\{Z_{ij_1}, Z_{j_1 j_2}, \cdots, Z_{j_k f}\}$. It follows from these conditions that all the X's are in fact *positive*. Obviously, this must be so, for each G_i being an IP is either directly or indirectly necessary for the production of G_f, and hence must itself be produced for there to be any production of G_f at all. Note again, the production (or output) of G_f is not yet represented in our production system.

69 We now come to the *cost-equations* of the system. Let us follow the line of reasoning given in fn. 57. There, the material cost component of the cost of production of G_j was simply $c_{j-1}Z_j$. Now, it appears as $\sum c_i Z_{ij}$ [81]. So, the cost-equation for G_j is given by:

$$C_j = \sum c_i Z_{ij} + W_j, \quad j = 1, \cdots, n, f$$

where

$$c_i = C_i / X_i, \quad i = 1, \cdots, n, f$$ [82]

Now on, we discuss the cost-equations directly in terms of the *unit costs* or *cost-coefficients*, c_i, instead of proceeding via the total cost C_i as previously. These equations are obtained at once by substituting C_j by $c_j X_j$ in the first set of equations, which gives:

$$c_j X_j = \sum c_i Z_{ij} + W_j, \quad j = 1, \cdots, n$$

Since the X's are all positive, we can write

[81] For neatness, we omit the index and its range in the summations where they are clear from the context.

[82] `` f '' is included for completeness. We do not actually need C_f and c_f for our purpose here. So, we simply omit them from the next equation onward.

$$c_j = \sum c_i \frac{Z_{ij}}{X_j} + \frac{W_j}{X_j}$$
$$= \sum c_i \alpha_{ij} + w_j \quad (where\ \alpha_{ij} = Z_{ij} / X_j, w_j = W_j / X_j)$$

or, in vector-matrix notation

$$c = cA + w \qquad (ii)$$

where $c = (c_i)$ and $w = (w_i)$ are n-component row-vectors and $A = (\alpha_{ij})$ is a square matrix of order n. Note, w a strictly positive vector and A is a non-negative matrix. These are our data here.

70 Now, our problem is not only to solve *(ii)*. The solution must be *non-negative*. Otherwise, it is simply not meaningful. To investigate this question, we need a little bit of the algebra of square non-negative matrices. This tells us that *(ii)* has a non-negative solution *iff* $\phi(A) < 1$ where $\phi(X)$ denotes the dominant eigenvalue of the square non-negative matrix X.

To investigate this question in turn, we first define the *distributive ratios* δ_{ij}:

$$\delta_{ij} = \frac{Z_{ij}}{X_i}, \quad i = 1, \cdots, n \quad j = 1, \cdots, n, f.$$

By definition,

$$\delta_{ij} \geq 0, \quad all \quad i, j$$

and

$$\delta_{i1} + \cdots + \delta_{in} + \delta_{if} = 1, all\ i$$

Note,

$$\delta_{if} > 0, \quad at \quad least \quad one \quad i.$$

Let us now define the *square* non-negative matrix $D=(\delta_{ij})$, $i,j=1,\cdots,n$. If follows from the conditions just stated that *each row-sum of* $D\le 1$ *with at least one inequality*. This ensures that $\phi(D)<1$. We now note that *A* and *D* are similar matrices in the sense of matrix algebra.

$$A=\hat{X}D\hat{X}^{-1}, \quad where\ \hat{X}=diag(X_i)$$

So, *A* and *D* have the same set of eigenvalues. Since $\phi(D)<1, \phi(A)<1$. So, *(ii)* does have a meaningful solution.

71 Let us write down the solution and interpret.

$$c=w(I-A)^{-1} \qquad\qquad (iii)$$

The interpretation is straightforward. Cost of production of IPs derive ultimately from costs actually incurred in the process. Since this is PLA, cost actually incurred is simply the wages paid. So the costs derive ultimately from wages. As before, this boils down to the summation of a seres of direct and indirect costs incurred in the production of respective IPs. This is easily seen by solving *(ii)* by a process of successive substitutions.

$$\begin{aligned} c &= w+cA \\ &= w+(w+cA)A \\ &= w+wA+cA^2 \\ &= \cdots \\ &= w+wA+wA^2+\cdots \end{aligned}$$

The first term on the RS defines the direct costs. Remaining terms define successive rounds of indirect costs.

72 We can now pass on to *capital*. As before, we start from its material form of expression:

$$K = \sum c_i S_i$$
$$= cS$$

where $S = (S_i)$ is a column-vector of stocks.

Let us now introduce the stock-flow ratios. In our process, the rate of replacement flow into a stock is given simply by the rate of production of the IP concerned. Hence the stock-flow ratios are given by $\theta_i = S_i / X_i$. Let $h = (\theta_i)$ denote the column-vector of these ratios. By definition

$$h = \hat{X}^{-1} S$$

So

$$S = \hat{X} h.$$

Let us bring back the distributive ratios for the total wages, $\delta_i = W_i / W, \quad i = 1, \cdots, n, f$. Let $d = (\delta_i)$ denote the row-vector of these ratios for $i = 1, \cdots, n$. Note d is an n-component vector. We then have the following transformation :

$$w = Wd\hat{X}^{-1}$$

So,

$$c = w(I - A)^{-1}$$
$$= Wd\hat{X}^{-1}(I - \hat{X}\ D\ \hat{X}^{-1})^{-1}$$

Substituting c and S in the material form of expression of capital by the expressions just obtained, we at once have the pure value form of expression of capital. This goes as follows:

$$K = Wd\hat{X}^{-1}(I - \hat{X}\ D\ \hat{X}^{-1})^{-1}\hat{X}\ h$$
$$= Wd(\hat{X}^{-1}\hat{X} - \hat{X}^{-1}\hat{X}\ D\ \hat{X}^{-1}\hat{X}\ )\ h$$
$$= Wd(I - D)^{-1}\ h$$

We are thus back at a pure *wage-valued expression of capital*. We simply define

$$\theta = d(I - D)^{-1} h$$

and write

$$K = W\theta \qquad (iv)$$

73 This *looks* exactly like our first formula of capital in our first view of PLA (eq. *(i)* of sec. *xi*). However, this ``look'' is somewhat deceptive because the earlier formula included capital in the form of the final product, which is now abstracted. This abstraction was indeed made at of the end of sec. *xi* (§ **53**). But that yielded a formula of capital (eq. *(ii)*) which *looks* different. This is to be cleared up.

The point at issue is really the interpretation of θ in the above equation. To get there, we have to bring up the notion of capital-intensity of production. Let us briefly review how we arrived at this notion. We had a notion of ``successive layers of capital going deeper and deeper'' along with a measure of the respective ``depths'', which we then combined into a measure of ``overall depth'', same as ``capital intensity''. We now recognise that the starting point of this exercise is irretrievably lost in the ``genaralisation'' carried out in the meanwhile. The ``successive layers'' was simply a reflection of the linear structure of pfpp, which we no longer have. Let us then simply eschew the notion of ``layers'' and speak simply in terms of ``forms'' of capital. The important point is that we can still associate the notion of ``depth'' with each form of capital, for this comes in simply with the θ's (time stayed by different forms of capital in the process).

Now, our measure of the depth of successive layers of capital was given by a vector of partial sums of θ's. Let us look at this through the matrix D. In the earlier case, this matrix was simply a *(0,1)* matrix with 1's along the super-diagonal. As a result, $(I - D)^{-1}$ was also a *(0,1)* matrix with *1*'s on and above the principal diagonal, in other words, an upper triangular matrix with the triangle made up of *1*'s. Consequently, the vector-matrix product $(I - D)^{-1} h$ was simply a vector partial sums of the components of *h*, i.e., of θ's.

At present, D is simply a matrix of pure fractions with properties as stated. Because of this, the earlier ``partial sums'' are generalised to a set of *weighted sums* -- $\sum b_{ij}\theta_j$'s where $b_{ij}$ are elements of the inverse matrix $(I-D)^{-1}$. These ``weighted sums'' now serve to define measures of the depths of the respective forms of capital.

It remains to combine the above ``measures'' into a measure of the ``overall depth'' of capital in the process. This calls for a ``weighted average'' (with proper weights). No such thing is defined by the vector d, for its components add up to *less than 1*, this because δ_f is left out in this vector, and that because we abstract from the stock of the final product in the process. At this point, we can join up with the analysis given in § **53**. By parallel steps, we now have the following measure of the overall depth of capital in the process or its capital intensity

$$\theta' = \frac{1}{1-\delta_f} d(1-D)^{-1} h$$

The corresponding formula of capital is given by

$$K = (1-\delta_f)W\theta' \qquad (v)$$

This is an exact generalisation of eq. *(ii)* of sec. *xi*.

Let us end with a simple observation. θ and θ' here are related simply by a scaling factor. So, so long as this factor is treated as ``given'', we can indeed speak of $\theta$ as a measure of capital-intensity in an ``as if'' sense. This simplifies the writing, for *(iv)* is so much neater than *(v)*.

XV

74 We have carried the story of PLA only upto the point of capital. We now bring it upto the point, first, of *profit* (this sec.) and then, of *rate of profit* (next sec.). Simultaneously, we link up with certain strands of the classical theory of value and distribution, equivalently, those Sraffa themes. These strands or themes are however properly defined only at the level of the *economy as a whole*. We shall come to that in the following section. In these two sections we simply establish a preliminary contact with the classical theory through the microcosm of a particular unit of production like the ``pin-factory".

75 Now, profit is simply sale-proceeds minus cost incurred in the process of production or cost of production[83]. Note again that for our purpose, it is only the ``present" that matters. So, the stream of sales is converted into a stream of sale-proceeds at the price at which the commodity is *presently* sold. This is essential for conceiving sale-proceeds as a *rate p.u.t.*. It too is a hypothetical rate calculated parametrically w.r.t. present conditions.

Let us now invoke PLA. As a result, sale-proceeds divides up directly between wages and profits and thus corresponds to the classical notion of ``revenue" (present-day ``income"), whice we can also call the ``value of production" or ``value produced". On the other side, cost incurred in the process is simply the wage paid.

Let us state all this in symbols.

$$P = V - C$$
$$V = pX$$
$$C = W$$

and so

$$P = pX - W .$$

[83] A more connected notion is that profit is the money that can be taken out of the process by which capital yields profit after maintaining intact the ``capital" in the process, where capital is conceived in an *organic* sense as mentioned earlier (§ **36**). Precisely because we stop short of this concept, we have to be satisfied with an *ad hoc* definition of profit disconnected from capital. In the organic view, calculations of capital and profit make up a *connected whole*. Here, they run *separate*. This is the difference.

P, V, C and X stand respectively for profit, value of production (or revenue or sale-proceeds), cost of production and rate of production. p stands for the present price of the commodity under refernce. X is also called the valume of production or more simply production, output, produce etc.[84]

76 We can now establish our first direct contact with the classical theory of value and distribution. We refer to a famous statement of Ricardo coming at the end of this chapter on ``value'', ch.1 of the *Principles*.

> ``A rise in wages, from an alternation in the value of money, produces a general effect on prices and for that reason it produces no real effect whatever on profits. On the contrary, a rise of wages, from the circumstances of labour being more liberally rewarded, or from a difficulty of procuring the necessaries on which wages are expended, does not, except in some cases, produce the effect of raising prices, but has a great effect in lowering profits.'' (p 31).

Viewed through our microcosm, Ricardo's ``alteration in the value of money'' appears simply as an equi-proportionate change (rise) in the price p and the wage or wage bill W, given the labour employed[85]. Supposing this to be case, it follows that, given the volume of production[86], the profit P rises in the same proportion as well. We can say that this is precisely what Ricardo meant by ``no real effect whatever on profits''. No *redistribution* of income gets defined in this case. The *rise* in wage is not accompanied by a *fall* in profit. Such is claimed to be the effect in general of ``the labour being more liberally rewarded''[87]. Now, ``more liberally rewarded'' certainly means a greater command over commodities. This is possible in the present context if and only if p rises -- if it rises at all -- in a *lesser proportion* than W, i.e., if and only if there is a rise is in the *product-wage* defined as the ratio W / p (wage expressed or measured in the product produced). So,

[84] But not ``product'' which we consider a veritable mix-up. We consistently use this term in the purely qualitative sense of specifying or identifying objects produced. ``Produce'' is the corresponding quantitative term. Thus ``mango'' is a product. ``Mango crop'' is the produce.

[85] So, the change in W originates in a change in wage rate(s).

[86] This ``givenness'' is only the other side of the just assumed givenness of labour employed. Volume produced and labour employed together come from the state of production which is simply taken as ``given'' throughout the present discussion, as already stated (§ **67**). However, see fns. 92 and 93 below.

[87] The other clause, ``difficulties of procuring …'', is taken up later (§ **78**).

we have the proposition that a rise in product-wage produces a fall -- in fact an equal fall -- in ``product-profit" similarly conceived. This can stand as a restatement of Ricardo's basic proposition in this passage.

XVI

77 Our object here is to bring up the story of PLA to the point of *rate of profit*. Let us not lose any time but do this by simply bringing up the story just begun -- the effect of a rise in wage -- to this point, given PLA.

Grant that the rise in wage does produces a fall in profit. This by itself lowers the rate of profit. But that is not all. The rise in wage also means a *revaluation of stocks constituting capital*[88] -- clearly an *upward* revaluation. This by itself *again* lowers the rate of profit. Thus, there are *two distinct effects* -- two distinct *channels* of effects -- of a rise in wage upon the rate of profit, one defined through *profit*, one defined through *capital*. One is a *redistributive effect*, the other is a *revaluational effect*. Clearly, the two effects work in tandem, reinforcing one another[89].

Let us again consider for a moment an equi-proportionate rise in wages and price (and hence also in profit). Obviously, capital must also rise in the same proportion. Consequently, the rate of profit remains unchanged. This then is another way of conceiving Ricardo's ``no real effect whatever on profit".

[88] This proposition depends crucially upon the definition of capital as the cost-value of stocks engaged in a capitalist activity or process where ``cost'' is calculated at *present* cost-conditions. It follows that a change in these conditions, e.g., in wage rates, leads to an instant *revaluation* of stocks and consequent change in capital.

[89] Careful reading will show that all these propositions are independent of PLA, which simply lends transparency to them. See below (§ **79)**.

78 Let us now pick up the other clause in Ricardo, ``difficulties in the procurement of necessaries". This was his peculiar mode of reference to *agriculture*. The idea was simply that extension of cultivation is met with *increasing* difficulties because *less fertile* land is brought under cultivation.

Let us now shift our attention to the beginning of Ricardo's chapter on ``profits", ch. 6 of the *Principles*. Here he gave a rather extended analysis of the course of wages, prices and profits in the course of successive extensions of cultivation by means of a hypothetical numerical example. Key points of the analysis were that (a) the extensions are possible only under successive rises in the product-price off-setting the cost-rises, and (b) these price-rises cause compensatory rises in wage, i.e., in money wages, the product-wage remaining unchanged (``compensatory"). Ricardo noted first that though the price rises, profits *fall*, both in money (our P) and in terms of the product (our P/p). He now went out write:

> ``But the *rate* of profits will fall still more, because the capital of the farmer, it must be recollected, consists in a great measure of raw produce such as his corn and hay-stacks, … which would all rise in price in consequence of the rise of produce. His absolute profits would fall from $480\,l$. to $445\,l$.; but if from the cause which I have just stated, his capital should rise from $3000\,l$. to $3200\,l$., the rate of profit would, when the corn was at $5\,l$.2*s*.10*d*., be under 14 percent (as compared to 14.8 percent stated earlier for capital remaining at $3000\,l$.-- SB & PG)." (p 69, italics in the original).

He repeated the proposition a few pages later in the following words:

> ``I must again observe that the rate of profits would fall much more rapidly than I have estimated in my calculations, for the value of the farmer's stock would be greatly increased from its necessarily consisting of many of the commodities which had risen in value." (p 73).

These passages show conclusively that our ``two effects" are already there in Ricardo. This is essentially all that we meant to show by the quotations. However, now that we have given the quotations at length, we must also note the *difference* between his and our arguments. We leave out the precise causal sequence in Ricardo, for that is specific to ``agriculture" which is of no concern to us[90]. The point we call attention to is simply that Ricardo's argument is based very clearly upon

[90] This is to be stressed to no end. Starting with pfpp, all our concepts are solidly *industry-based*, and we keep to this reference point all through, except for a certain stretch at the end, by much the same way. We are ``brought to"

the valuation of the stock of the *product produced* at its *price* in his account of the farmer's *capital*. We on the other hand simply got off the ground on the question of ``value'' in capital by *rejecting* such valuations (§ **39**). This has been one of our strongest propositions in the essay, and we surely stand by it. This aspect of the matter seems simply to have eluded Ricardo. May be, he was detracted by ``value'' as such. May be we repeat that our object has all through been, and will continue to be, a ``certain fulfillment of certain classical ideas, thought to be `correct' ''.

79 Rest of the section is given to formulating the ``two effects'' in terms of a *functional relation* between product-wage as ``independent variable'' and rate of profit as ``dependent variable'', as in Ricardo. This will also give us occasion for certain clarifications. Note, once we establish such a relation, we can speak of the rate of profit being *determined* by product-wage as per the substantive conditions entering the relation. We shall not however take up this point of view (``determination'') here. It comes of its own at the level of the whole economy, where we speak of it (sec. *xix*).

Let us start from the general definition rate of profit

$$r = \frac{P}{K} = \frac{V - C}{K}$$

Under PMC, the wage bill W is mixed up with various ``commodity terms'' in both C and K. All this clutter is simply cut out in PLA. This is its essential simplification in the present context. Here, we can write straight

$$r = \frac{V - W}{\theta W} = \frac{pX - W}{\theta W}$$

with W appearing explicitly and very simply in both numerator and denominator.

agriculture here by Ricardo. Quesnay brings us there in § **93**. This is certainly not the place to talk of pitfalls in transferring concepts from ``agriculture'' to ``industry'' or *vice-versa.*

Now, we have already taken the state of production as *given* for our purpose. Let us now take the distribution of the wage bill over SPs of the production process under reference -- the δ's of § **72** -- as *given* as well. Then θ also becomes a ``given'' like X. This leaves us with only two unknowns, p and W, on the RS of the above equation. By the very form of the equation, the number of unknowns reduces to just *one* if we divide both numerator and denominator of the RS ratio by p. That unknown is simply the product-wage bill W/p. This establishes the functional relation sought.

It is convenient to *re-define* the function by replacing W/p by W/pX as independent variable. Obviously, this ratios -- which we will denote by s -- represents the *relative share of wages in the value of production* (or ``wage share'' for short). Hence, $0 \le s \le 1$. Note, s can also be looked upon as the *unit product-wage*. The two notions are simply one and the same for any particular unit of production.

We can now write the above equation as:

$$\begin{aligned} r &= \frac{1-s}{s\theta} \\ &= f(s;\theta), \quad 0 < s \le 1 \end{aligned}$$ [91]

``$f$'' is the function we were looking for. Our ``two effects'' are obtained simply by differentiating the function and interpreting its terms. We leave out this bit of algebra. The function is depicted in fig. 3 and its basic algebraic properties are stated below the figure. We simply point out that while the sign of f' reflects both effects, the sign of f'' reflects only the revaluational effect. The two limiting values reflect respectively the revaluational effect and the redistribution effect.

[91] The value $s = 0$ must be left out as f is undefined at this point.

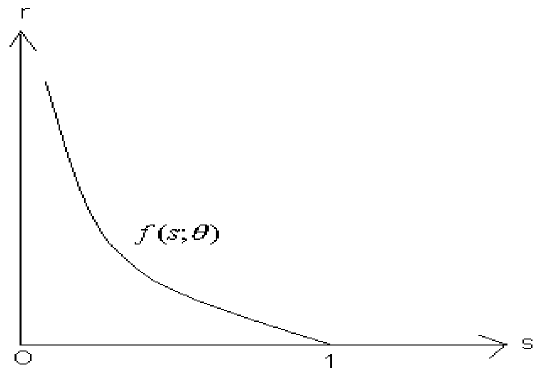

Fig 3

Rate of profit (r) as a function of relative share of wages (s)

$$f' < 0, \quad f'' > 0, \quad \lim_{s \to 0} f = \infty, \quad \lim_{s \to 1} f = 0$$

Let us end with a substantive clarification of what we have talking of. Whether we talk of a change in wage, product-wage or wage-share, the change arises from a change in wage *rates*. The *bottom* relation of our concern is also the relation between wage *rate* with suitable qualification as given by the notion of ``product-wage'' (independent variable) and rate of profit (dependent variable). Once we make this adjustment, we have the *productivity of labour* appearing explicitly as a parameter in our functional relation besides the *capital-intensity of production* $\theta$. Precisely because ``labour'' and ``labour productivity'' do not appear explicitly in our equations and formulae, it is especially important to keep this interpretation in mind.

XVII

80 Subject of this essay is stated as ``capital, production and price''. We now come to the last part, ``price''. This is the very *door* to the theory of value and distribution we have been talking of. It is also the essential link by which to proceed from the unit level of analysis so far to the level of the economy as a whole. Precisely because we kept to the ``unit level'', we could sidetrack this subject so far. However, we have already had occasion to clarify the *concept* of price underlying the theory (fn. 51).

We will be explicitly ``classical" in our treatment of this subject. Recall the basic classical proposition that forces of free competition always tend to equalise rates of profit across board (§ **37**). Note, this statement leaves in the open the precise *instrument* through which the forces of free competition produce this effect. That instrument is *price*. This gets us into the subject.

We consider a state of the economy where the rates of profit are *already* equalised. So, there is only *one* rate of profit. Commodity prices are what they must be for this condition to be satisfied. These are the ``natural prices" of the classical theory. At these prices, there is a certain *demand* for each commodity (given the distribution of income in the background). These are the ``effectual demands" of the classical theory. We tacitly assume that the output or production of each commodity equals its effectual demand in our state of the economy[92]. This is all of the classical theory of price -- in a sense, its core -- that enters the following discussion.

81 Before proceeding further, we adapt our notations to the present context. This marks a transition point in the whole paper so far as notation is concerned. We are now through with the inside view of a production process. This sets free the whole notation, in particular the subscripts, used earlier to denote IPs and SPs of a production process. We simply use them over to denote different *commodities* and related variables. Thus, now on, G_i represents a particular *commodity* in the economy and X_i, C_i etc. denote its rate of production, cost of production etc.

We can now give a formal shape to the price theory just outlined. Let as start from the equation showing the division of value of production or sale-proceeds between wages paid and profits earned for any commodity.

$$p_i X_i = W_i + P_i$$

Since there is only one rate of profit, which we denote by r (no subscript), we can write

$$P_i = rK_i = r\theta_i W_i$$

Hence by substitution, we have:

$$\begin{aligned} p_i X_i &= W_i + r\theta_i W_i \\ &= (1 + r\theta_i) W_i \qquad (i) \end{aligned}$$

These are the equations which prices and outputs (p's and X's) must jointly satisfy in our state of the economy. Since outputs are assumed equal to effectual demands which in turn depend upon prices, the brunt of adjustment to make the equations hold falls on prices. Hence we call these the *price equations* of the economy.

XVIII

82 Let us write V, W and P for the total value of production, total wage and total profit in the economy, $V = \sum V_i$ etc.. Clearly,

$$V = W + P$$

We can call this the *value-distribution equation* of the economy as it sates that the value of production gets distributed between wages and profits. A more pointed statement is that it is only in ``value" that this ``distribution" gets defined -- hence the term ``value-distribution".

Suppose now V were *invariant* to changes in P and W, *given* the state of production as assumed[93]. We can then talk of ``redistribution of income" without getting into *changes* in ``income" caused by the same redistribution of income. In a way, this makes it possible to *separate*

[92] Obviously, this conditions our given state of production, which now becomes part of a *consistent configuration* of relevant physical *and* value magnitudes describing the presumed state of the economy.

[93] This is admittedly at variance with the just-noted fact that the state of production is part of a consistent configuration of physical and value magnitudes. Nevertheless, we maintain the assumption here and in the next section as a *basic simplification*. As we see, removing the assumption simply complicates the problems discussed without appearing to yield any fresh insights.

out the area (or ``theory") of ``distribution of income" from within the general complex of ``value and distribution" within which it is embedded. Such in brief appears to be the logic or motivation of Ricardo's famous (or infamous) search for an *invariable measure (or standard) of value*. We are concerned here with this particular strand of the classical theory of value and distribution, surely a very intricate one.

83 Suppose there *is* a redistribution of income in our economy. Say, wages *rise* and profits *fall*. We assume this to be a *uniform* redistribution in the sense that (a) wages rise everywhere in the same proportion, and (b) the fall in profits maintains the uniformity of rates of profit so that these falls are captured simply in a fall in the rate of profit. Such changes are possible only through appropriate price-changes defined through the price-equations of the economy i.e., the equations remain satisfied. Through this, we approach the question of what happens to the total value of production or income V.

Let us start back from the price equations. It follows at once from these equations that should the price of *any* commodity rise in the *same* proportion as wage, then the rate of profit remains simply unchanged. So, for the rate of profit to actually fall, the price must rise -- if it rises at all -- in a *lesser proportion* than wage. This is true for all prices. This is the first condition to be satisfied by price-changes for the hypothesis of a (uniform) redistribution of income to be true.

Let us put down the condition in symbols. Let ρ denote the proportion by which wages rise every where:

$$\rho = \frac{\Delta W_j}{W_j} > 0, \quad j = 1,2\cdots$$

The condition under reference is that

$$\frac{\Delta p_j}{p_j} < \rho, \quad j = 1,2\cdots$$

Note, nothing is said here about whether $\Delta p_j > 0 \quad or \quad < 0$.

84 This is as far as we can go so far as the behaviour of *individual* prices is concerned. Let us now turn our attention to the behaviour of *relative* prices, p_j / p_i. Let us repeat that if each price p_j were to rise in the proportion ρ, then the rate of profit r would simply remain unchanged. But r in fact *falls* in our ``redistribution''. We now note that this fall in r simply drives down each p_j from the levels just referred *in proportion of the capital employed per unit of output in the respective productions*, i.e., in proportion to $W_j\theta_j / X_j$. From here one can see that, in the total, p_j rises or falls *in relation to* p_i according as the capital intensity of production of G_j, i.e., θ_j, is smaller or greater than that of G_i, i.e., θ_i[94]. An algebraic demonstration of this proposition is given below.

Let us start back from the price equations. This yields the following equation for the proportional change in any price. (Note, both outputs and capital intensities are ``given'').

$$\frac{\Delta p_j}{p_j} \quad = \quad \rho + \frac{\theta_j}{1+\theta_j}\Delta\ r\,.$$

Hence

$$\frac{\Delta p_j}{p_j} - \frac{\Delta p_i}{p_i} \quad = \quad \Delta r\left(\frac{\theta_j}{1+r\theta_j} - \frac{\theta_i}{1+r\theta_i}\right)$$

$$> 0 \ or < 0$$

according as

$$\theta_j < or > \theta_i \qquad (for\ \Delta r\ < 0).$$

This is precisely what was to be demonstrated.

85 Let us now link up with Ricardo. All our ``values'' so far have been *money*-values. Money is the a priori standard (or measure) of value. But what precisely is ``money'' -- the *object*

[94] It is tacitly assumed at this point that the ordering of commodities by capital intensities of production is not affected by commodity-to-commodity variations in the proportion of wages paid that is accounted by respective ``final sub-processes'' so that we can continue with $\theta$ as the ``as if'' measure of capital-intensity of production.

serving as ``money", to be precise? Ricardo considered it to be a *commodity* like any other. Certainly true of ``gold" say, whatever the specialties. Let us now proceed along this line of thinking.

Let G_k be the commodity serving as ``money" in our economy. Since all values are now estimated in $G_k$, the value of $G_k$ , i.e., its *price*, is simply *unity*. This remains so through all changes in wages and profits, which are also but changes in ``value". So, by definition, we have in our context of reference

$$\Delta\, p_k = 0.$$

Combining this proposition with our earlier proposition on the behaviour of relative prices in our context of reference, we at once see that

$$\frac{\Delta\, p_j}{p_j} > or < 0 \quad acc.\, as \quad \theta_j < or > \theta_k\,.$$

If we now arrange commodities in order of the capital intensities of their production, say in increasing order, i.e., we define the commodity indices such that

$$\theta_1 \le \theta_2 \le \cdots \le \theta_k \le \theta_{k+1} \le \cdots$$

then we have the following proposition:

$$\frac{\Delta p_j}{p_j} > or < 0 \quad acc.\, as \quad j < or > k.$$

G_k marks a *watershed*. All commodities with lower index (read smaller capital intensity of production) *rise* in value. Opposite is the case with commodities with higher index (greater capital intensity). If follows that if G_k were produced in some sense with the *average* capital intensity of production in the economy then the proposition of a *pure* redistribution of income -- no change in total income caused by the redistribution -- would come true! We are home.

Such precisely was Ricardo's idea of an ``invariable measure of value''. To quote (from deep inside his chapter an ``value'' in the *Principles*):

> ``May not gold be considered as a commodity produced with such proportions of the two kinds of capital as *approach nearest to the average quantity* employed in the production of most commodities? May not these proportions be as *equally distant* from the two extremes, the one where little fixed capital is used, the other where little labour is employed, as to form a *just mean* between the two? If therefore I may suppose myself to be possessed of a standard so nearly approaching to an *invariant* one, the advantage is --- ``(p 28-29, italics ours).

No, we have not so far and do not here get into the subject of ``two kinds of capital''. That requires another paper. We simply take Ricardo's ``proportion'' of the ``two kinds of capital'' as having the same content as our ratio of ``capital'' to ``wage'', in other words, the capital intensity of production. Thus we do construct -- reconstruct if you like --Ricardo's ``invariable standard of value''. Needless to say, it is PLA that does the job.

86 Again, the algebra remains to be done. This is done very simply by reference to the equation defining the total value of production V.

$$\begin{aligned} V &= V_1 + V_2 + \cdots \\ &= p_1 X_1 + p_2 X_2 + \cdots \end{aligned}$$

Let us now continue

$$\begin{aligned} V &= (1 + r\theta_1)W_1 + (1 + r\theta_2)W_2 + \cdots \\ &= (W_1 + W_2 + \cdots) + r(W_1\theta_1 + W_2\theta_2 + \cdots) \\ &= W + r(\alpha_1\theta_1 + \alpha_2\theta_2 + \cdots)W \quad (\ where\ \alpha_i = W_i / W) \\ &= W + r\theta_{av}W \quad (\ where\ \theta_{av} = \alpha_1\theta_1 + \alpha_2\theta_2 + \cdots) \end{aligned}$$

This equation is of the *same from* as any of our price equations. It follows at once that

$$\frac{\Delta V}{V} > or < 0 \quad acc.\, as \quad \theta_{av} < or > \theta_k$$

The condition *defining* the invariable standard of value is therefore

$$\theta_k = \theta_{av}$$

precisely as argued earlier. To restate, the invariable standard of value is a commodity produced with the *average* capital intensity of production, the ``average" being a weighted average with proportions of the total wage accounted by the production of different commodities as ``weights"[95]. It is an ``invariable" standard in the sense of ensuring that (total) income does not change as the distribution of income changes in a ``uniform" way.

XIX

87 We now take up the question of *determination* of the rate of profit r. Discussion of the last section does not come directly into this question even though all strands of the classical theory of value and distribution culminate ultimately in this question.

The subject is not *monolithic*. The question can be answered in *alternative* ways within our framework. Germs of different possible *approaches* to the question are already there in the analytical apparatus introduced for this purpose. We refer to the functional relation between product-wage and rate of profit established earlier for any particular unit of production. Now, we have to transfer this relation to the whole economy in some way. One end of the relation remains fixed. Rate of profit now is *the* rate of profit in the economy r. Variations appear at the other end, ``product-wage". *One* way of extending this notion to the whole economy is to replace the earlier ``product" by a suitably defined *composite* product or commodity. Granting appropriate support to the definition, we can say that this defines a *structuralist approach* to our question. *An alternative* approach is simply to keep to the notion of product-wage with the proviso that the ``product" under

[95] We mention that it is possible that there exists no G_k satisfying the above condition exactly. The ``invariable standard'' is then understood as the nearest approximation. It is possible to allow a limited variation in the state of production through this backdoor, but this perhaps is a mix-up of issues.

reference serves as the *standard of value* or *money* in the economy, whether ``invariable" standard or not. Obviously, the notion of product-wage then coincides with money wage or simply ``wage". We can say that this gives us a *purely value-theoretic approach* to our question. A *third* approach follows at once from the identity of the notions of unit product- wage and wage-share in any particular unit of production. The point is that while the notion of product-wage remains specific to the product concerned, the notion of wage-share is at once defined for the whole economy. It becomes the *overall* wage share in the economy. For want of a better term, we say that gives us a *pure macro approach* to the same question[96].

Before we get into the substantive analysis, we simplify one term. Henceforth we shall refer to the relation between wage in an appropriate form of expression and the rate of profit simply as the *wage-profit relation*. Obviously, this is a shorthand. ``Profit" stands for the rate of profit, ``wage" for the relevant form of expression of wage. Note, once we have established the wage-profit relation for the whole economy, we have answered our question. We now see how this comes out, if at all, in the three approaches just distinguished.

88 We begin with the *macro approach*. This means that we now take the overall wage-share in the economy -- W/V or s in our notation -- as *given* for the purpose at hand. However, *just this* is not enough for our purpose. We also take as ``given" the *distribution* of total wage over different lines or branches of production (different ``industries") -- the α's appearing in our definition of θ_{av} in the last section[97]. So, θ_{av} now appears as a ``given" like θ's earlier. r is then at once determined by the *final* equation for V given in the last section. This equation is only a step removed from the wage-profit relation. Once we take this step -- have r on the LS -- we see that the wage-profit relation here is given by the same function $f(s;\theta)$ of § **79**, with $\theta = \theta_{av}$ and s interpreted or reinterpreted as the *overall* wage share in the economy. Thus the whole ``shape" of this relation is bodily carried over from the unit-level to the economy-level.

[96] We do not mean to say that all these approaches have a basis in classical writings.

[97] This is completely parallel to the assumption of given δ's on the basis of which we have our θ's as ``given''.

89 Let us now go over the *value theoretic approach*. Here it is simply wage or money wage that is taken as ``given'', given that one of the commodities, say G_k, serves as money. So, the relevant wage-profit relation here is simply $f(s_k;\theta_k)$. This suffices to determine the rate of profit r. Notionally, this determination can be broken down into two steps. In step one, r_k is determined by s_k according to the wage-profit relation of this unit of production. In step two, all *other* r's -- $r_1, r_2, \cdots$ excluding r_k -- are equated to this predetermined r_k. *Ipso facto*, $r = r_k$. Note, *prices* also get determined in step two.

90 Let us now take a breather. *One* classical notion is completely left out of the discussion so far. We refer to Ricardo's ``necessaries on which wages are expended'', henceforth just ``necessaries''. Obviously, to the workers themselves the whole significance of wages received depends upon its purchasing power over necessaries -- whence we have the notion of *real wage* in the proper sense of the term.

The assumption of ``given real wage'' is also certainly much more characteristic of the classical theory of value and distribution than the others just discussed. All this goes into the making of the *structurlist approach* to the determination of rate of profit, which we now take up. This will take time.

Let $G_1, \cdots, G_m$ denote ``necessaries''. By definition $\{G_1, \cdots, G_m\}$ is a *subset* of all commodities produced in the economy. The assumption or condition of *given real wage* means, for the economy as a whole, that the total wage W enables workers to buy certain *definite* amounts of $G_1, \cdots, G_m$ say $C_1, \cdots, C_m$.

So,

$$W = p_1 C_1 + \cdots + p_m C_m$$

I.e., the wage or money wage W satisfies this condition[98].

[98] Note, the *concept* of real wage is not yet defined. This is presently taken up.

Let us now halt to note that the given real wage just posited must be *viable* in the sense that *at least as much* of each of G_i is produced as the amount claimed by workers[99], $i = 1,\cdots,m$. So, we have the ``viability condition":

$$C_i \leq X_i, \quad i = 1,\cdots,m$$

Henceforth we take this condition to be satisfied.

Let us now turn to the *definition* of real wage. For this purpose, we first introduce a *composite commodity* denoted G_c. G_c is made up of $G_1,\cdots,G_m$ in the proportions $C_1 : C_2 : \cdots : C_m$. The unit of measurement of G_c is left in the open. We choose the unit such that one unit of G_c is made up of C_i units of G_i, $i = 1,\cdots,m$. Note, G_c is a fictitious or imaginary ``commodity" which we ourselves construct for the purpose of defining ``real wages". Neither is it produced nor is it bought and sold in the economy. However, for our purpose, it is necessary to assign a ``price" to $G_c$, This assignment has its basis in the fact that all our $G$'s are in fact *freely bought and sold*. Individual buyers simply buy whatever amounts they choose within their ``budget constraints". Because of this, we can think of G_c being bought -- as if bought -- at the price p_c defined as:

$$p_c = p_1 C_1 + \cdots + p_m C_m.$$

p_c is simply the money one would have to pay to buy the constituents of one unit of G_c.

``Real wage" is now defined simply by dividing wage or money wage by p_c. Obviously, this comes to the same as expressing wage in terms of the composite commodity G_c. Let us denote real wages paid -- i.e., the wages paid in real terms -- in the production of $G_1, G_2, \cdots$ by $u_1, u_2, \cdots$ and the total real wages paid in the economy by u . By definition

[99] We say ``at least as much as'' because necessaries are very generally consumed by all, not just by workers. Generality of the position taken is obvious.

$$\begin{aligned} u_i &= W_i / p_c, \quad i = 1,2,\cdots \\ u &= W / p_c \end{aligned}$$

Note, $u = 1$ by our choice of unit of G_c. So, the u's are all positive fractions.

Let us now consider the *price equations of necessaries*:

$$p_i X_i = (1 + r\theta_i) W_i, \quad i = 1, \cdots, m.$$

Let us multiply both sides of the equations by C_i / X_i and add up. We then get the equation

$$\sum^m p_i C_i = \sum^m (1 + r\theta_i) \frac{C_i}{X_i} W_i$$

This can we written in terms of p_c and the u's as:

$$\begin{aligned} p_c &= \sum^m (1 + r\theta_i) \frac{C_i}{X_i} p_c u_i \\ &= p_c \sum^m (1 + r\theta_i) \beta_i u_i, \quad where \quad \beta_i = C_i / X_i. \end{aligned}$$

Canceling out p_c, we get the equation

$$1 = \sum^m (1 + r\theta_i) \beta_i u_i$$

The point to note is that all the terms appearing in this equation *except* r are already assumed *given* -- θ_i and X_i (denominator of β_i) are given as part of the given state of production and u_i and C_i (numerator of β_i) are given as part of the given real wages. Hence the rate of profit is determined by this equation.

The explicit solution is given below:

$$r = \frac{1 - \sum \beta_i u_i}{\sum \beta_i u_i \theta_i} \qquad (i)$$

Clearly the ``determination" is meaningful if and only if i

$$\sum^{m} \beta_i u_i \leq 1$$

This is to be seen.

Now,

$$u_i = \frac{W_i}{p_c} = \frac{W_i}{\sum p_i C_i} = \frac{W_i}{W} = \alpha_i$$

So, we can write the required condition as

$$\sum^{m} \alpha_i \beta_i \leq 1 \qquad (ii)$$

Now, our α's are *a priori* defined for *all* commodities produced in the economy i.e., its index ranges from 1 to as many commodities as are produced. By definition, *all these* α's add up to 1. But only $\alpha_1, \cdots \alpha_m$ get into *(ii)* Obviously, they add up to *less* than 1. This means in turn that the LS of the *(ii)* is less than a weighted average of β's. Each β in turn lies between 0 and 1 by the viability condition. It follows that the LS of *(ii)* is indeed less than 1. The condition *is* satisfied and the rate of profit *is* determined by the stated equation.

91 We did not use the analytical apparatus spoken at the beginning in the analysis just given. The reason is that we started off directly from the assumption of ``given real wages" and never considered any *variations* in real wages. So, we did not need a functional relationship between real wages -- which is obviously the form of expression of ``wages" now considered -- and the rate of profit. We will now go on to develop this relation. *Inter alia*, we cast the solution of our problem in this form.

We meet a ``paradox" right at the beginning. Higher wage means, for the economy a whole, a higher value of u. But $u = 1$. The paradox arises because u is defined by reference to the equation

$$W = p_1 C_1 + \cdots + p_n C_n$$

which is true only for the *given* real wages considered so far. At present, this equation serves to define only a *possible benchmark value* of total real wages in the economy -- other values are also admitted. Obviously, this ``benchmark value" is $u = 1$. We now allow u to take all possible values $u > or < 1$ *subject to the viability condition*.

This restriction can be expressed as follows. The ``viability condition" entered our analysis only through condition *(ii)*. But this condition was defined in respect of the benchmark value $u = 1$. When u is made variable, we have to replace *(ii)* by:

$$(\sum^{m} \alpha_i \beta_i) u \leq 1 \qquad (ii')$$

Note, the u's now satisfy the equation

$$u_i = \alpha_i u$$

Substituting these values in *(i)*, we find

$$r = \frac{1 - u\sum \alpha_i \beta_i}{u\sum \alpha_i \beta_i \theta_i}$$

This can now be taken as the wage-profit relation of the economy.

However this equation is not exactly in the same *form* as earlier. We can get to this through a transformation of the independent variable u. Let us transform it into the variable u_c defined by

$$u_c = (\sum^m \alpha_i \beta_i) u$$

Let us also define θ_c as

$$\theta_c = \frac{\sum^m \alpha_i \beta_i \theta_i}{\sum^m \alpha_i \beta_i}$$

We can now write

$$r = \frac{1 - u_c}{u_c \theta_c} = f(u_c; \theta_c) \qquad (iii)$$

Obviously, r is determined by u_c according to this equation, for θ_c remains a parameter.

We end write a word of caution. It is tempting to interpret *(iii)* in terms of the production -- ``as if'' production -- of $G_c$. This is problematic. For the purpose here, it is necessary to think only of the production of *one unit* of $G_c$. But this means that we think of the production of $G_1, \cdots, G_m$ in the *hypothetical* amounts, $C_1,\cdots,C_m$. The ``thinking" is all right. But where do we get the relevant *production conditions* from? What precisely do we equate u_c and θ_c with? How?[100]

XX

92 This is a tailpiece. It stands outside the mainstream of arguments of this essay. That has now run its full course. Here we simply pick up threads from here and there and weave then into a *fresh* view of something very *familiar*.

Our construct of PLA has come with a lot of structure, IPs, SPs and all that. Suppose we cut that out. We are then left with a production process *whose product is also its sole produced means of production*. This in turn simply reopens a point kept closed so far (``no IP directly used in its own production") -- in re-set context. These are the ``threads".

We go one step further and assume that the production process just referred is the *only* production process in the economy. We are thus in the familiar set up of a one-product, one-commodity or one-sector model of the economy[101]. We simply view it afresh in our framework.

93 Before coming to this, we do a little groundwork. The production process here is a pure abstraction. Nevertheless, it has an empirical kernel that goes back to the very beginning of the idea of ``production" in history of economic thought. We refer to the embryonic *seed-harvest model of*

100 Of course, one may assume $C_i = X_i$, all i. However, this runs counter to the observation made in fn. 99.

101 These are admittedly rather casual terms. The correct term in our vocabulary is ``one-product". ``One-commodity" may as well mean the model described and discussed in sections xiv-xvi. ``Sector of production" is very vague and undefined. So is ``one-sector".

production (SHMP) of Quesnay or the Physiocrats[102]. Allowing a little play of words, this says that harvest comes out of seed, seed out of harvest[103]. However, this is not a *closed* model of production. A harvest provides not only seed for the next harvest but also *food etc. for* our *consumption*. This is possible because seed *grows* into a harvest under proper care and conditions. So, only *part* of the harvest need be kept aside as seed for *reproducing* the harvest (under the same ``care and conditions"). The *rest* can be consumed without affecting production conditions. All this calls for a distinction *within* the notion of the *amount* produced. ``Harvest" defines the *gross produce*. ``Harvest minus its reproduction requirement" defines the *net produce*.

Let us put the notions in symbols. Let H, R and N, denote respectively the gross produce, the reproduction requirement and the net produce[104]. Then

$$N = H - R .$$

94 Let us now view the production process in our framework. First, *self-repetition*. The idea has already come in through the very Physiocratic notion of ``reproduction". We simply assume that R amount of a harvest H *is* used as seed for the next harvest. This puts the economy in a *state of self-repetition* (or self-reproduction). Consequently, H, R and N are understood as *rates p.u.t.*. Note, N now equals consumption.

Next, we link up with the notion of *flow*. We place consumption *outside* the production process. So, N-part of the harvest *flows out of the process*[105]. This is all we see from outside.

---

[102] This is our reading of Quesnay. The ``model" spoken is prior to and therefore lies hidden behind the Physiocratic first principle of ``subsistence". Glimpses of the ``embryo" may nevertheless be had from the passage on the notion of ``renascent wealth" set out on p 103 of Ronald Meek's **The Economics of Physiocracy: Essays and Translations** (1962). See also p 207 and p 209 of the book. Yes, all these references are to the ``translations" part of the book.

[103] The play of worlds of course is that the first ``coming out" represents a physical process while the second ``coming out" represents merely a mathematical truism.

[104] We do not write G for gross produce because we do not want to give up this symbol for ``goods", which we use again later on.

[105] *Given* self-repetition or self-reproduction, ``net produce" simply coincides with the flow *out of* the production process. This is measured on the boundary of the process. ``Gross produce" takes the measurement inside this boundary and simply *adds together* all the productions serving the purpose of this ``flow" to the flow itself.

Going *inside*, we see the *divisioning of the harvest*. Prior to that, we see the *harvesting* itself. This too is a *flow*. The crop is not only cut off the plants. It is taken *out* of the field *into* a farmhouse or may be just the outfield. So, we are led to the conception of *two distinct processes* at work -- one, the ```farm process'', which is the process *as a whole*, and two, the ``field process'', which is *contained within* the farm process. (Yes, a *sub-process* in the general sense of the term). The harvest H then flows out of the field process, and stays within the farm process till it is divided. Once divided, one part (N) flows out of the farm process. The other part (R) *flows back* into the field process. Fig. 4 gives a diagrammatic representation of this whole process.

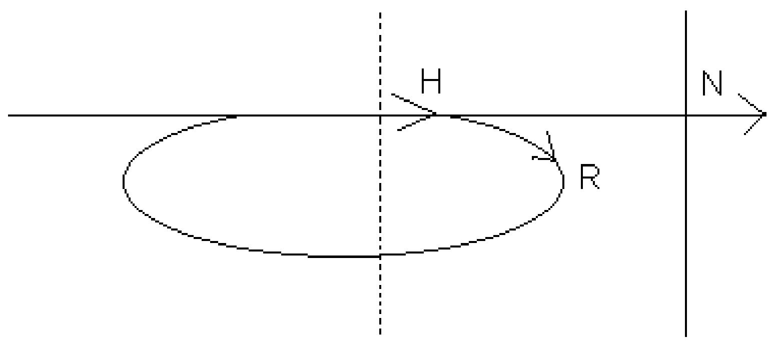

Fig 4

Flows in SHMP

The two vertical lines of this diagram represent respectively the boundary of the farm process (solid line) and the field process (dotted line). H flows out of the field process (crosses dotted line from inside) into the farm process where it is divided into two parts, R and N. R flows back into the field process (crosses dotted line from outside) while N flows out of the farm process (crosses solid line from inside).

It remains to get *stock* in to the picture. We simply assume that the flow-back just talked is a *flow via a stock* as depicted in fig. 5.

We can now easily read these notions into the IP-laden models of PLA of secs. xi and xiv. In these models, the net produce is given by X. The gross produce is X *plus* $X_1, \cdots, X_n$ -- not, of course, an algebraic plus. That has to be reserved for the value-plane.

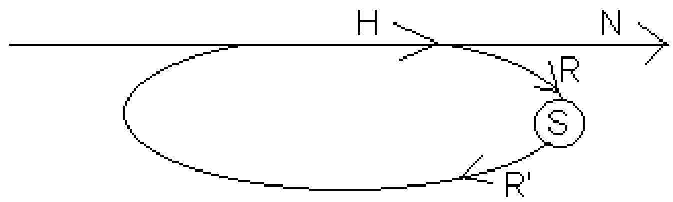

Fig 5
``Flow via stock'' in SHMP

As before, both the circle and the letter S inside the circle represnet the stock. By definition, R is now a flow into this stock. The flow out of it is denoted R'. At this point, we tacitly carry over the ``rate" interpretation to R' as well and assume $R = R'$. So, the stock is maintained intact.

95 SHMP has now played its role for our purpose. So, we simply leave it behind and see the production process just outlined as a pure abstraction. What is called ``seed" so far is now understood as some sort of a *versatile generalised produced means of production*. This is especially important for interpreting the ``stock" just introduced. Seed literally staying in the farmhouse for some time is one thing. The stock of a generalised produced means of production *sustaining* the whole process of production -- which is how we link up with the *rest* of our framework (see below) -- is quite another[106]. We simply assume that the rates of flow spoken eailier -- H, R and N -- are defined *only on the basis* of the stock maintained at a *definite* level. Since the ``rates" are already prsumed, so must be this whole condition of the stock being maintained intact at a definite level. The interpretation of $S$ is accordingly adjusted. This in sum is the idea of the stock ``sustaining" the process of production. More preasisely, we should say the ``technical" process of production. The reason for this insertion is made clear later.

Let us proceed on. R is now a *replacement flow* -- rate of replacement flow into the stock of our generalised produced means of production -- so that the ratio S/R is precisely *the* stock-

[106] A whole sea of difference between a ``farm process" and a ``factory process" is writ large in this statement. But, to repeat, this is not the place to go into that (see fn. 90).

flow ratio in our sense of the term, our θ. There are other stock-flow ratios around. They have not the interpretation and significance of this stock-flow ratio.

96 We now come to see our ``production'' as *capitalist* production with focus upon the word ``capital''. Note first that the ``product'' produced, say $G$, is now a *commodity*. It is bought and sold. There is nothing problematic about this. ``Money'' comes from outside, as so far[107].

Let us get back to capital, K. We can write

$$K = cS$$

where c denotes the cost-coefficient of G in the sense clarified (§ **45**). Under PLA

$$c = \frac{W}{H},$$

where W denotes total wages, for this is obviously the *whole* cost incurred for the *whole* production H.

We can now proceed to the pure value-form of expression of capital by usual steps. It is convenient to slightly rearrange the steps and go as follows:

$$\begin{aligned} K &= cS \\ &= \frac{W}{H} S \\ &= \frac{R}{H} W \frac{S}{R} \\ &= (1-\delta) W \theta \end{aligned}$$

where $\delta = N/H$ and so $(1-\delta) = R/H$.

[107] Discussions in **§ 85** and **§ 89** are truly the ``exceptions'' to prove this general rule or principle.

97 This formula looks exactly like the earlier formulae of capital when there was no stock of the final product in the process (eq. *(ii)* of sec. xi and eq. *(v)* of sec. *xiv*). There is infact nothing deceptive about this ``look''. All these formulae fall in line irrespective of differences in the underlying models of production. What falls outside this line is simply the first formula of capital in sec. *xi* (eq. *(i)*).

Let us argue this out step by step. Let us begin with the term δ. It defines a division of produce between net produce N and reproduction requirement R. Clearly, there is a *division of wage* corresponding to this division. We can say that δ fraction of the wage bill W is accounted by the net produce; the rest is accounted by the reproduction requirement. Recall now the parallelism between the present N and the earlier X. It follows the present δ corresponds precisely to δ_{n+1} of sec. xi and δ_f of sec. xiv.

The next step goes deeper. In a *material* sense, the one product of our one-product economy, i.e., G, encompasses *all* the products of the earlier models, including the final product. *Ipso facto*, there should be a place for the earlier S_{n+1} in the present S. This completely upsets the ``line'' we set out to argue.

To answer this point, we have to bring to light the ``role'' of $S_{n+1}$ in pfpp, which we simply left in the blank (see fn. 39). A minute's reflection will convince one that this role must have a reference to the relevant ``outside'', i.e., to *demand conditions*. Let us simply say that the stock sustains the *sale-process* of pins -- process of meeting demands come from outside, given the production conditions. The present S cannot simply handle this notion. That calls for a different *location* of the stock in our diagram.

A stock sustaning the sale-process in the present model must mean by definition that there is first a flow of the *net produce* into this stock and then a flow out of it, this ``flow'' being nothing but the sale of the product. So, the earlier flow denoted $N$ is now again a *flow via a stock* (see diagram below). This introduces a *qualitatively distinct* stock in the picture forcing us to concieve $S$ as stock sustaining the purely ``technical'' process of production. The rest is just incidental symbolism : S' denotes the stock sustaing the process of sale in our model and N' denotes the flow out of it. The flow into this stock is already given by N. The two rates are connected by the condition, $N = N'$.

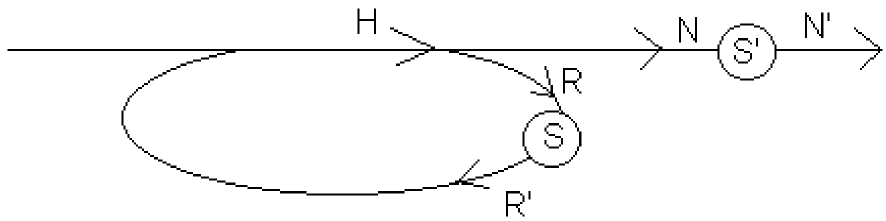

Fig 6

Stocks and flows in the production process of a one-product economy with a stock sustaining the technical process of production (S) and a stock sustaining the process of sale (S').

Let us see what all this means for capital. Making the usual adaptations, we can write

$$K = c(S + S') = cS + cS'.$$

The first term cS is already equated to $(1-\delta)W\theta$. For the second term, we have the stock-flow ratio $\theta' = S'/N$, and so

$$cS' = cN\theta' = \delta W\theta'.$$

Hence

$$K = [(1-\delta)\theta + \delta\ \theta'\ ]W.$$

This coresponds exactly to eq. *(i)* of sec. *xi*, and that clinches the issue.

98 The story can now be easily carried forward to profit, rate of profit etc. But this hardly serves any further purpose. We end by simply seeing the notions of gross and net produce on the *value* plane where they appear as *gross* and *net value of production* (GVP and NVP). The net produce is *sold*. It is valued at the *price sold*, say p. This defines NVP. NVP then corresponds precisely to the earlier ``value of production''. The other part of gross produce, i.e., the reproduction requirement, is *held back* in the process of production. It is valued *internally* exactly like our IP's so far. It is valued at the *cost-coefficient*, c .

Let us set down the definitions in symbols:

$$
\begin{aligned}
NVP &= pN \\
GVP &= pN + cR \\
&= pN + \frac{W}{H} R \\
&= pN + \frac{R}{H} W \\
&= pN + (1-\delta)W
\end{aligned}
$$

Let us look a little more into this equation. There is by definition ``double counting" in GVP. The double counting factor expressed as a proportion of the cost-value of gross produce (DCF) is given here by $(1-\delta)$. This follows at once from the fact that

$$NVP = P + W$$

and so

$$GVP = P + W + (1-\delta)W,$$

i.e., $(1-\delta)$ fraction of the wage bill W is counted over again.

There is another way of arriving at this result. The two wage terms in *GVP* combine into $(2-\delta)W$. This appears rather queer. Just write it as $[\delta + 2(1-\delta)]W$ and interpret. δ fraction of W is accounted by the net-produce-part of gross produce. This is counted *once* in GVP. $(1-\delta)$ fraction of W is accounted by the reproduction-requirement-part of gross produce. This is counted *twice* in *GVP*.

We can again read back these concepts into the earlier IP-laden models of production, *with* the ``algebraic pluses" put in (see fn. 105). We do not take out time on this. We simply point out that DCF in these models is greater than $(1-\delta)$ because of the cumulations or series-summations.