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On Keynes's Theory of the Aggregate Price Level in the *Treatise*: Any Help for Modern Aggregate Analysis?

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Abstract

The paper explores the theory of the aggregate price and profit in Keynes's *Treatise* for its implications for modern macroeconomic analysis. Here profits are defined in terms of aggregate investment and saving. Deriving aggregate total revenue and aggregate total cost from this price theory, the paper shows how to construct a version of the Keynesian cross diagram. It then examines an IS-LM model from the perspective of the *Treatise*'s price theory, focusing on an interpretation of the business cycle in which savings and investment may not equal. Comparing the *Treatise*'s price theory with a neoclassical definition of profit, the paper reconstructs the cross diagram and reconsiders a related IS-LM model, with a focus on fiscal policy. This clarifies how microfoundations affect the standard cross and IS model. Further, the reconstructed cross diagram allows for derivation of neoclassical aggregate supply, to which the derivation of neoclassical aggregate demand can be added. Comparative statics of this AS-AD analysis suggests that a focus on profit might be useful in identifying the manifestation of exogenous technology shocks of real business cycle theory.

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1. Introduction

The struggle to synthesize Keynesian and neoclassical economics has continued at least since Patinkin (1965) without any broad consensus as to whether such a synthesis exists. In contrast, with what might be called the anti-synthesis approach, many economists started with Keynesian research agendas and began advancing such theory by building the aggregate concepts from microeconomics, such as Baumol (1952), Friedman (1957), Tobin (1958), and Phelps (1967). And indeed most of the currently dominant neoclassical research agenda can be seen as a natural evolution of the theory of Marshall, Fisher, Keynes and Hicks. This leaves in question the evolution of one still dominant foundation of synthesis attempts: the Keynesian "cross" and IS-LM models. Will these models after all be accepted as a legitimate synthesis of Keynesian and neoclassical theory, as generations of textbooks continue to suggest, or will these also evolve through their development from microeconomic foundations? This question, and the deep division in macroeconomists who answer it differently, seems to confuse students of macroeconomics worldwide.

This paper suggests a way to answer the question by taking the microfoundation route. But the idea is to show that a microeconomics direction is not inconsistent with the original construction of these Keynesian models. So in a sense, the paper suggests that the deep division is unnecessary. It argues that the fundamental idea is to derive aggregate supply and demand. And it shows how part of Keynes's approach is microeconomic oriented and, when modified, is perfectly consistent with the neoclassical derivation of aggregate supply and demand. It also suggests that in this modified framework, part of the original focus of Keynes's *Treatise* may be able to help resolve current "Keynesian" objections to neoclassical business cycle theory.

2. The Treatise's Theory of the Aggregate Price

Keynes discusses Fisher's (1911) quantity theory of money demand at length in his *Treatise on Money*. He uses it as the basis for his recommendation of a policy to achieve price stability in his *Tract on Monetary Reform* (offset velocity movements with changes in money supply growth rates). [1] However, as a theory of the aggregate price level,

[1] Keynes (1923).

Keynes expresses dissatisfaction with the quantity theory [2], and explicitly attempts in his *Treatise* to replace it with what might be considered a type of microeconomic, or micro-founded, approach. It can also be thought of as a real, cost-based, rather than a nominal, money based, approach to the theory of the aggregate price level. And this theory links the dynamics of the price level to the *Treatise*'s theory of the business cycle.

The *Treatise* posits that the aggregate price of output is the average cost of aggregate output plus the average aggregate profit. This can be viewed as an aggregation based on the Marshallian theory of the firm. [3] And in fact, besides applying it to the aggregate, the only *prima facie* difference in the *Treatise*'s price theory from standard neoclassical price theory is the definition of profit. This definition follows an involved discussion of profit in the *Treatise*, that is defended against critics in the *General Theory*. [4] In particular, aggregate profits are defined to equal aggregate investment minus savings. Per unit profit is the aggregate profit normalized by output. [5]

The idea in the *Treastise* is that, in a type of long-run equilibrium, profit is zero when investment equals savings. In the short run over the business cycle, profit is positive in the upturn as investment demand exceeds savings supply, and so output expands. In the downturn, profits are negative as savings supply exceeds investment demand, and so output contracts. [6] This theory is developed as a business cycle description that is

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[2] "The fundamental problem of monetary theory is not merely to establish identities or statical equations relating (e.g.) the turnover of monetary instruments to the turnover of things traded for money. The real task of such a theory is to treat the problem dynamically, analysing the different elements involved, in such a manner as to exhibit the causal process by which the price level is determined, and the method of transition from one position of equilibrium to another. The forms of the quantity theory, however, on which we have all been brought up– I shall give an account of them in detail in chapter 14– are but ill adapted for this purpose. … they do not, any of them, have the advantage of separating out those factors through which, in a modern economic system, the causal process actually operates during a period of change" (Keynes, 1930, vol.1, p.120).

[3] Contemporaneously Marshall (1920, pp.264–265) also could be said to have ventured towards aggregate analysis on the basis of the theory of the firm with his discussion of the representative, or average, firm: "We shall have to analyse carefully the normal cost of producing a commodity, relatively to a given aggregate volume of production; and for this purpose we shall have to study *the expenses of a representative producer* for that aggregate volume" (italics in original).

[4] Keynes (1936, pp. 77–81).

[5] "profits (Q) are … $Q = I - S$ so that entrepreneurs make a profit or a loss according as the money value of current investment exceeds or falls short of current savings" (Keynes, 1930, vol 1, p.136); "the reader will appreciate that the condition of zero profits means that aggregate profits are zero" (italics in original, Keynes, 1930, vol.1, p137.

[6] "If producers as a whole are making a profit, individual producers will seek to enlarge their output so as to make more profit…by employing more of the factors of production…Thus we may conclude that, as a rule, the existence of profit will provide a tendency toward a higher rate of employment and of remuneration for the factors of production; and *vice versa*". (italics in original, Keynes, 1930, vol.2, p.163). See also Keynes (1930, vol.1, p.136–165).

consistent with the *Treatise*'s theory of the aggregate price. Formally the *Treatise*'s price theory can be stated as the following. With P denoting the aggregate price level, y denoting real aggregate output, I denoting nominal aggregate investment, S denoting nominal aggregate savings, and AC denoting the average cost of aggregate output, the theory is expressed notationally as [7]

$$P = AC + [(I - S) / y]. \qquad (1)$$

At the "long run equilibrium", $P=AC$. In the "short run", there is a mark-up from positive profit with $I>S$, and a mark-down from negative profit with $I<S$, giving a procyclic aggregate price. Thus the Marshallian, market-clearing, scarcity rent from demand in the short run here takes the form of investment in excess of savings.

This paper will focus on four implications of the *Treatise*'s price theory.

1) The theory forms the basis for one way to construct and interpret the so-called "Keynesian cross".

2) It presents a stronger microeconomic link between the Keynesian cross and the IS-LM model that reflects on the analysis of fiscal policy.

3) It contains an inconsistency with neoclassical price theory that gives another perspective on how to qualify the cross and IS-LM analysis.

4) Eliminating the inconsistency shows how the *Treatise*'s approach can be made consistent with a micro-founded theory of aggregate supply and demand that underlies modern real business cycle theory.

3. Construction of a Keynesian Cross

Darity and Young (1995) discuss generations of the Keynesian 45 degree diagram, with the name "Keynesian cross" attributed to Fusfeld (1985). A version of this cross, perhaps not exactly like any particular other version, but with similarities, can be

[7] In the book III, *The Fundamental Equations*, Keynes (1930, vol.1, pp.122-125) describes the equation $\Pi=(E/O)+[(I - S)/O]$, where P is "the price level of output as a whole", O is "the total output of goods" E is the "earnings of the community" or the factors of production, E/O is "rate of earnings of the factors of production", and $(I - S)/O$ is "the rate of profits per unit of output". Note that O is real output rather than nominal output as Keynes (p.135) also uses it in the Fisher equation that he writes as "$PO=M_1V_1$." Meltzer (1988, pp.63-64) also interprets this equation of Keynes, stating that "The point of the fundamental equations is to show that when prices differ from costs of production, investment and saving differ…The deviation of prices from long-run equilibrium is equal to the difference between investment I and saving S per unit of real product."

constructed from equation (1) in combination with other assumptions. Consider simply multiplying the price equation through by real output *y*. The product of the price of output and the quantity of real output is an aggregate version of total revenues (*TR*), or nominal output, and equation (1) gives this as

$$TR \equiv Py = (AC)y + (I - S). \qquad (1')$$

Now consider adding an accounting proposition in which the total firm revenues *Py*, or "proceeds", are defined as equal to nominal consumption *C* plus investment: [8]

$$TR \equiv Py = C + I. \qquad (2)$$

Equations (1') and (2) imply that $C + I = Py = (AC)y + I - S$. Solving for total costs (*TC*),

$$TC \equiv (AC)y = C + S. \qquad (3)$$

In sum, assuming that aggregate total revenues (*TR*) are given as in equation (2) and combining this with the *Treatise*'s price theory of equation (1) implies the aggregate total cost formula of equation (3).

A cross diagram can be constructed from the aggregate total revenue and cost equations with additional assumptions. On the nature of *C* and *I*, the *General Theory* has been widely interpreted as letting *C* be a line with a slope positive but less than one in magnitude, and with a positive vertical-axis intercept. This will be assumed here for *C*. And investment *I* will be assumed to be independent of *y*, as is typical for the cross diagrams. Then the aggregate total revenue line of $C + I$ is also a line with a slope positive but less than one, and with a positive vertical-axis intercept.

For the total cost line, it is assumed that cost reflects the long run. Taking the *Treatise*'s case of a long run with zero profit as in classical theory, marginal costs are assumed to equal average costs and these cost curves are flat, or horizontal. As in a constant returns-to-scale (CRS) Cobb-Douglas production function, this implies that total costs are a straight line, slanting up from the origin. To get a 45 degree line, the aggregate price is set equal to one, justified either by the modern Keynesian textbook convention, or more formally by defining y as the aggregate output basket and then letting the basket

[8] Keynes (1930, vol.1, p.122) has an equation similar to this, whereby real output equals the sum of the "volume of liquid consumption goods and services" plus " the net increment of investment"; also arguably found in the Keynes (1936, p. 29).

be the numeraire good. With CRS and $P=1$, the constant slope of the total cost curve is one: $[(WI+Rk)/y]=Py/y=1$, where WI and Rk denote the nominal aggregate costs of labor and capital.

The resulting standard-looking cross diagram is shown in Figure 1, with the total cost line cutting the total revenue line from below. At the intersection, *Treatise*-defined profits of $I - S$ are zero since $TR=TC$, and this could be argued to be some sort of long run equilibrium. In particular, the diagram can support the *Treatise*'s dynamic explanation of contraction and expansion of output. When $I>S$, the economy is to the left of the intersection and profits are positive. If output then expands, the economy moves towards the intersection of TC and TR, as in a dynamic equilibrium adjustment. When $S>I$, the economy is to the left of the intersection and profits are negative. If output then contracts, the economy symmetrically moves towards the intersection of TC and TR as in a dynamic equilibrium adjustment. Put differently, in more of a proposition form, the *Treatise*'s theory of the aggregate price can be used to construct a *Treatise*- type theory of an equilibrium business cycle as represented in the cross diagram of Figure 1.

4. Linkage Between the Treastise – Type Cross Diagram and the IS-LM Analysis

A linkage can be made between the *Treatise*'s aggregate price theory, the just-constructed cross diagram, and a simple IS-LM model. This relates to the *Treatise*'s definition of the gap between investment and savings as profit and whether investment and savings can be unequal. An accounting equivalence of savings and investment can be achieved in many ways. One is to posit that there is additional long-term investment that is not designed to yield profit in the current business cycle and that fills the so-called savings-investment gap. With A denoting some type of "autonomous", long-run, investment, and I' denoting shorter term investment, Hicks (1950) considers the equation

$$S=I'+A=I. \tag{4}$$

Such a definition, of $S - I' \equiv A$, is not exactly the same as defining the gap between savings and investment as losses. But it may not be entirely inconsistent with a profit/loss definition if the argument is that long run investment of savings can yield a loss in a downturn (for example, high fixed costs), a gain in the upturn, and no profit over the competitive long run trend.

The completion of the savings-investment equation, in the autonomous investment fashion of equation (4) marks a departure from the mathematical structure behind the cross of Figure 1. Equation (4) creates a related but different business cycle explanation within the cross and can be use to construct a simple IS-LM model. And by also adding a special assumption about total cost, the same result for fiscal policy can be achieved in each the total-cost/total-revenue cross and the IS-LM models as in standard representations.

In the cross diagram, if $S=I'+A=I$ and $Py=C+I$, then $Py=C+I'+A$, and we have the ability to shift up the total revenue line in Figure 1 by increasing autonomous investment. However, the effect of an increase on total costs from an increase in A must also be considered. If it is assumed *ad hoc* that total costs do not change, then the total revenue curve shifts up along the stationary total cost curve. Output increases, as in the standard Keynesian cross analysis of fiscal policy. To justify the assumption of no cost increase, it might be said that there exists savings in excess that has already been incurred as part of total cost, but has not been turned into investment, which is a part of total revenue. For example, if the private banking system collapses, savings already allocated to financial intermediation sector cannot be easily processed into in intertemporal investment. And if the government can somehow act as the intermediary of this unallocated savings in place of the private intermediaries, then the investment would go up while savings remains constant. This is a speculative case that may or may not have occurred during the Great Depression.

The total-revenue/total-cost construction of equations (1) to (4) plus the assumption that total costs do not change when A increases produces the result of an increase in output. Simply setting $A \equiv G$, calling G government expenditure, keeping G independent of y, and suppressing the total-revenue/total-cost concepts, gives a version of how the cross diagram is often presented in modern textbooks. The total revenue line might be called the income line, and the total cost might be called just the 45 degree line, or the words aggregate demand and aggregate supply lines might be used. Either way, the notion of profit and losses plus the idea of unused savings is, from the point of view of the construction from the *Treatise*, substituted with the concept that increased government spending can get the economy to a new equilibrium. This results in a jump in the analysis from positing losses that coincide with savings in excess of investment in a downturn, to finding an increase in equilibrium output through government spending at any time.

With equation (4), a standard IS-LM model can be constructed to also give the result that (non-Ricardian, debt-financed, deficit) government spending increases output. Consider denoting Py as nominal income Y instead of as total revenue (TR), so that $Y \equiv Py = C + I' + A$. With R denoting the interest rate, now let C be specified for example as $C=a+bR+cY$, with $b<0$ and $c<1$; and let $I'=d+eR+fY$, with $e<0$ and $f=0$. The last

restriction of $f=0$ is consistent with the modern cross diagram in which I' does not depend on Y, and it guarantees a downward sloping IS curve, as constructed from the capital market under the assumption that S is dependent on income. [9] With $S=I'+A$ of equation (4) as the only other equation, S typically is assumed to be a vertical curve that is independent of the interest rate, and dependent on y. As y exogenously increases, S shifts out, I does not shift, and a downward sloping IS curve is traced out in the plane of y and R.

For fiscal policy with equation (4), an increase in A can be graphed in the capital market as a parallel shift out of the downward-sloping investment schedule I', with the horizontal-axis intercept rising by A. This causes a shift up in the IS curve and, with a standard LM curve, causes an increase in y. Mathematically, computation of the multipliers for C and for I also shows that an increase in $A \equiv G$ causes an increase in output. [10]

In sum, adding equation (4) to the total revenue and total cost equations, as constructed from the *Treatise*'s price theory, replaces the profit notion implicit in equation (1) with autonomous investment. Further keeping total costs constant as autonomous investment rises allows conversion of the cross diagram of total revenue and total cost into a textbook -type cross in terms of fiscal policy results. And with equation (4) and no allowable cost increases, the IS model gives the same fiscal policy results when combined with a flat or upward-sloping LM schedule.

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[9] Keynes (1936) and Hicks (1937) use the capital market to construct the (first) IS diagrams with investment and savings on one axis and the interest rate on the other axis.

[10] The standard interpretation is that S is vertical, with no sensitivity to the interest rate. However equation (4), $S=I'+A$, with no other equation describing S, can be interpreted as implying a *horizontal* savings curve. When A rises (say from 0), the downward-sloping investment schedule shifts up by A along its horizontal-axis intercept and moves by A along the horizontal S schedule. S rises by the same amount as A, using equation (4) or the graph, and Y also rises by the same amount since $Y=C+I'+A$. A horizontal S curve implies the notion of excess, unused, savings that is found in the literature. For example let $C=a+bR+cy$ and $I=I_0$. An increase in G from 0 means that savings ($S=I+G$) rises in tandem by G, that output ($Y=C+I+G$) initially rises in tandem by G, and then that output rises again because C rises. Consider that solving for C from $Y=C+I+G$ implies that $C=[cI\text{ø}+cG+a+bR]/[1-c]$. With the increase in G from 0, the consumption solution gives an extra $cG/(1-c)$ increase in C. The total increase in Y is then $G+cG/(1-c)=G/(1-c)$, which is the standard IS multiplier. However the decomposition into the above two components can be interpreted as a result of two perfectly-elastic supplies, of output and savings. The multiplier increase in Y results from turning G amount of the unlimited savings into more Y directly, and from the consumption out of a non-scarce income that has now increased by G. Therefore the multiplier can be interpreted as resulting directly from the lack of scarcity of savings and income, in the sense of horizontal savings and output supply curves. Note also that total cost, in terms of the area under a horizontal savings or output curve, would still increase. A special assumption that cost does not increase (when G increases) in the cross framework from the total-cost/total-revenue perspective is therefore not completely consistent with the IS model as interpreted above.

5. Modification with a Neoclassical Definition of Profit

The *Treatise*'s price theory is innovative and interesting for its micro-related construction, its relation to a business cycle theory, and its ability to form a basis for the modern cross and IS-LM models. However by equating profits with the difference between investment and saving, it departs from generally accepted micro-based macroeconomic theory. Modern neoclassical theory lets investment exceed saving when a country borrows capital from abroad (Obstfeld and Rogoff, 1996), which Keynes in the *Treatise* actually discusses, [11] but this borrowed capital is not equated with aggregate profit (although it may lead to an increase in the nation's permanent income stream).

Neoclassically defined profit can be expressed in a form relative to equation (1). Looking at the marginal and average cost curves of a competitive firm, per unit profit at the equilibrium output is given by the marginal cost minus the average cost. And the competitive price as applied to an aggregate consumption basket, instead of equation (1), is

$$P=AC+(MC-AC), \tag{5}$$

or of course just $P=MC$. Consider a reconstruction of a cross diagram from equation (5). Multiplying equation (5) through by y, and again setting $TR=C+I$, implies that $C+I=Py=(MC)y$, which is correct if $TR=C+I$. But unlike when the same operations were conducted with equation (1), this gives no information on total costs in general. And consider the classical long run. If $AC=MC$ and $P=AC$, then $TR \equiv C+I=(AC)y \equiv TC$. There is no implication that $TC=C+S$, although total cost can still be graphed as a 45 degree line by assuming constant returns to scale and $P=1$. The Hicks-type equation of $S=I'+A=I$ still can be inserted so that $Y=C+I'+A$, and A has a role. However the business cycle explanation based on differences between I and S is no longer implied. And it is harder to form the argument, as in some of the literature, that there are unused excess savings that the government can convert to output through increases in $A \equiv G$.

With the revised cross, as derived from equation (5), a potentially different analysis results for changes in A (say from an initial level of 0). If the government or private sector increases long run investment, then the purchases show up as increases in total revenue, or current dollar GDP, and then $TR=C+I+A$. However without any equivalence of total costs with $C+S$, or any special role of savings in total cost, then total costs presumably rise as well when A goes up. In this case, if the total cost increase is a fixed cost and not

[11] Keynes (1930, vol.1, pp.145–149).

proportional to y, then both total revenue and total cost curves shift up by the same amount and the intersection, say at y^*, remains the same. With the total cost increase proportional to y, and equal to A at the level of y^*, then total cost pivots up, while total revenue shift up, and again the intersection remains at y^*. An *ad hoc* assumption that total cost does not change when A increases would again keep the 45 degree line unmoved, while the total revenue line shifts up, with the result of an intersection of total cost and total revenue at a higher y. But without $TC=C+S$ and the existences of unused savings such an assumption is harder to justify.

In the IS model above except simply with $I=S$, instead of equation (4) and the assumption of no increase in total cost, there is no description of S at all. It need not be horizontal or vertical. Any increase in Y by government action would require some conversion of scarce debt or tax revenue, either explicit current taxes, or increases in future taxes, or seignoirage, into something greater than it would otherwise yield. This could happen in general for example if the government more efficiently lowers transaction costs in markets than can the private sector.

Therefore if the price theory of the *Treatise* is altered to be consistent with a neoclassical definition of profit, the reconstructed cross diagram offers, in the first instance, little in the way of finding increases in output from government action. Further, without a gap between savings and investment, in a closed economy, it is hard to deduce the existence of a government-induced increase in output from the IS equations, unless unused or unlimited savings are re-imposed. (Alternatively it could be assumed that Barro-Ricardian equivalence does not hold in that the government is not bound to an intertemporal budget constraint, or unborn generations are allowed to be taxed and discounted more heavily, etc.). It could be stressed that there may be special cases when there are such seemingly unlimited savings. In particular, during a collapse of the banking sector, perhaps as in the US 1930's, the private intermediation system of turning savings into investment may collapse. And it is conceivable that the intermediation may temporarily need to be taken over by the government (or the International Monetary Fund for example or some other insurance-type agency for aggregate risk), until the private banking system can be re-established. The theory of the *Treatise* may be interpreted as being of interest in special cases.

6. A Treatise – Motivated Approach to Aggregate Demand Analysis

Problems with such modern cross and IS-LM models as constructed above include how to derive the aggregate-demand/aggregate-supply (AS-AD) analysis (as in Colander, 1995) [12], how to make these two models consistent with microfoundations, and how to find consistency with real business cycle (RBC) analysis. Because equation (1) is not in general a neoclassically correct theory of the price, since it incorrectly represents profit, the cross diagram that is constructed from the *Treatise*'s price theory presumably cannot imply a correct AS or AD schedule. However with the modification of inserting the neoclassical definition of profit, the framework can be used as a basis for a micro-founded AS-AD analysis. Further, the *Treatise*'s focus on profit within a neoclassical total-cost/total-revenue approach may suggest how the exogenous technology shocks, which Mankiw (1989) considers as a weak point of real business cycle theory, might be empirically verified.

Substituting in the neoclassical definition of profit, the *Treatise*'s theory of aggregate price becomes in a sense only a shell for modern macroeconomic analysis as based on a representative consumer/firm. But, at the same time, with the total-revenue/total-cost approach to the cross diagram, it is possible to derive aggregate supply and, to add onto this the derivation of aggregate demand. Consider a simple example, in which there is no investment, but rather only the aggregate good y and leisure $100 - l$, where l is the fraction of time spent working. With s and d superscripts denoting supply and demand, utility is defined as $u = \ln y^d + \alpha \ln(100 - l^s)$. The production technology is $y^s = A(l^d)^\gamma$, where $\gamma \in (0,1)$, and A is a technological shift factor. The optimization problem can be divided into consumer and firm parts. With Π denoting nominal firm profit, W denoting the nominal wage and P denoting the nominal price of the aggregate good, the consumer maximizes u subject to $Py^d = \Pi + Wl^s$, and the firm maximizes $\Pi = Py^s - Wl^d$ subject to the production technology. The supply and demand for goods and labor can be solved as can the profit and the equilibrium wage. Profit is equal to $(1 - \gamma)Py^s$, and the cost of labor is then γPy^s. Interpreting the profit as the cost of capital is consistent with a Cobb-Douglas view of the production function, where the shares of capital and labor in total revenue are constant at $(1 - \gamma)$ and γ.

Profit, as in the *Treatise*, can be expressed as total revenue minus total cost. But now these are given as $TR \equiv Py^s$ and $TC \equiv Wl^d$. In equilibrium, the aggregate supply curve (AS)

[12] See also, for example, King (1995) and Neville and Rao (1996).

is $y^s = (A^{1/\gamma}\gamma P/W)^{\gamma/(1-\gamma)}$ or, it can be written as $P = W(y^s)^{(1-\gamma)/\gamma} / (\gamma A^{1/\gamma})$.

Also $l^d = (y^s / A)^{1/\gamma}$, so that $TC = W(y^s / A)^{1/\gamma}$. Deriving marginal cost, $MC \equiv \partial(TC) / \partial y^s = W(y^s)^{(1-\gamma)/\gamma} / (\gamma A^{1/\gamma})$, which is equal to the AS function. Thus $P=MC$ is the AS function and the AS can be derived from the equilibrium total cost function as an application of Sheppard's lemma. Equilibrium *TR* can be expressed as $TR \equiv Py^s = W(y^s)^{1/\gamma} / (\gamma A^{1/\gamma})$. And therefore along with the AS graph, the *TC* and *TR* can be graphed as functions of y^s, with each rising monotonically with y^s and the real profit per unit of goods constant at $(1-\gamma)$. Expressing each of these functions in real terms by dividing through by the nominal wage *W*, the actual relative price of the AS function is $P/W \equiv 1/w$, the inverse of the real wage, as in Figure 2 in which $\gamma = 0.5$ and $A=1$.

The equilibrium quantity of goods that are supplied and the equilibrium price cannot be determined of course without the aggregate demand. And while AS can be derived from the total cost function, the aggregate demand cannot be derived from the total revenue function because total revenue, a part of the profit function, is a function of aggregate supply; $TR = Py^s$. Instead aggregate demand is the marginal benefit function that can be derived from the equilibrium total benefit (*TB*) function by using the envelope theorem. The total benefit is the indirect utility, $u^* = ln[y^d]^* + \alpha ln[100 - (l^s)^*]$, where * denotes equilibrium, divided by the equilibrium marginal utility of income, which is the value of the Lagrangian multiplier, denoted λ , of the above consumer maximization of *u* subject to the income constraint. The total benefit can be expressed as $TB \equiv u^* / \lambda$. By the envelope theorem the derivative of *TB* with respect to the quantity of goods demanded is equal to the marginal utility divided by λ, which in turn can be defined as the marginal benefit (*MB*) function; or $\partial(TB) / \partial y^d = (\partial u^* / \partial y^d) / \lambda \equiv MB$. From the first-order conditions of the consumer problem, the marginal benefit equals the price of the consumption good *P* ($[\partial u^* / \partial y^d] / \lambda = P$) and this equation of $P=MB$ is the aggregate demand (AD) function. Since in equilibrium $y^d = (\Pi + 100W) / [P(1+\alpha)]$, the AD function can be expressed as $MB=P = (\Pi + 100W) / [y^d(1+\alpha)]$. In real terms the AD function is $P/W = 1/w = [(\Pi / P) + 100w] / [y^d(1+\alpha)]$; with $\gamma = \alpha = 0.5$ and substituting in the equilibrium value of Π / P, which is $\Pi / P = A^2 / (4w)]$, the AD function can be written as $y^d = (2/3)[100w + A^2 / (4w)]$. The intersection of the AS and AD occurs at the equilibrium quantity of goods where the slopes of the *TC* and *TB* curves are equal, where $MB=MC$, and where by welfare theorems (not proved here) the distance between the *TB* and *TC* curves is at a maximum (not where *TR* and *TC* intersect as in Figure 1). Thus in Figure 2 the output supplied rises as the relative price $1/w$ rises, and the output demanded falls as $1/w$ rises.

The derivation of the AS and AD functions relative to the TC and TR functions shows a link between the *Treatise* and modern macroeconomic analysis. It suggests that the

standard cross diagram can be modified so as to be micro-founded, but without the standard cross results for fiscal policy. However the advantage of the microfoundation is the derivation of AS and AD, which now can be linked directly to the real business cycle and exogenous growth theories. Comparative statics of *A* in the example economy show how a technology shock affects AS, AD, and profit. Figure 3 shows how for $\gamma = \alpha = 0.5$, the AS and AD curves both shift out when the parameter *A* rises in value from 1 to 2. Supply pivots out because of higher productivity and demand pivots out because of higher income from a higher profit. Also the demand for labor shifts out because of higher productivity and the supply of labor pivots up because of the income effect of the higher profit. The equilibrium real wage rises, so that the relative price *1/w* falls, as supply shifts out by more than demand. The fall in *1/w* is consistent with a cyclic upturn and with the secular growth trend, described here by a supply that shifts out faster than demand (see Harberger 1998 for a focus on secularly falling costs).

Note that in this example, behind the AS-AD shifts, *TB*/*W* pivots up because the marginal utility of income $W\lambda$, which in equilibrium is given by $W\lambda = 1.5 / \{[A^2 / (4w)] + 100\}$, falls as the increase in *A* causes an increase in profit. This makes the slope of *TB*/*W* higher for each *y* and this corresponds to a higher price *1/w* for each y^d along the new AD curve. The *TC*/*W* curve pivots down, making the slope lower for each *y* and this corresponds to a lower price *1/w* for each y^s along the AS curve. The curve *TR*/*W* also pivots down whereby the real profit per unit of output, $\Pi / (Py)$, remains the same at 0.5.

The simple example economy can conceivably be expanded into a fuller model with physical capital and constant returns to scale, and even two-sectors with a market and non-market good. Then the "price" against which the AS-AD curves is graphed can be the ratio of the real interest rate to the real wage, which is generally thought to be procyclic, rather than only the inverse of the real wage as above. Exploring the cyclic movement of the ratio of the real interest rate to the real wage moves over the business cycle in response to shocks that shift AS and AD would not only further the development of AS-AD analysis but also would extend the real business cycle literature (see for example Cochrane, 1999). Profits could be interpreted as part of the return to capital, as reflected in changes in the marginal product of capital. Getting deeper into the manifestation of negative technology shocks may be possible by following the profit route. "Restructuring" changes by corporations that show up as detractions from individual firm profit are the writing off of unsuccessful investment capital that in effect disappears from the economy. The negative shocks of restructuring are found in nearly every firm in every market. These are real dollars lost because the technology, including production, marketing, management, and sales, loses out in the market.

Taken this far, the paper contributes another way towards mitigating the schism between neoclassical and Keynesian analysis. It offers a micro-based construction of a

Keynes-based analysis and replaces the *Treatise*'s specification of profit with a Marshallian definition. Deriving AS-AD from an extended total-revenue/total-cost framework shows how a Keynes-motivated analysis is fully internally consistent with neoclassical analysis. This approach also offers a Keynes motivated approach to enhancing real business cycle theory, in particular by meeting the challenge of bringing out an interpretation of profit's comovement with output and how it potentially relates to the manifestation of exogenous technology shocks.

Figure 1. Total Cost and Total Revenue Construction of a Keynesian Cross

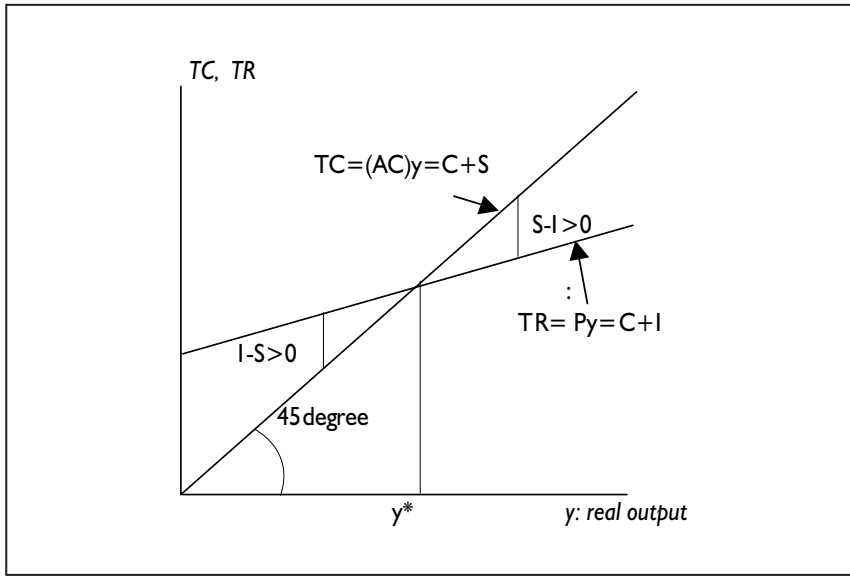


Figure 2. Derivation of AS-AD from TC and TB with $\gamma = \alpha = 0.5$, $A=1$

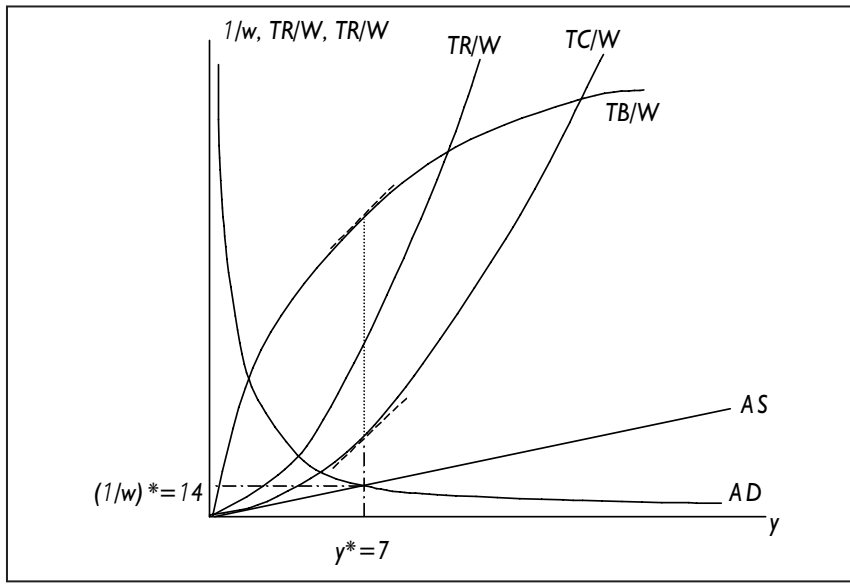
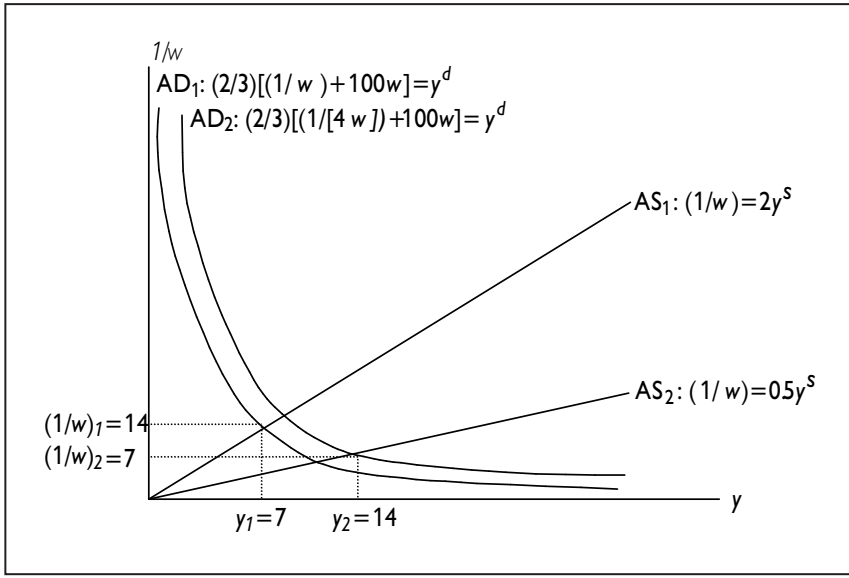


Figure 3. Comparative Statics of an Incarse in Productivity from *A=1 to A=2*



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