Will World Economies Stabilize?

by

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2009m04d05

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Introduction

This paper considers the traditional argument offered in introductory economic texts concerning the tendency of pricing and supply / demand to seek a balance or equilibrium point in the absence of interference (see the following section for a typical example). The argument assumes that, because the information used to adjust an imbalance is applied so as to oppose the error, the system will eventually converge to the desired equilibrium point.

Unfortunately this is not always true. There is a technical discipline used extensively in engineering applications called "Feedback Control Theory"[A,B] which deals with situations like this in a general and mathematically precise way. This theory indicates that opposing or "negative" feedback can, in fact, result in systems that either oscillate or even diverge from the desired result if certain conditions are met. But these critical constraints are not addressed in economic arguments.

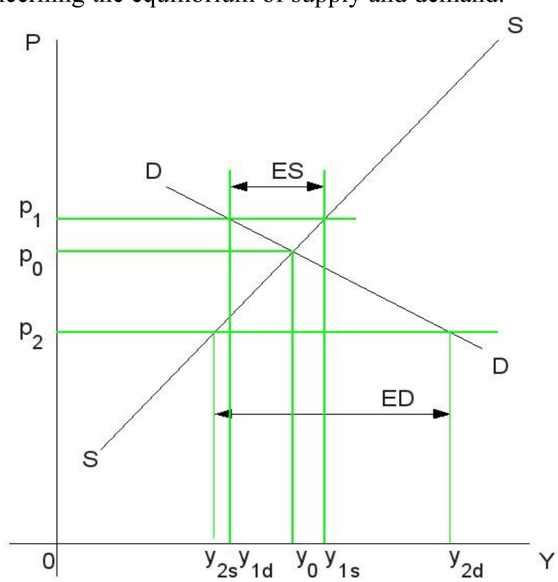
The following discussion is an elaboration of this problem. It is intended to show clearly that the elementary economic analysis is overly simplistic, what general conditions will cause problems, and relevance to today's economic situation.

Excerpt Illustrating the Traditional Economic Argument

The following is an excerpt from an introductory economics text[C] concerning the equilibrium of supply and demand.

From page 29, 2nd paragraph...

"Given a competitive market, we can say that the price of a good will tend to a level which equates the total quantity demanded of the good with the total quantity supplied. This is the equilibrium price. Suppose in a particular market for some good, that DD is the demand and SS the supply curve as shown in Figure 3-3. With the given demand and supply curves, the equilibrium price, in Figure 3-3, is p_0, with the total quantity demanded and supplied per period of time equal at y_0."



The Equilibrium Price

Figure 3-3 (numbered from quoted source)

"If the price is not at the equilibrium point, will it tend to move to equilibrium or will it remain above or below the equilibrium level? Suppose the price in the market is above the equilibrium level, say at p_1 dollars per unit, in Figure 3-3. At this price the suppliers in the market are willing to supply y_{1s} units per period, but the buyers in the market only desire to purchase y_{1d} units per period. There is an excess supply of y_{1s} - y_{1d} units per period, designated as ES in Figure 3-3. The excess supply will generate pressure to reduce prices, since the sellers can dispose of their unsold surpluses only at lower prices. The competition between sellers to dispose of their surplus stocks will cause any price above p_0 to fall. As the price falls toward the equilibrium level, the excess supply will gradually diminish, partly because at lower prices suppliers will put a smaller quantity on the market and partly because at lower prices the buyers will take a larger quantity of the good off the market."

"Similarly, if the price is below the equilibrium level, say at p_2, in Figure 3-3, there is an excess demand for the product, equalt to y_{2d} - y_{2s} units per period, ED in the figure. In this situation more is being demanded than is being supplied to the market, and some potential buyers are unable to purchase the good at the current price, but are willing to pay a higher price. These would-be buyers raise their bids in an effort to obtain the product. Thus the competition between buyers tends to increase the price under conditions of excess demand."

etc.

The essence of this argument is repeated in the following simple example, but the argument is broken down into smaller steps to illustrate the problems. Three cases with different outcomes arise instead of just one.

A Simple Example

Referring to Figure 1...

Case 1: Suppliers Use Raw Market Demand Data

- Step 1: Suppose the supply is currently at point F5. Suppliers find they cannot sell their production, and measure the demand at B. They wish to remain on the supply curve (which they know), so they move to point B1 for the next round of production.

- Step 2: Seeing the reduction in price to level 1, consumers attempt to buy F units per week, but find it is not available. They create backorders in demand equal to F - B, the difference of the supply and demand curves at price level 1.

- Step 3: Seeing the insufficient supply, suppliers again adjust their production to the point F5 on the demand curve, completing the cycle.

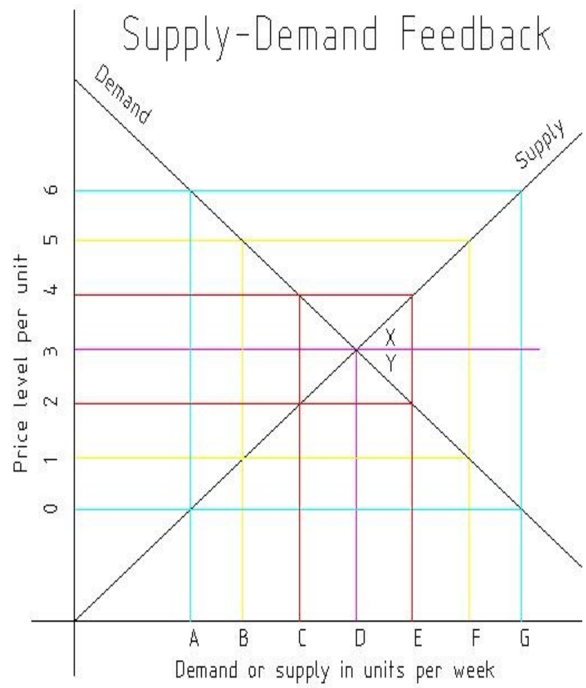


Figure 1

- Discussion of Case 1: The important feature of this case is that the system does not converge to the equilibrium point, D3, but cycles perpetually between the operating points F5 and B1.

Case 2: Suppliers Correct Production by More Than the Measured Discrepancy

- Step 1: To illustrate this case we start at point E4. Instead of using the measured demand, C, and correcting production by E – C, the supplier over-corrects production, and moves to point B1.

- Step 2: Consumers now face the same situation described in Step 2 of Case 1. This produces a measured discrepancy of F - B, which is bigger than the first estimate.

- Step 3: If suppliers over-correct again, following a consistent policy, they would move to production G, at price level 6.

- Discussion of Case 2: When operated under this strategy the system gets farther away from D3 with every cycle. The divergence would continue until either production or demand reaches zero, at which point the market collapses in ruin.

Case 3: Suppliers Correct Production by Less Than the Measured Discrepancy

- Step 1: This analysis begins at point G6. However, instead of correcting by the full amount of the discrepancy, G - A, suppliers move to the point B1, correcting by G – B instead.

- Step 2: Consumers again generate backorders, but only by the amount F – B. The discrepancy has been reduced from it's original value G – A.

- Step 3: Suppliers again correct by less than the measured error, and select a production point E4, which is closer to the equilibrium point D3 than the first correction choice B1 of Step 1.

- Discussion of Case 3: This is the strategy described in the traditional analysis, *viz*., the system spirals in to D3. The eventual result is a balance between supply and demand, at a single price.

A More General Example

The simple example of the previous section actually is a special case in regard to the slopes of the supply and demand curves. In Figure 1 the angles X and Y are equal. In a more general case these angles are not necessarily equal.

In Case 1 above the suppliers used raw market demand data without any adjustment. Suppose we follow that same strategy but in situations with unequal angles. Once more three cases arise: the demand curve slopes more, the same, or less than the supply curve. If one works through the geometry it becomes apparent that the indicated strategy converges if, and only if, the slope of Demand is greater than that of Supply (Y > X). Once again, only one of the three cases converges, and the rate of convergence depends heavily on the relative slopes of the curves.

As if these difficulties weren't enough, both these examples assumed straight lines for both Demand and Supply. In the real world these well may not be straight, with all that implies in regard to the complexity of suppliers' calculations.

Stability Analysis

It should be clear from these convergence problems that the traditional analysis of market behaviour is over-simplified. In both examples two of three cases would not converge to the point D3, but would either cycle around it indefinitely or move farther away.

It might seem obvious that a rational supplier would elect to use a strategy that, theoretically, should converge. However, the real situation is that the demand curve may not be known. Furthermore, because real markets involve many suppliers, many consumers, and the ability to use substitute products the demand curve may shift between assessment cycles. Like the stock market, historical data is not necessarily a predictor of future behaviour. In other words, any attempt to use measured data is subject to significant error, which may switch the situation between the cases illustrated above. Also, changes in pricing or availability of inputs may cause the supplier to move his supply curve, again unpredictably and with potential consequences in regard to stability.

Thus, despite a supplier's best intentions, a discrepancy between supply and demand does <u>not</u> guarantee a situation that will converge. The effort to find the equilibrium point, D3, is subject to many and variable errors that may create an unstable situation of serious magnitude.

An Alternative Perspective: Feedback Theory

From a more abstract perspective: the correction strategy in this single product example is iterative. The output of a given production run is placed on the market by the supplier, and withdrawn by the consumer. In order to adjust production for the next cycle the supplier collects information about the net result of the current one. Note that this information is applied in principle in such a way as to oppose or correct the error...an excessive production rate is reduced, a deficient one increased...in an attempt to move to the equilibrium point.

These strategies are particular examples of a generic theoretical discipline called “feedback control”, wherein information about the output of a process is fed back into, and used to control, the subsequent production of that output. The strategy is called “negative feedback” because the normal effect of feedback information opposes imbalance or error in the system.

As we saw in two of the three cases above, however, negative feedback does not guarantee the system will converge despite the intuitive conclusion that it will. Conventional economic theory, such as that quoted in the excerpt, does not acknowledge this problem, and assumes on the basis of the qualitative analysis that all will be well because the feedback is negative.

Instability arises from two sources. One is the “gain”, or multiplier applied to adjust the raw measured data. The three cases considered in both examples above are distinguished by different gains. As we saw in the simple example, if the gain was unity or above the system did not converge. The other, less conspicuous, problem is the time delay inherent in getting feedback information into the control cycle.

The Hazard Arising From Time Delay

Consider someone pushing a swing that is already moving. Pushes are synchronized with the natural motion of the swing by watching the motion and intervening at appropriate times. This is a feedback system, just like the economic examples above but with an additional feature over our examples of the system having cyclic behaviour.

Assume that the swing is currently moving too slowly. Negative feedback would consist of pushing <u>with</u> existing motion on every cycle, thus increasing the range of motion (the “amplitude”) and speed over several cycles, correcting the “error”. But, if these same pushing actions are simply advanced so that they act <u>against</u> existing motion the amplitude and speed decrease over several cycles, aggravating the error. This is positive feedback. The simple act of changing the timing of the periodic actions for negative feedback, with no other change, turns it into positive feedback.

In this example pushes are applied at the same point in every cycle. That is, the frequency of feedback is the same as the frequency of the basic motion. In the general case, including economic systems, these frequencies don't have to correspond. If this mismatch occurs the behaviour of the system will be even more complex, and harder to analyse and control.

Again, time delay is not considered in the traditional elementary economics argument[1]. Yet we have more uncertainty entering the system from this source. Is there a natural oscillation in the demand? What behaviour results if the frequencies don't match exactly? Will the supplier amplify a natural oscillation by not timing his (oscillating) response correctly?

Discussion

The foregoing clearly illustrates that the traditional economic argument is overly simplistic in that it ignores the influence of both gain and time delay on stability. Lacking more advanced training in economics I don't know whether this problem is carried through at more advanced levels, but the fundamental complexity of the economic system virtually guarantees great difficulty. In any case the simplistic argument is misleading at best, and possibly catastrophic if the hazards of feedback are not recognized formally in more advanced work.

The example considered deals with a single supplier of a single product, with (possibly) several consumers of that product, which is idealized to a degree comparable to that assumed in the excerpt. The same conclusions concerning instability, however, likely apply on a statistical basis to markets as a whole. Models of the real situation rapidly become intractable due to the sheer quantity of trade activity and difficulty in measuring it. This prevents rigourous demonstration or precise prediction, but the observed “business cycle” (an oscillation) and occasional instability clearly suggests relevance of feedback theory to economic problems.

From a “macroeconomic” perspective: one[2] of the primary roles of money is to serve as a medium of exchange. In essence money is just another commodity in this role. In the current global economic situation many governments and major financial institutions are injecting money into their economic systems. They are acting as suppliers in the above analysis, with general economic activity identified with demand. Let us all hope they don't drive entire economies in the world into instability by getting either gains or timing wrong in the months and years to come.

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1 As an aside: this also appears to be the problem in Russell's Paradox from set theory.
2 Money also serves two other relevant functions. See the appendix for brief comments.

References

A) Applied Digital Control, 2nd Edition, by J. R. Leigh. Published by Dover Publications, 2006

B) Feedback Control System Analysis and Synthesis, by John J. D'Azzo and Constantine H. Houpis. Published by McGraw- Hill Book Company, 1960

C) Economics: An Analytic Approach, by Ralph K. Davidson, Vernon L. Smith, and Jay W. Wiley. Published by Richard D. Irwin Inc. 1958

Acknowledgement: My sincere thanks go to my companion, Tannis Ewing, for her encouragement, helpful suggestions, and proof reading of the paper. All responsibility, of course, remains mine.

Appendix

Money actually serves three functions that are important to individuals in the context of the current world situation:

1. as a medium of exchange. Feedback management is critical for the this function, as discussed above.
2. as a “unit of account”, much as the metre is a unit of distance or the second is a unit of time.
3. as a store of wealth over time.

While feedback management is critical only for function 1, it is unsettling to consider the implications of macroeconomic “stimulus” intervention on the other two as well.

Concerning function 2:

Changes in this role are, perhaps, familiar when a price in 2009 dollars is corrected to, say, the price for the same commodity in 1990 dollars for comparison of “real” value. Accurate and reliable measurement of economic indicators becomes more important than normal under crisis conditions. From this perspective it is disturbing to realize that the time of a crisis is the worst time to take actions that will alter the size of the measurement unit, yet that is one significant effect of altering the money supply through the stimulus packages.

Concerning function 3:

This role is important to anyone attempting to save or borrow. Other things being equal, the injection of money ultimately results in a general increase in prices, frequently called “inflation”. Anyone saving money pays for an investment in today's dolllars, but receives the principle repayment in inflated dollars, thus incurring an inconspicuous loss of wealth. Borrowers, however, get to spend the borrowed money at the time it is invested, getting full value.

To add insult to injury, if part of the interest earned is used to compensate for inflation loss that interest is taxed as if it were true earnings.

The stimulus actions of financial institutions effectively transfer saved wealth to money used as a medium of exchange. If the stimulus money is not withdrawn from the economy at an appropriate later time, to counter the implied inflation precisely in line with feedback stability considerations, wealth is transferred within the society by the action. Savers usually lose. Financial institutions (both private and government), being the first in line to spend borrowed money, usually win.

Is it any wonder people lose confidence and trust in the value of money, or the institutions that manage it?

But *c'est la vie*. We live in interesting times!