SHORT COMMUNICATION

Interpreting employment in a recession using an epidemiological model

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Interpreting employment in a recession using an epidemiological model

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Abstract: This note suggests that the employment characteristics in a typical recession are somewhat similar to the disease characteristics found in an epidemic. Preliminary numerical results indicate that the model may have some validity.

Subjects: Engineering Management, Mathematical Modeling, Economics, Finance, Business & Industry, Education, Technology

Keyword: employment characteristics in a recession

This note interprets the employment characteristics found in an individual economic recession using a model that has been used in the past to describe the characteristics of epidemics of various diseases. It appears that both recessions and epidemics do have some similar characteristics in that they both seem to recur at various times with little remembrance of the previous occurrence and each episode usually reoccurs on a rather slow timescale which we will indicate with the independent variable τ. In the past according to records compiled by Wells Fargo Bank, this separation time τ for recessions is of the order of a decade or so. Within an individual recession, populations of employed people may become unemployed and these unemployed may in turn somewhat discourage the remaining employees who are still employed or if unemployed, hopefully become reemployed. The variable of time within a particular recession will be t and this time which is typically measured in weeks or months is significantly less than the interval between recessions and one can usually assume that $t \ll \tau$.

The purpose of this note is to suggest a model that has been used in epidemiology to describe the disease characteristics in an epidemic can possibly be reinterpreted to describe the employment characteristics in a recession. In a disease, a certain proportion of the total population S is susceptible to becoming ill and therefore becoming an infected population I which could possibly in turn infect members of the healthy community. Eventually, the infected population hopefully recovers and becomes a recovered population R. The description of the three populations during the epidemic has been described by Kermack and McKendrick (1927) and is now known as the SIR model in epidemiology

ABOUT THE AUTHOR

Karl E. Lonngren was born and raised in South Milwaukee, Wisconsin before receiving his BS, MS, and PhD degrees in Electrical Engineering from the University of Wisconsin-Madison. After a postdoctoral research appointment at the Royal Institute of Technology in Stockholm, he joined the faculty at the University of Iowa where he presently is an Emeritus Professor. In his career, he has carried out research throughout the world, mainly examining nonlinear waves in plasmas and has published more than 230 scientific articles and several books.

PUBLIC INTEREST STATEMENT

This short note suggests that a model that was first introduced by Kermack and McKendrick in epidemiology to describe the temporal evolution of sickness in the healthy population and their subsequent recovery in an epidemic can also be interpreted in terms of the employment characteristics in a recession.

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(Kermack & McKendrick, 1927). As an example of the separation of timescales in epidemiology, a typical measles epidemic could have a temporal duration of weeks or months and the interval before the next outbreak would have a temporal separation of four or five years.

The employment characteristics of the temporal evolution of the three populations that occur in the nth individual recession at the time $\tau = \tau_n$ can be interpreted in terms of the proposed employment model with the three first-order ordinary differential equations.

$$\frac{dE}{dt} = -\beta UE$$

$$\frac{dU}{dt} = \beta UE - \nu U \qquad (1)$$

$$\frac{dR}{dt} = \nu U$$

where the dependent variable E represents the population of fully employed members, U represents the population of unemployed members and R represents the population of members who have been reemployed in the recession. The term βU reflects the proportion of the unemployed population who may subsequently discourage members of the employed community which in turn will cause a reduction in the employed community in that particular recession. The constants β and ν, respectively, represent the rate of populations being laid-off or being rehired in the recession. The coefficient β could also have a negative value if one interprets rumors of impending layoffs in the company cause the remaining employees to work harder in the hope of impressing the supervisor that their particular employment is required.

The proposed simplified model is labeled as being the EUR model since it is very similar to the SIR model in epidemiology (Kermack & McKendrick, 1927). The simplification that is made is assuming that the constants β and ν will have numerical values rather than being functions that depend nonlinearly upon the dependent variables.

Adding the three equations in Equation 1, we find that

$$\frac{dE}{dt} + \frac{dU}{dt} + \frac{dR}{dt} = \frac{d(E+U+R)}{dt} = 0 \qquad (2)$$

which has the solution

$$E + U + R = N(\tau_n) \qquad (3)$$

This states that the total population of employed E, unemployed U, and reemployed R members in a particular recession is equal to a constant $N(\tau_n)$. This result supports the validity of the model in Equation 1. As time goes on to the next recession at the time $\tau = \tau_n + 1$, this number may either increase, remain the same, or decrease. This model assumes that the details of an individual recession are independent of the previous or subsequent recession.

Arbitrarily selecting values for the numerical constants of

$$\beta = 0.5 \text{ and } \nu = 0.3$$

we numerically solve the three equations. Choosing the initial conditions at the nth recession to have the normalized values of 99% employed and 1% unemployed, where the normalization parameter is given in Equation 3

$$E(\tau = \tau_n) = 0.99 \text{ and } U(\tau = \tau_n) = 0.01$$

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Figure 1. Evolution of the employed, unemployed, and reemployed populations as a function of time in a particular recession. All values are normalized by Equation 3.
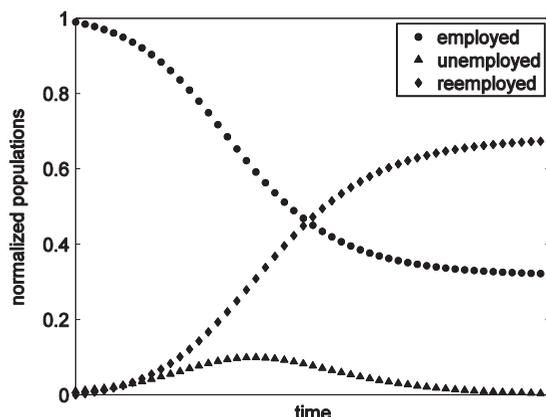
we obtain the behavior for the three normalized populations as shown in Figure 1. As the fully employed population E becomes unemployed, there will be a slow increase in the unemployed population U until the employment recurs and the reemployed population R increases as the recession dissipates.

Just as epidemics of various diseases such as measles or malaria appear and disappear in the temporal evolution of mankind, we speculate that economic recessions and recoveries will follow a somewhat similar pattern in time. The simplified model that has been proposed here can be used to describe such an evolution. A more detailed analysis would include more correct numerical values for the constants and also introducing nonlinear functions which would replace the assumed constant values for β and ν that appear in our preliminary numerical analysis. There does not appear to be an a priori reason to assume that there will be a periodicity in the long-time behavior in the occurrence of a recession.

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