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Volatility**

Amnon Levy

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A NOTE ON INCOME INEQUALITY AND MACRO-ECONOMIC VOLATILITY

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Abstract

Income inequality may influence macro-economic variables by affecting the money multiplier and the trade-off between inflation and output. In an AD-AS model with imperfect foresight income inequality intensifies the volatility of output and inflation rate by increasing the likelihood of oscillations as well as their magnitude. Volatility is, however, moderated when income inequality prolongs the business cycles.

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A NOTE ON INCOME INEQUALITY AND MACRO-ECONOMIC VOLATILITY

1. Introduction

During the last quarter of the twentieth century many countries suffering from low and fluctuating rate of growth and high and largely fluctuating inflation rates were characterized by a high degree of income inequality. At the same period, in contrast, many countries experiencing a steady rate of growth and low and moderately oscillating rate of inflation also enjoyed low levels of income inequality. A significant number of Latin American countries including Argentina, Brazil, Mexico and Uruguay are notable examples of the first group of countries. The technologically advanced European countries such as Germany, Norway, Sweden and the United Kingdom represent the second.

Is there a causal relationship underlying the high correlation between macro-economic volatility and income inequality?

One may argue that the high correlation between macro-economic volatility and income inequality can be attributed to the effect of the former factor on the latter: namely, severe fluctuations in major aggregate economic variables raise the levels of uncertainty, confusion, and employment instability, which, in turn, widen the income gap between those endowed with large stocks of human and physical capitals and those possessing small stocks of these capitals, especially when human and physical capital stocks are highly correlated.

Is it possible that causality also flows in the opposite direction and income inequality intensifies macroeconomic volatility?

Recent studies suggest that it is possible. Alesina and Perotti (1996) argue that income inequality has an indirect effect on macroeconomic volatility via increased political instability. Aghion, Banerjee and Piketty (1997) propose that inequality also means unequal access to investment opportunities and combined with a high level of capital market imperfection may generate persistent credit cycles. In this context, Aghion, Caroli and Garcia-Penalosa (1999) claim further that inequality of access to high-yield investment opportunities and the consequent separation of investors and savers generates macro-economic volatility.

Are there other channels through which inequality, and income inequality in particular, may cause macroeconomic volatility?

This note suggests that income inequality reduces: 1. the aggregate propensity to consume and thereby the money multiplier, and 2. the trade-off (on the supply side) between inflation and output. The implications of these possible effects on the business cycles are theoretically illustrated within a standard AD-AS macro-economic model with imperfect inflationary expectations. Section 2 uses this model as a benchmark for generating business cycles. Section 3 provides a rationale for the possible moderating effect of income inequality on the money multiplier and the inflation-output trade off. Section 4 shows that income inequality might intensify macro-economic volatility by increasing both the likelihood of oscillations in the output and inflation rate trajectories and by enlarging the magnitude of these oscillations. As the likelihood of business cycles oscillations and their magnitude are not the sole aspects of instability, the analysis also introduces the possible effects of income inequality on the length of the business cycles. Section 5 suggests that macro-economic volatility may be moderated by the possible effect of income inequality to prolong the business cycles. Section 6 concludes.

2. Business cycles in an imperfect foresight augmented AD-AS model

Although the AD-AS model is criticised for lacking microeconomic foundations, for excluding perfect nominal adjustment, and for focusing on the quantity of money rather than the interest rate as the central banks' policy instrument (Romer, 2000), its simplicity rendered it a comprehensible, wide, baseline framework for analysing short-run fluctuations of output and prices. In a standard AD-AS model (Dornbusch and Fischer, 1978) the aggregate supply schedule is given by

$$\mathbf{p} = \mathbf{p}^* + \mathbf{d}(Y - Y_p) \quad (1)$$

and the aggregate demand schedule by

$$Y = Y_{-1} + \mathbf{g}f + \mathbf{f}(m - \mathbf{p}) \quad (2)$$

where Y is the output level, Y_p is the potential output level, \mathbf{p} is the actual inflation rate, \mathbf{p}^* is the expected inflation rate, f is the increase in autonomous spending, m is the growth rate of nominal money stock, \mathbf{g} is the fiscal multiplier, \mathbf{f} is the money multiplier and \mathbf{d} is a positive parameter reflecting, on the supply side, the short run trade-off between inflation and GNP.

Imperfect inflationary expectations are essential for generating business cycles in the AD-AS model. As in Cagan (1956), the public inflationary expectations are assumed here to be adaptive: namely, adjusted to the last period unanticipated rate of inflation

$$\mathbf{p}^* - \mathbf{p}_{-1}^* = \mathbf{b}(\mathbf{p}_{-1} - \mathbf{p}_{-1}^*) \quad (3)$$

where $0 < \mathbf{b} < 1$. This adaptive inflationary expectations can be equivalently rendered by

$$\mathbf{p}^* = \frac{\mathbf{b}}{1 - (1 - \mathbf{b})L} \mathbf{p}_{-1} \quad (4)$$

where L denotes the lag operator.

By substituting equation (4) into equation (1) the aggregate supply scheduled can be now expressed as

$$\mathbf{p} - \mathbf{p}_{-1} - \mathbf{d}Y + (1 - \mathbf{b})\mathbf{d}Y_{-1} = -\mathbf{d}\mathbf{b}Y_p. \quad (5)$$

By pre-multiplying both sides of the system of equations (5) and (2) by the inverse of the matrix of the coefficients associated with the current output level and inflation rate, the adaptive expectation augmented AD-AS model can be expressed as a system of two first-order difference equations whose solution is

$$\mathbf{p}_t = m + a_{11}\mathbf{I}_1^t + a_{12}\mathbf{I}_2^t \quad (6)$$

and

$$Y_t = Y_p + a_{21}\mathbf{I}_1^t + a_{22}\mathbf{I}_2^t \quad (7)$$

where,

$$\mathbf{l}_1 = \frac{1}{2(1+\mathbf{df})} \{2 + \mathbf{df}(1-\mathbf{b}) + \sqrt{[\mathbf{df}(1-\mathbf{b})]^2 - 4\mathbf{dfb}}\} \quad (8)$$

$$\mathbf{l}_2 = \frac{1}{2(1+\mathbf{df})} \{2 + \mathbf{df}(1-\mathbf{b}) - \sqrt{[\mathbf{df}(1-\mathbf{b})]^2 - 4\mathbf{dfb}}\} \quad (9)$$

and $a_{.1}$ and $a_{.2}$ are the eigenvectors associated with the eigenvalues \mathbf{l}_1 and \mathbf{l}_2 , respectively.

The trajectories of inflation rate and output display oscillations when the discriminant in equations (8) and (9) is negative, in which case \mathbf{l}_1 and \mathbf{l}_2 are complex conjugate pair. This is the case where

$$\frac{4\mathbf{b}}{(1-\mathbf{b})^2} > \mathbf{df}. \quad (10)$$

Condition (10) is satisfied, for example, in the limiting case of naïve inflationary expectations ($\mathbf{b} = 1$). When this condition is fulfilled, the stationary point of inflation rate m and output Y_p is a spiral and the deviations of the current inflation rate and output from their stationary levels are given by

$$\mathbf{p}_t - m = \tilde{a}_1 \left[\frac{1}{1+\mathbf{df}} \right]^{0.5t} \cos(\mathbf{y} + \mathbf{q}t) \quad (11)$$

$$\mathbf{p}_t - m = \tilde{a}_2 \left[\frac{1}{1+\mathbf{df}} \right]^{0.5t} \cos(\mathbf{y} + \mathbf{q}t) \quad (12)$$

where the complex roots' amplitude, \mathbf{q} , satisfies

$$tgq = \left\{ \frac{4(1 + df)}{[2 + df(1 - b)]^2} - 1 \right\}^{0.5} \quad (13)$$

and the parameters \tilde{a}_1 and \tilde{a}_2 and \mathbf{y} are chosen so as to satisfy the initial conditions.

3. Possible effects of income inequality on the money multiplier and the inflation-output trade off

In recalling Engel's law of negative relationship between the marginal propensity and income, one may argue that the less equal the distribution of income is the lower the fraction of the aggregate income spent on consumption. In other words, the higher the degree of income inequality the lower the private sector's propensity to consume. In recalling further that the AD-AS' money multiplier increases with the private sector's propensity to consume, one may continue and argue that the higher the degree of income inequality (\mathbf{S}) the lower the money multiplier:

$$\frac{\mathcal{M}}{\mathcal{S}} < 0. \quad (14)$$

One may also argue that the less equal the distribution of income is the larger the number of people willing to work for relatively low wages. In this case, a reduction of the output gap causes a smaller rise in the price level than in the case of more equal distribution of income. It is therefore suggested, in terms of the AD-AS model, that the higher the degree of income inequality the smaller the trade-off (on the supply side) between inflation and output:

$$\frac{\mathcal{D}}{\mathcal{S}} < 0. \quad (15)$$

The implications of these possible negative effects of income inequality on the money multiplier and the trade off between inflation and output for business cycles is analysed in the next two sections.

4. Possible effects of income inequality on the oscillations of the business cycles

The possible effects of income inequality on the oscillations of the business cycles are summarised in the following claims.

Claim 1: The greater the degree of income inequality, the higher the likelihood that the trajectories of inflation rate and aggregate income oscillate.

Proof: In recalling condition (10) and that df decreases with S , a rise in S , *ceteris paribus*, increases the likelihood that I_1 and I_2 are a complex conjugate pair. *QED*

Comment: Recalling that the parameters d and f are positive, the modulus of the complex roots, $1 / (1 + df)$, is smaller than 1 and hence the joint oscillations of income and inflation rate are damped.

Claim 2: The higher the degree of income inequality the larger the oscillations of the inflation rate and output.

Proof: The greater the complex roots' modulus the larger the oscillations of p and Y . The modulus, $1 / (1 + df)$, decreases with df which, by inequalities 14 and 15, decreases with S . *QED*

5. Possible effects of income inequality on the length of the business cycles

The possible effects of income inequality on the length of the business cycles is summarised in following claim.

Claim 3: If $dfb < 1$, the higher the degree of income inequality the longer the economic cycle. However, if $dfb > 1$, the higher the degree of income inequality the shorter the economic cycle.

Proof: The length of the economic cycle is $\ell = 2\Pi / q$ where $0 \leq q \leq 0.5\Pi$. By differentiating equation (13) with respect to S

$$\frac{\mathcal{I}tgq}{\mathcal{I}S} = 2 \left\{ \frac{4(1+df)}{[2+df(1-b)]^2} - 1 \right\}^{-0.5} \left\{ \frac{(1-dfb)}{[2+df(1-b)]^3} \right\} \frac{\mathcal{I}(df)}{\mathcal{I}S}$$

where $\frac{\mathcal{I}(df)}{\mathcal{I}S} < 0$ by inequalities (14) and (15). Hence, $\frac{\mathcal{I}tgq}{\mathcal{I}S} > 0$ if $dfb > 1$,

$\frac{\mathcal{I}tgq}{\mathcal{I}S} = 0$ if $dfb = 1$ and $\frac{\mathcal{I}tgq}{\mathcal{I}S} < 0$ if $dfb < 1$. Recalling that tgq rises with q

and that ℓ decreases with q , then $\frac{\mathcal{I}\ell}{\mathcal{I}S} > 0$ if $dfb > 1$, $\frac{\mathcal{I}\ell}{\mathcal{I}S} = 0$ if $dfb = 1$ and

$\frac{\mathcal{I}\ell}{\mathcal{I}S} < 0$ if $dfb < 1$. *QED*

Comment: The inequalities (14) and (15) also suggest that the probability of $dfb < 1$ increases with the degree of income inequality. Moreover, in the extreme case of $b = 1$ (naïve inflationary expectations) $tgq = 1/\sqrt{df-1}$ which, combined with the inequalities (14) and (15), implies that $\frac{\mathcal{I}tgq}{\mathcal{I}S} < 0$ and consequently income inequality prolongs the economic cycles.

6. Conclusion

This note was concerned with the possible effects of income inequality on the business cycles within the framework of a standard AD-AS macroeconomic model with imperfect foresight. It was argued that income inequality reduces the private sector's propensity to consume as well as the trade off (on the supply side) between inflation and output. Consequently, the effect of income inequality is to increase both the likelihood of short-run oscillations of output and inflation rate and their magnitude on the one hand, but not necessarily to shorten the economic cycles. It may prolong the economic cycles when the product of the inflation-output trade off coefficient, money multiplier and the expectation correction coefficient is smaller than one.

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