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A New Model for AS-AD Analysis Based on Input-Output Frame

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Abstract

This paper has established a new kind of AS-AD models with input-output techniques. The models take the standard input-output tables as its starting points. We analyze the change effects of government consumption, direct consumption coefficient, labor productivity, and surplus rate on the equilibrium output. In this paper, we propose that the aggregate demand function curve should be right upward, and this lead to a series of inconsistent conclusions with the traditional views. Finally, we also analyze the well-known issue of stagflation.

Keywords: AS-AD Model, Input-Output, Aggregate Supply, Aggregate Demand

1. Introduction

It was pointed out that the input-output (IO) analysis had no longer been included in the core of mainstream economics since the middle of 1980s. The authoritative magazines, such as *Econometrica*, the *Review of Economics and Statistics*, and the *Quarterly Journal of Economics*, didn't continue to publish input-output papers, and the best economists seemed seldom to have interest in the development of input-output analysis field [1]. In fact, input-output (IO) economics has never had access to the core of mainstream economics. Leontief's input-output economics[2] and Keynesian economics[3] were both generated in the mid-1930s, but the Keynesian theory is the inheritance and development of traditional mainstream economics and has the same basic category to it, whereas the Leontief theory born out of Marxist economics and is completely different from the traditional classic economics in the core category. The key difference between them is that the foundation concept of Keynesian theory is national income such as GNP or GDP, and the foundation concept of Leontief theory is total output which contains intermediate inputs, such that the Keynesian theory's research object mainly focused on the transaction processes and the Leontief theory's object mainly focused on the production processes. Although IO analysis has obtained a huge developing space in the study of practical economies, it is yet impossible to enter the mainstream economic theory system. They two can not be combined together seamlessly. However, Leontief's theory is closer to reality than the mainstream one because some intermediate inputs are necessary for most of real production processes and any unit of products must contain some products which were produced previously. The AS-AD analysis approach is a new development stage of the mainstream economics in the 1980s to 1990s when it was used to solve the stagflation problems which had troubled mainstream economics for more than 20 years.

This paper develops a new AS-AD model with a single-sector IO framework and analyses the slopes of new AD and AS functions at first, and then explores the impacts of government expenditure, direct consumption coefficient, labor productivity and operating surplus rate on the equilibrium states in the second part. It discusses the stagflation issue in a two-sector model in the third part. The last part gives the conclusion views of the paper

2. Single-Sector AS-AD Model

2.1. Basic Input-Output Relations

The model of a single-sector input-output table shown as following:

$$\begin{pmatrix} X & C & G & I & NX \\ W & & & & \\ T_1 & T_2 & & & \\ Z & & & & \end{pmatrix}$$

where X is intermediate input (or intermediate use), C is household consumption, G is public consumption(or government consumption), I is capital formation, NX is net export, W is total wage, T_1 is net taxes on production, T_2 is net taxes on income, Z is operating surplus.

For this economic system, its input-output balance relations are following:

$$X + C + G + I + NX = Q \quad (1)$$

$$PX + W + T_1 + Z = PQ \quad (2)$$

where P is the price level, Q is the total output.

If let Q^d denote aggregate demand and Q^s denote aggregate supply, then Formulas (1) and (2) should be written as following:

$$X + C + G + I + NX = Q^d \quad (3)$$

$$PX + W + T_1 + Z = PQ^s \quad (4)$$

When the supply and demand are balanced, there is

$$Q^d = Q^s$$

Formulas (3) and (4) show that the rows of an IO table represent the demand sides of an economy and the columns represent the production processes.

2.2. Aggregate Demand (AD) Relations

If we have the behavioral functions of the aggregate demand as following:

$$X = Q^s a,\ C = f_1(W, Z)/P,\ G = T_1 + T_2 - H,$$
$$I = f_2(r, Z)/P,\ NX = f_3(Q^d, e),$$

where a is the direct consumption coefficient, H is a planned deficit, r is an interest rate, e is an exchange rate.

The above behavioral functions contain following basic ideas:

1) In a short term, a is constant. This is not only the basic usage of input-output techniques, but also conforms to the characteristics of short-term economy.

2) For a given economic system, consumption was mainly influenced by income. The resident income includes two main parts: one is the total wage which considered as remuneration for labor, and the other is from operating surplus which considered usually as capital income. For a national economy, income also includes the transfer payments (ignored here) from abroad. The influences on consumption from wage W or surplus Z are very different. Z's main function is to provide the investment fund for expanded reproduction; W's main function is to provide consumption fund.

3) A large part of the government expenditure is a short-term or annual decision variable, so financial deficit, for a functional finance, may be a short-term decision-making. Generally, taxation as a long-term factor cannot change greatly and frequently. The deficit decision-making which generally takes GDP as a benchmark is a percentage of GDP and can not be too large.

4) As derived demand, investment is not only affected by financial interest rate r, but also affected by surplus level. Obviously, the higher the surplus level is, the bigger the power of enterprises investment is. In this paper we will not discuss the balanced problem of money market, but directly take r as a kind of exogenous constant. We do not consider its change in the following analysis, so it will be omitted in the investment function. Although the bank deposit and loan interest rates may be endogenous as market variables in microeconomic level, the modern economic system provides a space for monetary policy. The guidance or benchmark interest rate is drawn up by the central department of financial management. The real interest rate fluctuates generally above or below the guidance interest rate. From the macroscopic effect, the benchmark interest rate affects the level of investment through control rules.

5) What affects the economic import and export level is not only exchange rate, but also the economic level of activity as a major contributing factor for import and export in fact. This factor can be represented by demand level. The changes of imports and exports induced by aggregate supply can be embedded in X and I. This paper takes exchange rate as an exogenous constant and does not consider its change, so it will be omitted in the following analysis.

Substituting the above demand behavior functions into Formula (3), we will have

$$Q^d = Q^s a + f_1(W, Z)/P + f_2(Z)/P + f_3(Q^d) + G \quad (5)$$

where it is assumed that

$$f_{1W} = \partial f_1/\partial W > 0,\ f_{1Z} = \partial f_1/\partial Z > 0,$$
$$f_{2Z} = \partial f_2/\partial Z > 0, 1 > f_{3Q^d} = \partial f_3/\partial Q^d > 0$$

When the price level is given constant and let $Q^s = Q^d$, Formula (3) coupled with various behavior functions can be equivalent to the IS formula in mainstream economics.

2.3. Aggregate Supply (AS) Relations

The main development of contemporary mainstream economics is about aggregate supply theory, and various schools' arguments are mainly on the aggregate supply model. The traditional Keynes theory considers aggregate supply completely elastic in short term and thinks an economic equilibrium is mainly decided by aggregate demand. Neoclassic economics assumes that aggregate

supply is decided by the people's expectation of price level. If the expectation is rational, the expected price will be consistent with the actual price. Thus, the aggregate supply is equal to the natural rate of output and completely inelastic and is not disturbed by random factors and macroeconomic policies. The new Keynesian economics believes that the market is not always cleared up because of the stickiness of wage and price, thus $P \neq P^e$. Therefore, the aggregate supply is elastic, but is not completely elastic as Keynes defined. In the literatures of mainstream economics, there are many ways to define an aggregate supply function. In the following, we adopt the way used by Blanchard [4].

2.3.1. AS Function Derivation Steps of Blanchard

Let's first show how Blanchard derived AS function.

1) Wage decision function. Assuming

$$w = P^e F(u, z) \tag{6}$$

where w is a wage rate, P^e is an expected price level, u is an unemployment rate. This relation is decided by the supply and demand of labor together. For labors, if w rises and P^e does not change, the supplied labor will increase and then u will decrease. For enterprises, the wages that they're willing to pay when u rises will be reduced and the strength of wage bargaining of workers will be weaken; thus $F_u = \dfrac{\partial F}{\partial u} < 0$.

Formula (6) reflects the behavior characteristics when labor and capital bargain for employment contract. z represents the other factors which affect wage besides u and P^e, such as the unemployment insurance level, the economic structure regulation and so on. Generally we assume z changes in the same direction with w. Formula (6) also means that what the labor and capital think highly of when they negotiate a labor contract is real wage(w/P^e)rather than nominal wage (w).

2) Production function. Assuming a simple production function:

$$Y = AN$$

where N is the employed labor. If measuring the total output (National income) Y by a suitable unit which make $A = 1$, thus

$$Y = N \tag{7}$$

then $u = 1 - \dfrac{N}{L} = 1 - \dfrac{Y}{L}$. Here L is the total labor force.

3) Price decision rule. Assuming

$$P = (1 + \mu) w \tag{8}$$

where μ is called price markup. Formula (8) may regard as a cost-plus pricing model. The mainstream economics does not consider intermediate inputs, so the only cost is wage at present. Blanchard pointed out that If the market is competitive completely, there are $\mu = 0$, $P = w$. Therefore, it considers a state of incomplete competition here.

4) Combination. Substitute Formula (6) into Formula (8), we get

$$P = P^e (1 + \mu) F(u, z) \tag{9}$$

5) Aggregate supply function. From the above formulas, we may obtain the relation of P and Y:

$$P = P^e (1 + \mu) F\left(1 - \frac{Y}{L}, z\right) \tag{10}$$

2.3.2. AS Function in Input-Output System

Similarly to Blanchard's steps, we can establish the AS relation under an input-output framework. From Formula (4), we have $PQ^s a + wQ^s l + T_1 + Z = PQ^s$ where l is the labor input used to produce one unit product. Assuming that all labors are homogeneous and the work condition is the same, then l may be regarded as the labor number taken by one unit product and w is the remuneration for one unit labor in certain time, so that $l = N/Q^s$. Suppose that taxation is a proportion t of added value or GDP, then

$$T_1 = t\left(wQ^s l + T_1 + Z\right) \tag{11}$$

Similarly to Blanchard's price deciding model, we assume that

$$Z = \mu P Q^s \tag{12}$$

From Formulas (11) and (12), we have

$$T_1 = \frac{t}{1-t}\left(wQ^s l + \mu P Q^s\right) = \frac{tQ^s}{1-t}\left(wl + \mu P\right)$$

Let $\dfrac{t}{1-t} = t_1$, then

$$PQ^s a + wQ^s l + t_1 Q^s \left(wl + \mu P\right) + \mu P Q^s = PQ^s$$

and then

$$Pa + wl + t_1\left(wl + \mu P\right) + \mu P = P$$

$$P = \frac{\left(1 + t_1\right) wl}{1 - a - \left(1 + t_1\right)\mu}$$

Let $k_0 = \dfrac{\left(1 + t_1\right)}{1 - a - \left(1 + t_1\right)\mu}$, then it gets

$$P = k_0 wl, \quad k_0 > 0 \tag{13}$$

Formula (13) is just the price deciding formula in an input-output system. Then we apply Blanchard's wage deciding relation *i.e.* Formula (6), there is

$$P = k_0 l P^e F(u, z) \tag{14}$$

Introducing the production function $Q^s = N/l$, then

$$u = 1 - \frac{N}{L} = 1 - \frac{l}{L} Q^s$$

Therefore we may have the AS function as following,

$$P = k_0 l P^e F\left(1 - \frac{l}{L} Q^s, z\right) \tag{15}$$

We will not consider about the change effect of z, so that z will be omitted in the following context.

2.4. The Slope Signs of AD and AS Curves

For brief, we use the symbol $\theta = wl - (1-u) l P^e F_u$, $\lambda = \mu\left(P - (1-u) k_0 l P^e F_u\right)$.

2.4.1. AS Curve

From Formulas (14) and (15), we have

$$\frac{\mathrm{d}P}{\mathrm{d}Q^s} = k_0 l P^e F_u \left(-\frac{l}{L}\right)$$
$$\text{or } \frac{\mathrm{d}Q^s}{\mathrm{d}P} = \frac{1}{k_0 l P^e F_u}\left(-\frac{L}{l}\right) \tag{16}$$

where F_u express the partial derivative of function F to u[1] the same below).

Because $k_0 > 0, F_u < 0$, so $\frac{\mathrm{d}Q^s}{\mathrm{d}P} > 0$, thus the AS curve inclines up toward right in the $P - Q^s$ or $Q^s - P$ space (see **Figures 1-3** below).

2.4.2. AD Curve

From Formula (5), we have

$$\frac{\mathrm{d}Q^d}{\mathrm{d}P} = a\frac{\mathrm{d}Q^s}{\mathrm{d}P} + \frac{f_{1W}}{P}\frac{\mathrm{d}W}{\mathrm{d}P} + \frac{(f_{1Z} + f_{2Z})}{P}\frac{\mathrm{d}Z}{\mathrm{d}P} + f_{3Q^d}\frac{\mathrm{d}Q^d}{\mathrm{d}P} - \frac{f_1 + f_2}{P^2}$$

$$\frac{\mathrm{d}W}{\mathrm{d}P} = \theta\frac{\mathrm{d}Q^s}{\mathrm{d}P}$$

$$\frac{\mathrm{d}Z}{\mathrm{d}P} = \mu\left[P\frac{\mathrm{d}Q^s}{\mathrm{d}P} + Q^s\right] = -\frac{Z}{(1-u)k_0 l P^e F_u} + \mu Q^s$$

From the above formulas, we may educe

$$\left(1 - f_{3Q^d}\right)\frac{\mathrm{d}Q^d}{\mathrm{d}P} = \left[a + \frac{f_{1W}}{P}\theta + \frac{(f_{1Z} + f_{2Z})}{P}\mu P\right]\frac{\mathrm{d}Q^s}{\mathrm{d}P} + \frac{(f_{1Z} + f_{2Z})Z - (f_1 + f_2)}{P^2} \tag{17}$$

[1]In this paper all of the differential coefficients is partial derivatives, but we use the ordinary derivative symbols for simplification.

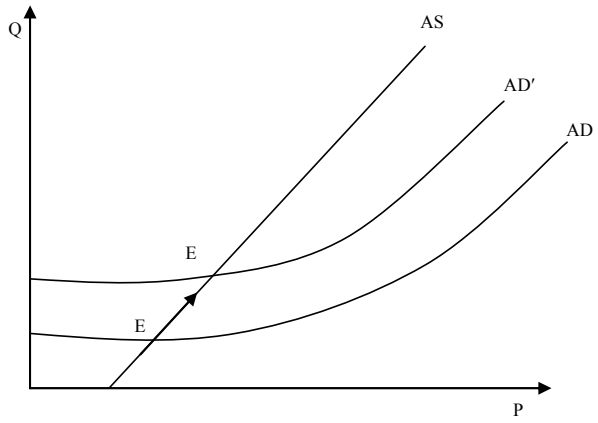

Figure 1. The change of *G*.

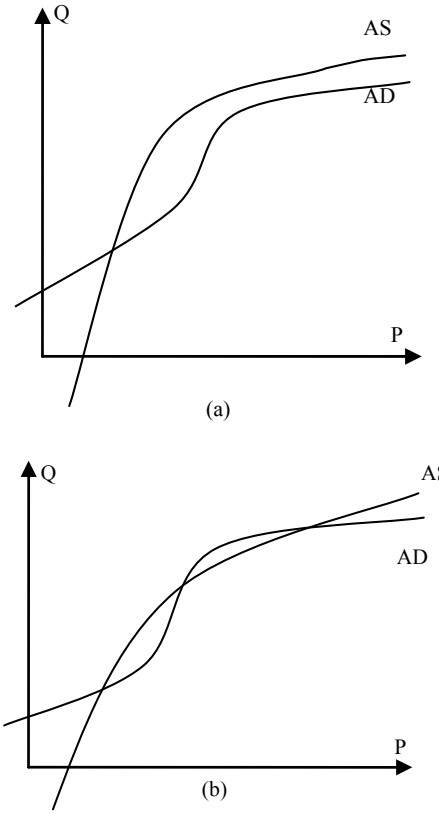

Figure 2. Practically possible AD and AS curve.

Because $\frac{\mathrm{d}Q^s}{\mathrm{d}P} > 0$, so it has $\frac{\mathrm{d}W}{\mathrm{d}P} > 0, \frac{\mathrm{d}Z}{\mathrm{d}P} > 0$, and $f_{1W} > 0, f_{1Z} > 0, f_{2Z} > 0, f_{3Q^d} < 1$. The symbol of $(f_{1Z} + f_{2Z})Z - (f_1 + f_2)$ is not too definite. Using some data which close to reality and giving price changes in usual range (for instance $P < 0.2$) to simulate, we found $\frac{\mathrm{d}Q^d}{\mathrm{d}P} > 0$. This shows that the AD curve also inclines up toward right. This conclusion is obviously

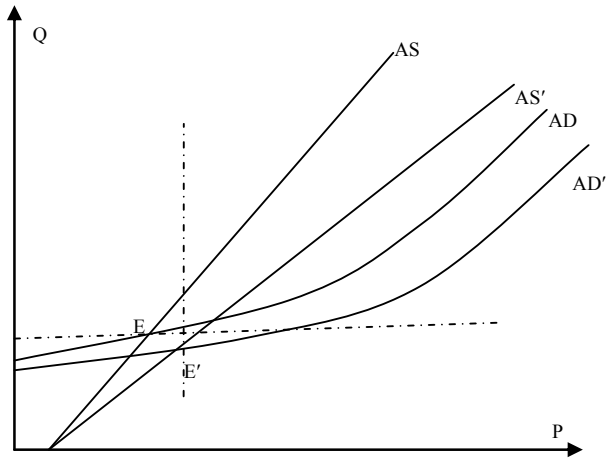

Figure 3. The change of *a*.

against the traditional theory. Let us see how this happens.

In mainstream economics, the general derivation process of AD function starts with

$$Y^d = C\left(Y_d\right) + G + I\left(r\right) \quad \text{(for a closed economy)}$$

where Y_d is disposable income, r is the interest rate decided by money market. In money market, $\frac{\mathrm{d}r}{\mathrm{d}P} > 0$. Because $\frac{\mathrm{d}I}{\mathrm{d}P} = I'\left(r\right)\frac{\mathrm{d}r}{\mathrm{d}P}$, $\frac{\mathrm{d}C}{\mathrm{d}P} = C'\left(Y_d\right)\frac{\mathrm{d}Y_d}{\mathrm{d}P}$, and usually $Y_d = Y^d - T$ (T is tax) and G is considered constant, so $\frac{\mathrm{d}Y^d}{\mathrm{d}P} = \frac{\mathrm{d}I}{\mathrm{d}P}\frac{1}{1-C'\left(Y_d\right)}$. Because $0 < C'\left(Y_d\right) < 1$, $I'\left(r\right) < 0$, so that $\frac{\mathrm{d}Y^d}{\mathrm{d}P} < 0$. In fact, there is a subjective mistake of self-righteousness in the above process of the deduction[2]. That is we consider $Y_d = Y^d - T$ by mistake. Because income roots in production process, while the production process is decided by supply, so actually it should be $\frac{\mathrm{d}C}{\mathrm{d}P} = C'\left(Y_d\right)\frac{\mathrm{d}Y^s}{\mathrm{d}P}$. Because $\frac{\mathrm{d}Y^s}{\mathrm{d}P} > 0$, so $\frac{\mathrm{d}C}{\mathrm{d}P} > 0$. Thus the symbol of $\frac{\mathrm{d}Y^d}{\mathrm{d}P} = \frac{\mathrm{d}C}{\mathrm{d}P} + \frac{\mathrm{d}I}{\mathrm{d}P}$ will be not definite. If we assume that r is constant, and I is the increasing function of Z, obviously we have $\frac{\mathrm{d}Y^d}{\mathrm{d}P} > 0$. Such a conclusion also shows the differences between macroeconomics and microeconomics. Besides very few commodities (such as Giffen commodity), the demand curves in microeconomics should incline down toward right (this is a conclusion under given income). But AD curves in macroeconomics generally should incline up toward right and have the same orientation with AS curves. Looking from the real economy observation, this point is intuitively correct. In macroeconomic level, the rise of price level shows that economic tends to be prosperous, the income will be higher and the demand will also increase. The investment would increase when price level move up. One reason for that mistake in traditional macroeconomics is that it was forgotten that the income determination theory was derived out under aggregate supply equal to aggregate demand when simple Keynesian income determination theory was turned into AS-AD analysis, *i.e.* it assumes $Y^s = C\left(Y^s\right) + I + G$ in advance. It must return to $Y^d = C\left(Y^s\right) + I + G$ when deducing AD function. The total income used in LM model for money market should be the Y when aggregate supply is equal to aggregate demand. A proper macroeconomic analysis framework should be the combination of AD formula, AS formula and the money market formula, and an equilibrium state can be solved from these three formulas, but it is not to add the money market (or general financial market) formula to income determination model at first. The foreign exchange and the international money market should be added in for an open economy. In this paper, we assume the two markets are exogenous, *i.e.* r and e are given.

2.5. The Perturbations of AD and AS

With the AS and AD functions given above, we will make some comparative static analysis based on the perturbations caused by several parameters in the following.

Being equilibrium, $Q^d = Q^s$, therefore the above system satisfies the following equilibrium formula group:

$$Q = Qa + \frac{f_1\left(W,Z\right)}{P} + \frac{f_2\left(r,Z\right)}{P} + f_3\left(Q,e\right) + G \qquad (5)'$$

$$P = k_0 lw \qquad (13)'$$

$$w = P^e F\left(u,z\right) \qquad (6)'$$

$$u = 1 - Ql/L$$

$$Z = \mu PQ \qquad (12)'$$

$$W = Qlw$$

2.5.1. Changes of Government Consumption (G)

Differentiating the above formulas with respect to G, we have

[2]Samuelson reminds people not to commit three mistakes in the introduction of his 'Economics' [5]. They are post hoc fallacy, fallacy of composition and subjectivity. He said let us alert the assuming condition our subjective interest didn't express definitely.

$$\frac{\mathrm{d}P}{\mathrm{d}G}=k_0 l\left(-\frac{P^e l F_u}{L}\right)\frac{\mathrm{d}Q}{\mathrm{d}G}=-\frac{k_0 l^2 P^e F_u}{L}\frac{\mathrm{d}Q}{\mathrm{d}G}=-\frac{(1-u)k_0 l P^e F_u}{Q}\frac{\mathrm{d}Q}{\mathrm{d}G} \tag{18}$$

$$\frac{\mathrm{d}Q}{\mathrm{d}G}=\left[1-a-\frac{f_{1W}}{P}\theta-\frac{f_{1Z}+f_{2Z}}{P}\lambda-\frac{f_1+f_2}{P^2}\frac{(1-u)k_0 l P^e F_u}{Q}-f_{3Q}\right]^{-1} \tag{19}$$

Let

$$B=1-a-\frac{f_{1W}}{P}\theta-\frac{f_{1Z}+f_{2Z}}{P}\lambda-\frac{f_1+f_2}{P^2}\frac{(1-u)k_0 l P^e F_u}{Q}-f_{3Q},$$

then $\frac{\mathrm{d}Q}{\mathrm{d}G}=B^{-1}$.

Because the change of G has no influence on AS and it makes AD increase, thus it should also make the equilibrium gross output increase, namely there should be $\frac{\mathrm{d}Q}{\mathrm{d}G}>0$. Because $F_u<0$, according to Formula (18), there should be $\frac{\mathrm{d}P}{\mathrm{d}G}>0$. Therefore, the expansion of government consumption can make the equilibrium price and equilibrium output increase simultaneously. Thus, according to Formula (19), there should be

$$B=1-a-\frac{f_{1W}}{P}\theta-\frac{f_{1Z}+f_{2Z}}{P}\lambda-\frac{f_1+f_2}{P^2}\frac{(1-u)k_0 l P^e F_u}{Q}-f_{3Q}>0 \tag{20}$$

From the above results, we may also have $\frac{\mathrm{d}Q^s}{\mathrm{d}P}>\frac{\mathrm{d}Q^d}{\mathrm{d}P}$ at the equilibrium point, otherwise $\frac{\mathrm{d}Q}{\mathrm{d}G}<0$ and $\frac{\mathrm{d}P}{\mathrm{d}G}<0$ which is unreasonable. However, when an economy is close to potential production, there will be $\frac{\mathrm{d}Q^s}{\mathrm{d}P}\to 0$ certainly and may have $\frac{\mathrm{d}Q^s}{\mathrm{d}P}<\frac{\mathrm{d}Q^d}{\mathrm{d}P}$ (See **Figure 1**), thus $\frac{\mathrm{d}Q}{\mathrm{d}G}<0$ and $\frac{\mathrm{d}P}{\mathrm{d}G}<0$ may appear. We need introduce the money market and the foreign exchange market to explain or solve this problem. In fact a serious bubble economy appears then and the income no longer originates from production but from speculation or the unusual inflow of foreign exchange. On the other hand, because the economy is close to potential production, there should also be $\frac{\mathrm{d}Q^d}{\mathrm{d}P}\to 0$. Therefore, the possible AS and AD curves may be as that in **Figure 2**.

2.5.2. Changes of Direct Consumption Coefficient (*a*)

Direct consumption coefficient is the characteristic parameter of input-output analysis. By intuition, the increase of a will enhance the marginal cost, thus the price will rise, and equilibrium output reduces possibly. This conclusion is generally correct in microeconomics. We will observe the microeconomic effects with AS-AD model in an input-output system in the following.

Differentiating the equilibrium formulas with respect to a, we have:

$$\frac{\mathrm{d}P}{Ea}=l\left[w\frac{\mathrm{d}k_0}{\mathrm{d}a}+k_0\frac{\mathrm{d}w}{\mathrm{d}a}\right]=\frac{P}{1-a-(1+t_1)\mu}-\frac{(1-u)lk_0P^e F_u}{Q}\frac{\mathrm{d}Q}{\mathrm{d}a} \tag{21}$$

$$\frac{\mathrm{d}w}{\mathrm{d}a}=P^e F_u\left(-\frac{l}{L}\frac{\mathrm{d}Q}{\mathrm{d}a}\right)=-\frac{(1-u)P^e F_u}{Q}\frac{\mathrm{d}Q}{\mathrm{d}a} \tag{22}$$

$$\frac{\mathrm{d}Q}{\mathrm{d}a}=B^{-1}\left[Q+\frac{Z(f_{1Z}+f_{2Z})}{P(1-a-(1+t_1)\mu)}+\frac{P(f_1+f_2)}{P^2(1-a-(1+t_1)\mu)}\right] \tag{23}$$

Obviously it is $\frac{\mathrm{d}Q}{\mathrm{d}a}>0$. Substituting Formula (23) into Formula (21), we might judge immediately that $\frac{\mathrm{d}P}{\mathrm{d}a}>0$. These results are opposite to the microeconomic situation. This may be explained as following. Though the increase of direct consumption coefficient increases the cost, it also enhances the demand simultaneously. From the Formula about $\frac{\mathrm{d}w}{\mathrm{d}a}$, we know that the wage rate will also enhance, thus the consumer demand will also enhance and the investment demand will also increase. Therefore, the final results are that equilibrium output may also enhance simultaneously when the price rises. According to Formulas (16) and (17), the increase of a will make the slope of AS curve decrease and simultaneously the slope of AD curve may increase or decrease (See **Figure 3**). If the reduction of AD curve slope is within a certain range, the equilibrium output still enhances. If the slope of AD curve increases, the equilibrium gross output must increase.

2.5.3. Changes of Labor Productivity

If labor productivity increases (*i.e.* l reduces), an enter-

prise's marginal cost will reduce, thus it will cause the reduction of market price of that product and the increase of equilibrium output. Now let us see the macroeconomic situation.

Differentiating the equilibrium formulas with respect to l, we have

$$\begin{aligned}\frac{\mathrm{d}w}{\mathrm{d}l} &= P^e F_u\left(-\frac{l}{L}\frac{\mathrm{d}Q}{\mathrm{d}l}-\frac{Q}{L}\right)\\ &= -\frac{(1-u)P^e F_u}{Q}\frac{dQ}{dl}-\frac{(1-u)P^e F_u}{l}\end{aligned} \tag{24}$$

$$\begin{aligned}\frac{\mathrm{d}P}{\mathrm{d}l} &= k_0\left[w+l\frac{\mathrm{d}w}{\mathrm{d}l}\right]\\ &= k_0 w-(1-u)k_0 P^e F_u\left(1+\frac{l}{Q}\frac{\mathrm{d}Q}{\mathrm{d}l}\right)\end{aligned} \tag{25}$$

$$\begin{aligned}\frac{\mathrm{d}Q}{\mathrm{d}l} &= B^{-1}\left[k_0 w-(1-u)k_0 P^e F_u\right]\\ &\times\left[\frac{f_{1W}}{P}Q+\frac{(f_{1Z}+f_{2Z})Z-(f_1+f_2)}{P^2}k_0\right]\end{aligned} \tag{26}$$

According to Formula (26), we can judge that $\frac{\mathrm{d}P}{\mathrm{d}l}>0$ from Formula (25) so long as $\frac{\mathrm{d}Q}{\mathrm{d}l}>0$. This means that the increase of productivity (*i.e.* decrease of l) will reduce output and price level. Why does this happen? The reason is that although the enhancement of labor productivity increases the aggregate supply (this can be proven from Formula (15)), simultaneously it also causes the augment of unemployment rate[3] and the decrease of wage rate further. These two kinds of changes will obviously reduce the income, thus it causes the consumption demand reduced and makes the equilibrium aggregate output decrease finally. This conclusion seems to contradict with real situation. This paradox's solution relies on the changes of international market. The increase of labor productivity would enhance export competitiveness and increase export demand obviously, which would influence investment demand in turn, and then equilibrium output was finally augmented. However, the domestic consumption demand would not increase necessarily at the same time[4]. In the 1990s of the productivity increase and economic expansion caused by new economy, for the Expenditure structure of US GDP from 1990 to 2000, the net import proportion increased 2.95 percentage points, the total capital formation increased 1.53 percentage points, the government consumption dropped 2.93 percentage points, and the household consumption reduced 1.56 percentage points. Looking into the structure of income distribution, the Compensation of Employees reduced 2.04 percentage points but the operating surplus (including depreciation of fixed assets) increased 3.8 percentage points (See **Tables 1** and **2** for details). Therefore, how to transform the benefits of productivity increase into the income of ordinary residents and the increase of consumption level needs the support of government incomes policies (including tax policy), otherwise an economy would go to serious imbalance someday.

[3]In Formula (15), it is $P=k_0 lP^e F\left(1-\frac{l}{L}Q^S,z\right)=k_0 lP^e F(u,z)$. Let P = constant, then doing differentiation, thus $F(u,z)+lF_u\frac{\mathrm{d}u}{\mathrm{d}l}=0$. Because $F_u\le 0$, so that $\frac{\mathrm{d}u}{\mathrm{d}l}\ge 0$.

[4]Jorgenson once found, 'comparing the contribution of intermediate input with other source of output growth demonstrates that this input is by far the most significant source of growth. The contribution of intermediate input (for output increase) exceeds productivity growth and the contribution of capital and labor inputs. If we focus attention on the contribution of capital and labor inputs alone, excluding intermediate input from consideration, these two inputs are a more important source of growth than changes in productivity' [6].

2.5.4. Changes of Operating Surplus Rate (μ)

The enterprises' strength would enhance in the labor market when operating surplus increase, which means they can extort more surpluses therefore the aggregate supply would increase. The changes of aggregate demand rely on whether the increase of income caused by supply increase may compensate the income reduction caused by the reduction of labour reward share.

Differentiating the equilibrium formulas with respect to μ, we will deduce

$$\frac{\mathrm{d}w}{\mathrm{d}\mu}=P^e F_u\left(-\frac{l}{L}\frac{\mathrm{d}Q}{\mathrm{d}\mu}\right)=-\frac{(1-u)P^e F}{Q}\frac{\mathrm{d}Q}{\mathrm{d}\mu}$$

$$\begin{aligned}\frac{\mathrm{d}P}{\mathrm{d}\mu} &= \frac{\mathrm{d}}{\mathrm{d}\mu}(k_0 wl)=l\left(k_0\frac{\mathrm{d}w}{\mathrm{d}\mu}+w\frac{\mathrm{d}k_0}{\mathrm{d}\mu}\right)\\ &= l\left(-\frac{(1-u)k_0 P^e F_u}{Q}\frac{\mathrm{d}Q}{\mathrm{d}\mu}+wk_0^2\right)\end{aligned}$$

$$\frac{\mathrm{d}Q}{\mathrm{d}\mu}=B^{-1}\left[(f_{1Z}+f_{2Z})Q(1+\mu k_0)-\frac{k_0(f_1+f_2)}{P}\right]$$

From the above, it has $\frac{\mathrm{d}Q}{\mathrm{d}\mu}>0$, $\frac{\mathrm{d}P}{\mathrm{d}\mu}>0$. Therefore, the increase of surplus proportion causes the equilibrium output to expand.

3. The Explanation of Stagflation Issues

The mainstream economics generally attributes the stag-

Table 1. Total expenditure structure of American economy in the 1990s (%).

	1980	1990	1995	1997	1998	1999	2000
Government consumption	15.23	15.01	13.60	13.00	12.63	12.25	12.08
Household consumption	57.16	59.56	59.58	58.74	58.58	58.40	58.00
Total capital formation	18.06	15.69	15.97	17.00	17.59	17.77	17.22
Total exports	9.09	8.63	9.84	10.32	9.70	9.23	9.43
Net exports	9.55	9.75	10.85	11.25	11.20	11.59	12.70

Note: This table was calculated with the current price data. Data resource: http://www.stats.gov.cn/tjsj/qtsj/gjsj/.

Table 2. Total income distribution structure of American economy in the 1990s (%).

	1980	1990	1991	1992	1993	1994	1995	1996	2000
Indirect tax minus subsidy	7.42	7.45	7.86	7.85	7.92	8.01	7.99	7.73	7.33
Depreciation of fixed assets	13.48	10.84	11.00	10.95	10.65	10.84	10.68	10.47	0.00
Compensation of Employees	61.04	60.35	60.53	60.45	60.17	59.80	60.20	60.05	58.31
Operating surplus	17.58	21.05	20.45	19.99	20.33	20.85	21.14	22.57	35.69
Statistical errors	0.52	0.31	0.18	0.75	0.93	0.52	–0.03	–0.81	–1.33

Note: The operating surplus in 2000 includes the depreciation of fixed assets. Data resource: http://www.stats.gov.cn/tjsj/qtsj/gjsj/.

flation in the 1970s to the oil crisis, and that sort of inflation is called cost-push inflation. Regarding it, Blanchard pointed out that what we face is that Oil price was neither in AS relations nor in AD relations because we assumed that productions use labor force only. One way to deal with this issue is to relax this assumption and to let production simultaneously use labour and other investment (including energy), then the relations of price with wage and oil price can be inferred. However, Blanchard took a shortcut and used the parameter μ to reflect the rise of the oil prices. His principle was that the rise of oil price would increase the production cost for given wage level, which forces enterprises to promote their price level [4].

We must clarify the vague cognition in Blanchard's view at first. Mainstream economics does not assume that production only uses labor, but its rationales are established on the net income principle of "the Trinity". From microeconomics to macroeconomics, they have throughout thought that the essential factors of economic production are labor, capital and land, and sometimes Entrepreneurship was added, which is a fallacy actually. No other than "the Trinity", the output in macroeconomics can be interpreted as national income or GDP. Therefore, it is impossible to explain the phenomenon of stagflation caused by the rapid rise of oil prices in the interior of mainstream economics, saying nothing of explaining the further deep system causes of an economic crisis.

For simplicity, we assume that the oil that an economic system uses is completely imported and its domestic output is zero, thus we have an input-output table as following form.

$$\begin{pmatrix} X & 0 & C & G & I & NX \\ R & 0 & 0 & 0 & 0 & -R \\ W & 0 & & & & \\ T & 0 & & & & \\ Z & 0 & & & & \end{pmatrix}$$

where R represents the oil used as intermediate input. We assume that oil has no other final uses; moreover, the oil import has no immediate influence to the net export of other products. Let $b = R/Q^s$ represent the direct consumption coefficient to oil and the oil price is P_0, then it has

$$\begin{cases} R = Q^s b \\ PX + P_0 R + W + T + Z = PQ^s \end{cases}$$

Obviously R is decided by Q^s.

After adding up on the oil, the equilibrium formula set is as follows

$$\begin{cases} Q = Qa + \dfrac{f_1(W,Z)}{P} + \dfrac{f_2(r,Z)}{P} + f_3(Q,e) + G \\ P = k_0 lw + \dfrac{P_0 b}{1-a-(1+t_1)\mu} \\ w = P^e F(u,z) \\ u = 1 - Ql/L \\ Z = \mu PQ \\ W = Qlw \end{cases}$$

When being equilibrium, $Q^d = Q^s = Q$, then it can be worked out that

$$\frac{\mathrm{d}w}{\mathrm{d}P_0} = P^e F_u \left(-\frac{l}{L}\right)\frac{\mathrm{d}Q}{\mathrm{d}P_0} = -\frac{(1-u)P^e F_u}{Q}\frac{\mathrm{d}Q}{\mathrm{d}P_0} \quad (27)$$

$$\frac{\mathrm{d}P}{\mathrm{d}P_0} = -\frac{(1-u)k_0 l P^e F_u}{Q}\frac{\mathrm{d}Q}{\mathrm{d}P_0} + \frac{b}{1-a-(1+t_1)\mu} \quad (28)$$

$$\frac{\mathrm{d}Q}{\mathrm{d}P_0} = B^{-1}\frac{(f_{1Z}+f_{2Z})Z-(f_1+f_2)}{P^2}\frac{b}{1-a-(1+t_1)\mu} \quad (29)$$

According to Formula (29), if the rise of oil price (P_0) causes the decline of output (Q), it means $(f_{1Z}+f_{2Z})Z-(f_1+f_2) < 0$. But the total price level does not rise necessarily according to Formula (28). The influence factors are quite a lot according to the related parameter group. At the end of the 1960s in America, the unemployment rate (u) is relatively low, and the profit rate (represented by μ) is relatively high, and the labor productivity($1/l$) and the price expectation (P^e) are also quite high, therefore, the negative factors may be even greater and the price level is probable to decline at the beginning. However, because the output and the profit rate declined rapidly, the unemployment rate rises rapidly, and then the labor productivity may decline. When the negative factors rapidly reduce and the price movement transferred into inflation very quickly, thus the stagflation happened. The occurrence of stagflation should be the result of the enterprises transferring cost. If big enterprises willed to reduce profit greatly, inflation might be evaded.

4. Conclusions

Under the single-sector input-output analysis frame, we established an AS-AD model with total output as the main variable, and revealed the right upward characteristics of AD curve[5]. The analysis to some parameters' changes also indicated that the macro- and micro-effects of an economy are remarkable different. They are often opposite[6]. For example, the rise of direct consumption coefficient does not reduce but increases the equilibrium output. It shows that macro economy is not the simple superposition of micro individuals. In the analysis of the labor productivity's changes, we find that the positive role of enhancing labor productivity on equilibrium output lies on some conditions, such as good trade conditions or proper income policy, etc. From the analysis of stagflation, it is found that the oil crisis might not cause stagflation necessarily, but cause the usual decline.

5. References

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[5]In Oliver Blanchard's book, he gave a footnote, "A better name would be 'the goods and financial market equilibrium relation'. But because this is a long name, and because the relation looks graphically like a demand curve (that is, a negative relation between output and the price), it has become traditional to call it the 'aggregate output demand relation'. Be aware, however, that the aggregate supply and aggregate demand relations are very different from regular supply and demand curves". [4] For the reasons what Professor Blanchard said and we said above, I suggest that it is better to give up the name—AS-AD relation (or model) instead of four market (commodity, money or finance, labor and foreign exchange) equilibrium relations in usual textbooks.

[6]In fact, we have already known that the preconditions of macroeconomics and microeconomics are different. Income is fixed in microeconomics and variable in macroeconomics; the consumers are competitive in microeconomics and monopolistic as a collective in macroeconomics. Like the supply function of monopoly in microeconomics, AD and AS are not independent in macroeconomics.

Appendix: A Case of New AS-AD Model

If we assume that:

1) The household consumption is proportional to the total wage, *i.e.* $C = f_1 W/P$;

2) The investment is proportional to the gross operational surplus which equals to depreciation plus net operational surplus, *i.e.* $I = f_2 Z/P$;

3) The net export is proportional to the gross output or aggregate demand, *i.e.* $NX = f_3 Q^d$;

4) The wage rate is inversely proportional to unemployment rate, *i.e.* $w = \frac{k}{u}$;

then we can have the following AD and AS functions:

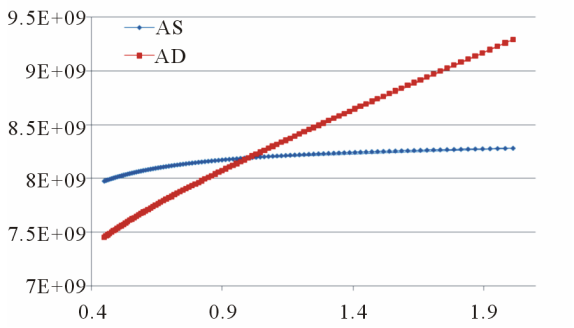
$$Q^d = \frac{Q^s a + \frac{f_1 lk}{P} Q^s \Big/ \left(1 - Q^s l / L\right) + f_2 \mu Q^s + G}{1 - f_3}$$

$$Q^s = \frac{L}{l} - \frac{k_0 k}{P}$$

Based on the input-output table of China 2007 and the data from The Yearbook 2010, we get the values of the parameters as following:

Names of parameters	values	Names of parameters	values
L (10,000 capita)	78,645	a	0.675104232
f_1	0.877373806	l	9.40211E-06
f_2	0.944173563	μ	0.143465228
f_3	0.026281005	G(10,000 yuan)	370,513,349
k_0	7.440972761		
k	300.7959285		

With these values of the parameters, we plot the AS and AD figures as following:



The Input-Output Table of China 2007 (Unit: 10,000 yuan)

	intermediate use	household consumption	government consumption	capital formation	export	import	others	gross output
intermediate input	5,528,151,509	965526184.3	351909186.2	1,109,194,214	955,409,910	740205546.8	18604162.77	81,88,589,620
payment for labor	1,100,473,000							
net production tax	385,187,233							
depreciation	372,555,322							
net operational surplus	802,222,556							
gross input	8,188,589,620							

