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Demand-Side and Supply-Side Equilibria, Old and New

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Abstract

Between the last half of the seventeenth century and the mid-eighteenth century macroeconomic theory reversed itself from a demand-side to a supply-side equilibrium. Policy conclusions reversed themselves correspondingly. For good measure the reversal repeated itself in our own century. The purpose of the paper is to derive such a reversal of one equilibrium into the other as rigorously and as succinctly as possible.

I. INTRODUCTION

1. Macroeconomics--The Oldest Part of Our Building

The term "macroeconomics" was coined in the early twentieth century. But the unnamed concept had been in use since the last half of the seventeenth century. Our founding fathers, i.e., mercantilists like Petty (1662), Mun (1664), and Yarranton (1677), practiced macroeconomics. In the mid-eighteenth century Cantillon (1755) and Quesnay (1759) gave us the first half of microeconomics, i.e., allocation theory. In the last fourth of the eighteenth century Smith (1776) gave us the second half, i.e., price theory.

Two distinct, indeed opposed, forms of macroeconomic equilibria are found in the oldest part of our building.

2. Early Demand-Side Equilibria

The concern of the mercantilists was unemployment. Petty [1662 (1899: 30)] estimated it at ten percent and analyzed it within the framework of a demand-side equilibrium. Here physical output was seen as bounded by demand. Supply was no problem: demand would always create its own supply. There was always excess capacity. The rate of interest was determined by the demand for and the supply of money hence could be affected by the money supply. Petty thought that ample money had reduced the rate of interest to six percent. Yarranton [1677 (1854: 38)] believed that the use of paper money would reduce it to four percent. Petty [1662 (1899: 29-31)] also recommended public works "of much labour, and little art." In short: monetary or fiscal policy could raise physical output and employment. Capitalism left to itself might be incapable of utilizing its own resources. Government action was the remedy.[1]

Within less than a century such a demand-side equilibrium was to reverse itself.

3. Early Supply-Side Equilibria

Hume's concern was inflation, and he analyzed it within the framework of a supply-side equilibrium. Here physical output was seen as bounded by supply. Demand was no problem: supply would always create its own demand. There was never excess capacity. The rate of interest was determined by saving and investment. As a result, Hume [1752 (1875: 321-322)] and Turgot [1769-1770 (1922: 74-76)] agreed, doubling the money supply would not reduce the rate of interest. Hume realized that doubling the money supply of a not fully monetized economy could widen the scope for division of labor hence expand the goods supply. But doubling the money supply of a fully monetized economy, Hume [1752 (1875: 333)] insisted, would merely double prices. Monetary stimuli would simply generate inflation and fiscal stimuli simply crowding-out. Capitalism was entirely capable of utilizing its own resources. Government action, however well meant, was the problem.[2]

4. Purpose

What interests us as historians of theory is not so much the equilibria *per se*. Taking a shorter view, textbooks past and present will identify the particular equilibrium cherished at the time.

What interests us is the reversal--all the more so since it occurred twice in three centuries: it repeated itself in our own century. This time the demand-side equilibria of Keynes (1936) and Hansen (1941) reversed themselves into the supply-side equilibria of Friedman (1968), Lucas (1972), and Sargent (1973).

Can we derive the reversal of a demand-side equilibrium, whether Mercantilist or Keynesian, into a supply-side equilibrium, whether vintage Hume or modern? The purpose of the present paper is to do so as rigorously and as succinctly as possible. We shall use the following notation.

5. Variables

C ≡ physical consumption

D ≡ desired holding of money

E ≡ excess demand in goods market

I ≡ physical investment

L ≡ labor employed

R ≡ tax revenue

r ≡ rate of interest

w ≡ money wage rate

$X \equiv$ physical output

$Y \equiv$ money national income

$y \equiv$ money disposable income

6. Parameters

$A \equiv$ autonomous consumption

$a \equiv$ joint factor productivity

$\alpha \equiv$ elasticity of output with respect to labor

$B \equiv$ autonomous investment

$b \equiv$ inducement to invest

$\beta \equiv$ elasticity of output with respect to capital

$c \equiv$ marginal propensity to consume

$F \equiv$ available labor force

$f \equiv$ inducement to hold speculative money

$G \equiv$ physical government purchase of goods

$J \equiv$ autonomous demand for money

$j \equiv$ propensity to hold transaction money

$\lambda \equiv$ "natural" fraction of labor force employed

$M \equiv$ supply of money

$S \equiv$ physical capital stock

$T \equiv$ tax rate

The price P of goods will be a parameter in a demand-side equilibrium but a variable in a supply-side equilibrium.

II. DEMAND-SIDE EQUILIBRIUM

1. Demand-Side Equilibrium: Solution

A Keynes-Hansen demand-side equilibrium encompassed two markets, a goods market and a money market, and two equilibrating variables, physical output and the rate of interest. It was a partial equilibrium having neither enough markets nor enough equilibrating variables. We write it as follows.

Let us ignore capital consumption allowances. We may then define national income as the market value of physical output:

$$Y \equiv PX \tag{1}$$

Let all such national income be distributed to persons and be taxed once and at the rate T. Then tax revenue is

$$R = TY \tag{2}$$

where $0 < T < 1$.

Define disposable income as national income minus tax revenue:

$$y \equiv Y - R \tag{3}$$

Let consumption be a function of disposable real income:

$$C = A + cy/P \tag{4}$$

where $A > 0$ and $0 < c < 1$.

Let investment be a function of the rate of interest:

$$I = B - br \tag{5}$$

where $B > 0$ and $b > 0$.

Let desired real money holdings be a function of the rate of interest as well as physical output:

$$D/P = J - fr + jX \tag{6}$$

where $J > 0$, $f > 0$, and $j > 0$.

Equilibrium in the goods and money markets requires supply to equal demand:

$$X = C + I + G \tag{7}$$

$$M = D \tag{8}$$

Equations (1) through (8) is a linear system of eight equations in the eight variables C, D, I, R, r, X, Y, and y. Basic algebra easily delivers solutions for physical output and the rate of interest:

$$X = \frac{(A + B + G)f + b(M/P - J)}{bj + [1 - c(1 - T)]f} \tag{9}$$

$$r = \frac{(A + B + G)j - [1 - c(1 - T)](M/P - J)}{bj + [1 - c(1 - T)]f} \tag{10}$$

2. Demand-Side Equilibrium: Policy Conclusions

How sensitive are our demand-side equilibria (9) and (10) to fiscal and monetary policy?

Fiscal-policy instruments are government purchases G and the tax rate T. So take the partial derivatives of (9) and (10) with respect to G:

$$\frac{\partial X}{\partial G} = \frac{f}{bj + [1 - c(1 - T)]f} > 0 \qquad (11)$$

$$\frac{\partial r}{\partial G} = \frac{j}{bj + [1 - c(1 - T)]f} > 0 \qquad (12)$$

So if physical government purchase G is up, so is physical output (9) and the rate of interest (10). The higher rate of interest will discourage investment. Consequently there is some crowding-out. Next take the partial derivatives of (9) and (10) with respect to T. On the latter use (6) with (8) inserted:

$$\frac{\partial X}{\partial T} = - \frac{cfX}{bj + [1 - c(1 - T)]f} < 0 \qquad (13)$$

$$\frac{\partial r}{\partial T} = - \frac{cjX}{bj + [1 - c(1 - T)]f} < 0 \qquad (14)$$

So if the tax rate T is down, both physical output (9) and the rate of interest (10) are up. Again there is some crowding-out.

The monetary-policy instrument is the money supply M. So take the partial derivatives of (9) and (10) with respect to M:

$$\frac{\partial X}{\partial M} = \frac{b/P}{bj + [1 - c(1 - T)]f} > 0 \qquad (15)$$

$$\frac{\partial r}{\partial M} = - \frac{[1 - c(1 - T)]/P}{bj + [1 - c(1 - T)]f} < 0 \qquad (16)$$

So if the money supply is up, physical output (9) is up but the rate of interest (10) is down. We turn to supply-side equilibrium.

III. SUPPLY-SIDE EQUILIBRIUM

1. The Natural Supply of Goods

Modern supply-side equilibria added the missing market and the missing equilibrating variable. The missing market was the labor

market. Here entrepreneurs are demanding labor and are facing diminishing returns to it. Let their production function be of Cobb-Douglas form:

$$X = aL^{\alpha}S^{\beta} \tag{17}$$

where $0 < \alpha < 1$; $0 < \beta < 1$; $\alpha + \beta = 1$; and $a > 0$.

At a frozen capital stock S let purely competitive entrepreneurs maximize their profits with respect to labor employed. Then the real wage rate equals the physical marginal productivity of labor:

$$\frac{w}{P} = \frac{\partial X}{\partial L} = \alpha a L^{-\beta} S^{\beta} \tag{18}$$

Raise both sides to the power $-1/\beta$ and find demand for labor

$$L = (a\alpha)^{1/\beta}\left(\frac{w}{P}\right)^{-1/\beta} S \tag{19}$$

Facing such a demand function, how does labor respond? Friedman's answer (1968) was his "natural" rate of unemployment to which current

labor-market literature adds institutional color: Lindbeck and Snower (1986) and Blanchard and Summers (1988) distinguish between "insiders," who are employed hence decision-making, and "outsiders," who are unemployed hence disenfranchised. Let insiders accept the "natural" employment rate λ where $0 < \lambda \leq 1$. In other words, if $L > \lambda F$ insiders will insist on a higher real wage rate. If

$$L = \lambda F \tag{20}$$

they will be happy with the existing one. If $L < \lambda F$ they will settle for a lower one.

The real wage rate insiders will be happy with, given their natural rate λ of employment, might be called the "natural" one. Find it by inserting (20) into (19) and rearranging:

$$\frac{w}{P} = a\alpha(\lambda F)^{-\beta}S^{\beta} \tag{21}$$

At the frozen capital stock S, then, labor can have a β percent higher natural real wage rate by accepting a one percent lower natural rate λ of employment.

May the actual real wage rate differ from the natural one (21)? It may. For example let a random hence unanticipated expansion of the money supply encourage demand. Let goods prices respond more readily than does the money wage rate and let employers perceive the response sooner than does labor. At first, then, a real wage rate lower than (21) will be perceived by employers but not yet by labor. As a result, actual employment will exceed the natural one (20). Vice versa, let a random hence unanticipated contraction of the money supply discourage demand. At first, then, a real wage rate higher than (21) will be perceived by employers but not yet by labor. As a result, actual employment will fall short of the natural one (20). But, as Friedman (1968) insisted, eventually labor will perceive and respond: new rounds of collective bargaining will restore the equality between the actual and the natural real wage rate, hence the equality between the actual and the natural employment.

According to New Classicals like Lucas (1972), Sargent (1973), and Sargent-Wallace (1975) only such random hence unanticipated variations of the money supply can generate deviations of actual from natural. Systematic variations would be anticipated by better-informed agents acting as if they knew the structure of the model as well as any systematic public policy applied to it. Ill-informed agents would not survive.

At the frozen capital stock S the supply of goods corresponding to the natural rate λ of employment might be called the "natural" one.[3] Find it by inserting (20) into (17):

$$X = a(\lambda F)^{\alpha} S^{\beta} \tag{22}$$

2. Supply-Side Equilibrium: Solution

At a frozen price P there is no reason why such a natural supply (22) should coincide with our demand-side equilibrium (9). There may well be positive or negative excess demand defined as the difference between the right-hand sides of (22) and (9):

$$E \equiv \frac{(A + B + G)f + b(M/P - J)}{bj + [1 - c(1 - T)]f} - a(\lambda F)^{\alpha} S^{\beta} \tag{23}$$

But modern supply-side equilibria also added the missing equilibrating variable enabling (22) to coincide with (9): unfreeze price P, then positive excess demand will raise price and keep raising it as long as $E > 0$, and negative excess demand will lower price and keep

lowering it as long as $E < 0$. Now excess demand (23) is itself a function of price:

$$\frac{\partial E}{\partial P} = - \frac{b}{bj + [1 - c(1 - T)]f} \frac{M}{P^2} \tag{24}$$

Since (24) is negative, a higher price will reduce excess demand and a lower price raise it.[4] Find the price at which excess demand will vanish by setting (23) equal to zero and solve for P:

$$P = bM/H, \text{ where} \tag{25}$$

$$H \equiv a(\lambda F)^{\alpha} S^{\beta} \{bj + [1 - c(1 - T)]f\} - (A + B + G)f + bJ$$

The new equilibrating variable P also occurred in our demand-side equilibrium solution (10) for the rate of interest. To find the supply-side equilibrium solution for the rate of interest insert (25) into (10):

$$r = \frac{A + B + G - a(\lambda F)^{\alpha} S^{\beta} [1 - c(1 - T)]}{b} \tag{26}$$

Policy conclusions drawn from such supply-side equilibria will reverse the policy conclusions drawn from our demand-side equilibria (9) and (10). Let us draw them.

3. Supply-Side Equilibrium: Policy Conclusions

How sensitive are the new supply-side equilibria (22), (25), and (26) to fiscal and monetary policy?

Fiscal-policy instruments are government purchases G and the tax rate T. So take the partial derivatives of (22), (25), and (26) with respect to G:

$$\frac{\partial X}{\partial G} = 0 \tag{27}$$

$$\frac{\partial P}{\partial G} = f\,\frac{P}{H} > 0 \tag{28}$$

$$\frac{\partial r}{\partial G} = \frac{1}{b} > 0 \tag{29}$$

So if physical government purchase G is up, so is price (25) and the rate of interest (26), but physical output (22) is unaffected. The higher rate of interest will discourage investment--but more than it did in the demand-side equilibrium: since physical output (22) is unaffected in the supply-side equilibrium, investment must be down by as much as government purchase is up. The crowding-out is complete. Next take the partial derivatives of (22), (25), and (26) with respect to T:

$$\frac{\partial X}{\partial T} = 0 \tag{30}$$

$$\frac{\partial P}{\partial T} = - acf(\lambda F)^{\alpha} S^{\beta} \frac{P}{H} < 0 \tag{31}$$

$$\frac{\partial r}{\partial T} = - \frac{ac(\lambda F)^{\alpha} S^{\beta}}{b} < 0 \tag{32}$$

So if the tax rate T is down, both price (25) and the rate of interest (26) are up, but physical output (22) is unaffected.

The monetary-policy instrument is the money supply M. So take the partial derivatives of (22), (25), and (26) with respect to M:

$$\frac{\partial X}{\partial M} = 0 \tag{33}$$

$$\frac{\partial P}{\partial M} = \frac{b}{H} > 0 \tag{34}$$

$$\frac{\partial r}{\partial M} = 0 \tag{35}$$

So if the money supply is up, price (25) is up in proportion, but physical output (22) and the rate of interest (26) are unaffected--as Hume (1752) had said they would be.

IV. SUMMARY AND CONCLUSION

A demand-side equilibrium encompassed two markets, a goods market and a money market, and had two equilibrating variables, physical output and the rate of interest. There was no price mechanism: price was a parameter. At that price industry would always produce a physical output matching demand. We have seen such a demand-side

equilibrium (9) as a partial one having neither enough markets nor enough equilibrating variables.

A supply-side equilibrium adds the missing market, i.e., a labor market. Here entrepreneurs demand labor and are facing diminishing returns to it at a frozen physical capital stock. Consequently their demand for labor (19) is a function of the real wage rate. Facing such a demand function, unions choose the natural rate of employment (20). The natural rate (20), in turn, determines a unique natural supply of goods (22).

Such a supply-side equilibrium also adds the missing equilibrating variable, i.e., price. An unfrozen price will enable the natural supply (22) to coincide with the demand-side equilibrium (9) and will reverse both fiscal-policy and monetary-policy conclusions.

In a demand-side equilibrium larger government purchases or a tax cut had raised physical output and the rate of interest: crowding-out was incomplete. In a supply-side equilibrium larger government purchases or a tax cut raise price and the rate of interest but leave physical output unaffected: crowding-out is complete.

In a demand-side equilibrium a larger money supply raised physical output and lowered the rate of interest: there was crowding-in. As Hume had observed, in a supply-side equilibrium a larger money supply raises price proportionately but leaves physical output and the rate of interest unaffected: there is neither crowding-out nor crowding-in.

Our demand-side and supply-side equilibria were both static equilibria in the sense that capital stock S was assumed to be frozen--as in early new classical macroeconomics.

The present paper will not go beyond such statics. But in closing we do observe that in the form of derivatives with respect to time inherent dynamics kept creeping into macroeconomics, at first only as afterthoughts. The Phillips curve took the derivative of the money wage rate with respect to time. The augmented Phillips curve added the derivative of price with respect to time. The government budget constraint took the derivatives of the money and bond supplies with respect to time. Growth theory went beyond the afterthoughts and took the derivatives of <u>all</u> its variables with respect to time. Capital stock was unfrozen, and its derivative with respect to time was the definition of investment.

FOOTNOTES

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1. Further documentation in Brems (1986: 19-24).

2. Further documentation in Brems (1986: 33-37).

3. Hume, to be sure, knew neither unions nor insiders. But if reflecting the equality sign of our $0 < \lambda \leq 1$, i.e., full employment, eighteenth-century institutions would still generate a unique natural supply of goods (22).

4. This is true even in our absence of a real-balance effect--and even more so in the presence of one.

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