The Tax System and the Asymmetric Effect of Monetary Policy

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Abstract

The goal of this paper is to introduce a theoretical explanation to the asymmetric effect of monetary policy. Particularly, the current paper tries to find a connection between the tax system and the asymmetric effect of monetary policy.

The finding of the current paper shows that the existence of progressive income tax creates a concave IS curve. The concavity indicates that the effect of injection in the economy is reduced as a consequence of the extensively conversion into leakages. This implies a limited economic expansion. In addition, investors are pessimistic regarding the expansion of their economy. Therefore, a tight monetary policy (increase in policy rate) supports the pessimistic view, and it will have a significant effect on the output. However, a decrease in the policy rate creates two forces working in opposite direction, and as a final outcome we have less effect on the output.

Keywords: Tax System, Monetary Policy, Concave IS Curve
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1. Introduction

The relationship between money and output is a vital, debatable issue, and still attracting the attention of many economists, who are trying to explore facts about this phenomenon. It is widely accepted that money affects the real variables over the short-run. Also, economists believe that the long-run effect of monetary policy fall entirely on the prices with little impact on the real sector. Recently, economists started to find empirical evidence supports that monetary policy has an asymmetric effect. In particular, the evidence shows that the effect of contractionary monetary policy on output appears larger than the effect of expansionary monetary policy of similar size.

In a seminal work, Cover (1992) shows based on data from the U.S. that an expansionary monetary policy does not have an effect on the output, while a contractionary monetary policy affects the output. Ball and Mankiw (1994) prove that price adjustment is asymmetric in the presence of trend inflation. They conclude that a positive monetary shock is more likely to induce price adjustment than is a negative shock. Garcia and Schaller (1995) apply Markov switching model on data from the U.S. and find statistically significant evidence of asymmetry. Karras (1996) proves that the effect of
monetary policy is asymmetric. In fact, he finds a negative money supply shock has a significant effect on output. However, the effect of a positive shock is statistically insignificant. In addition, the sample of Karras (1996) study covered 38 countries during the period 1950-1990. Therefore, his work illustrates that the asymmetric effect of monetary policy is an international phenomenon. Moreover, the empirical work of Karras (1996) shows the effect of monetary policy on prices is symmetric. Furthermore, Based on quarterly data from the Austrian economy, Kaufmann (2001) confirms that the effect of monetary policy is asymmetric. Peersman and Smets (2001) use data from seven countries of the euro area. The empirical results prove that the asymmetric effect is significant in Germany, France, Italy, Spain, and Belgium, while they are less significant in Netherlands and Austria.

Additionally, a recent vital work by Florio (2004) demonstrates that the literature concerning this phenomenon is largely devoted to empirical work, and there is a limited efforts devoted to give explanations. In the next section, we summarize the findings of Florio (2004).

2. Literature Review: Explanation of Asymmetry

Florio (2004) reviews five proposed explanations of the asymmetric effect of monetary policy. Florio (2004) puts all the ideas together, which give scholars a good chance to review developments in this area of research. These explanations are: first, is related to the degree of confidence that private sector places over the stages of business cycle. Usually, private sector tends to be pessimistic in a recession and optimistic during an expansion. Pessimism during a slump is greater than optimism during an expansion. Therefore, a tight monetary policy is more effective than an easy monetary policy. The second explanation connects the private sector’s explanations to the marginal efficiency of capital. It says that to eliminate the effects of expectations on investment a tight or an easy monetary policy should be adopted. The maneuver within each policy is different. Under an easy monetary policy, to bring investment back to its original level this might require to achieve negative interest rate. On the other hand, a tight monetary policy does not have this constraint.

The third justification is related to the expected inflation and the term structure of interest rate. The long-term interest rate is important because it affects investment decision today and in the future. Based on the expectation theory, the term structure of interest rate is defined as the long-term interest rate, and equal to the average of short-term interest rate that people expect to occur over a period of time. At the same time, and by using Fisher effect, this explanation states that the long-term interest rate has two components which they are; short term real interest rate and expected inflation rate. This justification states that implementing an easy monetary policy to encourage real growth might fail to decrease long-term interest rate because of inflation expectations. The crucial point in this explanation is that the behavior of expected inflation is uncertain. This clarification predicts that the effect of one type of monetary policy i.e. easy policy in all periods will affect the expectations. As a result the effect will be asymmetric.

Explanations four and five are basically the two theoretical explanations for asymmetric effect of monetary policy. The fourth explanation relies on the existence of a convex aggregate supply curve\(^1\) to generate an asymmetric effect of monetary policy. Theoretically, a convex aggregate supply curve can be produced from the Keynesian models which assume that prices and wages are downwardly rigid but they are upwardly flexible\(^2\). During booming period, represented by the relatively steep part of the aggregate supply curve, a monetary shock affects mainly price level rather than output. While during a sluggish period, the relatively flat portion of the aggregate supply curve, a monetary shock will result in a larger change in output and a smaller change in prices.

The fifth explanation is related to credit market imperfection, and demonstrates that the forces affect an economy in a boom are not the same as in a recession. During a boom the demand for credit is high. Adopting a tight monetary policy to control the economy raises two effects; the lending

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\(^1\) It means asymmetric price adjustment.

\(^2\) Also a convex aggregate supply curve can be generated from the capacity constraint model. This model assumes that in the short run as the economy expands, more firms find it difficult to increase their production capacity.
channel and the balance sheet channel. The former implies that the reduction in the supply of funding to firms enforces them to cut down their investment. While, the latter works through the effect of the rise in the interest rate on reducing the present value of the firms’ net worth, which diminishes the value of collateral introduced to lender who will ask firms to provide him with a larger premium. Therefore, those two effects are significant and work in the same direction which is to reduce output. By contrast, during a recession the demand for credit is not high. As a result, the credit constraint is not binding and the expected effect of an easy monetary policy on output is less significant.

3. The Contribution of the Current Paper
It is obvious from the previous section that all the explanations rely mainly on the behavior of the macroeconomic variables. However, none of the previous explanations study the effect of policy action i.e. the effect of fiscal policy on this phenomenon. Therefore, the question we have in the current paper is could the asymmetric effect of monetary policy caused by adopting certain fiscal policy i.e. certain tax system? As a result, the goal of this paper is to add a new dimension to the literature, and to submit a theoretical justification to this event, by examining the effect of fiscal policy on the appearance of the asymmetric effect of monetary policy. The idea is supported by evidence from the real world. Observations show that most countries in which monetary policy is asymmetric confirmed applying progressive tax system. Therefore, we took a step-back toward the short-run3, and we assume asymmetric effect of monetary policy stems originally from the existing of a progressive income tax. To achieve its goals, the current paper utilizes the IS-LM model to present our explanation. Several leading macroeconomists i.e. Blanchard (1997), Blinder (1997), and Solow (1997) agree that the IS-LM model is an important element of core beliefs. Blinder (1997) assures that the IS curve is fundamental to the Federal Reserve’s thinking about how monetary policy works. Revier (2000) mentions the IS-LM model as a valuable framework to understand the determinants of the effectiveness of monetary and fiscal policy. We believe that the IS-LM model is useful to the current paper because it provides a link between monetary and fiscal policies. The rest of the paper is organized as follows sections 4-6 introduce an IS-LM model appropriate to this study, and submit result analysis. Section 7 provides summary and conclusions.

4. The Model
The analysis in the current paper is driven by assuming that the problem exists in the aggregate demand side not the aggregate supply. The structural equations of two sector closed economy from which the IS-LM is derived as follows:

\[ Y = C + I + G \]
\[ C = A_0 + cY^d \quad 0 < c < 1 \]
\[ A_0 = a_0 - a_1r \]
\[ Y^d = Y - T \]
\[ T = t_0Y + t_1Y^2 \quad 0 < t_0 < 1 \quad 0 < t_1 < 1 \]
\[ I = I_0 - ir \]
\[ G = G_0 \]
\[ \left( \frac{M^d}{P} \right) = \frac{M^s}{P} \]

\[ ^3 \text{Compare to the studies used the aggregate demand-supply model.} \]
\[
\left( \frac{M}{P} \right)^d = KY - Lr
\]  

(9)

\[
\frac{M^*}{P} = \frac{M^*_0}{P}
\]  

(10)

Where \( Y \) is output, \( C \) is personal consumption, \( I \) stands for private investment, \( G \) represents government consumption and investment, \( Y^d \) is disposable personal income, \( T \) stands for taxes. \( r \) is interest rate. \( \left( \frac{M}{P} \right)^d \) stands for demand for money, \( K \) is sensitivity of money demand to change in income, \( L \) is sensitivity of money demand to change in interest rate. \( M^* \) is money supply and \( P \) stands for aggregate price level.

The first equation in this economy gives the equilibrium condition of national income, while equations from (2) to (6) show how the endogenous variables \( C, A_0, Y^d, T \) and \( I \) are determined in the model, respectively. Equation (7) illustrates government consumption and investment as an exogenous variable. Equations from (8) to (10) present the money market. It is clear from the model that this economy has a progressive tax system. This feature is consistent with most real-world tax systems. In a progressive tax system, the tax rates increase as incomes increase. Also, the marginal tax rate is always higher than the average tax rate. As a result, the consumption function will be concave down in income \( (Y) \). This means that the marginal propensity to consume decreases as income increases. The greater the progressivism of the tax rate system, the more the curvature of the consumption function. As well, the progressive tax system has the same effect on the saving function and the marginal propensity to save. The curvature of the aggregate expenditure has an important meaning which is; as income increases, both marginal propensity to consume and marginal propensity to save decline. However, the marginal tax rate increases. As a result, the larger leakages of income are in the form of taxes. Expansion in such an economy is limited to a certain point because the economy will deteriorate beyond the point where marginal propensity to consume = marginal propensity to save = 0. At this point, the multiplier is at its minimum level, it is less than one. For the purpose of this study, we assume that the economy will not work beyond this boundary. In addition, we assume the private sector in this model has an access to the information and able to make a responsible economic decisions.

5. The IS Equation

To continue the analysis we derive the IS curve. It shows all the combination of \((r, Y)\) at which the commodity market is in equilibrium. The IS curve can be derived by using equations (1) to (7). At the final step of derivation we have:

Leakages = Injections

Induced saving and induced taxes = autonomous planned spending \((Ap)\)

\[
(\text{ct}_1)Y^2 + (1 - c + \text{ct}_0)Y = a_0 + I_0 + G_0 - a_1r - ir
\]  

(11)

The left hand side of equation (11) shows that the leakages from the economy increasing at increasing rate as the income rises. As stated above, these leakages are in the form of taxes. By using the quadratic formula, the equilibrium output has the following equation:

\[
Y = \frac{-\left(1 - c + \text{ct}_0\right)}{2ct_1} \pm \frac{\sqrt{\left((1 - c + \text{ct}_0)^2 + 4ct_1\left(a_0 + I_0 + G_0 - (a_1 + i)r\right)\right)}}{2ct_1}
\]  

(12)

Leakages have a quadratic form, while injections are linear.
\[
Y = \frac{-(1 - c + ct_b)}{2ct_i} + \frac{\sqrt{\left(1 - c + ct_b\right)^2 + 4ct_i(Ap)}}{2ct_i}
\] (13)

Contrary to the proportional tax system\(^5\), equation (13) illustrates that the leakages coefficients in this economy play a crucial role in determining the equilibrium output in quadratic function. Figure (1) in appendix A helps to understand this case. Equation (13) shows that the equilibrium output depends on the following three terms:

1) The slope of the leakages equation \((1 - c + ct_b)\) or what is known the marginal leakage rate in the case of proportional tax system. It is apparent from equation (13) that the slope of leakage equation has a negative relation with the equilibrium level of output. At the same time, equation (13) shows that the square of the slope has a positive effect on the equilibrium output. This relation confirms that the slope of leakage equation has a negative relation with output because it is less than one, and becomes smaller when it squared.

2) The curvature of the leakages equation \((ct_i)\) which is less than one. It demonstrates the amount by which leakages increase because of the additional taxes \((ct)\).

3) The value of the injections which turns to be leakages because of the curvature of leakages equation. The term \(\sqrt{\left(1 - c + ct_b\right)^2 + 4ct_i(Ap)}\) is the marginal leakage rate in this model\(^6\).

Equation (13) displays that leakages have a negative relation with the equilibrium output. On the other hand, injections have a positive relation, but its effect is shrinking in such a model, and the economy is ended-up with a very small multiplier\(^7\). As a result, the increase in output (income) will be less than the increase in autonomous planned spending. Consequently, equation (13) states that the effect of injections is reduced over time as income increase because of two reasons: the curvature of leakages equation \((ct_i)\) and the square root. Those two effects are due to the existence of progressive income tax effect; the former is the quantitative effect of the progressive tax system, while the latter introduces the psychic effect of the private sector in the economy. Given the value of \((ct_i)\), mathematically, the square root reveals a degree of pessimism in the economy as a whole\(^8\) because of this tax system. The two effects of Progressive income tax motivates the investors to; first, be aware that a large portion of their additional income at any time either in recession or expansion is going to be taxed. Second, be quite reluctant at any time to have huge amount of investments because of their pessimistic view. Hence, the two effects are working in the same direction and diminish the outcome of injections in the economy. The private sector understands the fact that higher expenditure as a consequence of a cut in the interest rate means moving to higher tax brackets (quantitative effect). Therefore, the psychic effect works in the economy. Large portion of private economic units might prefer not to expand their investments. The final decision in this case relies on comparing the two outcomes; progressive income tax effect and interest rate effect (decline in the policy rate). Those two outcomes are working in the opposite direction. So, an easy monetary policy is unable to push the economy far away. Based on this conclusion, the income generated by this mechanism is increasing at decreasing rate. While in a tight monetary policy case progressive income tax effect and interest rate effect are working in the same direction. The increase in the cost of borrowing encourages investors more to reduce their investments. As a result, income is decreasing at increasing rate. We argue that this is the core of the problem that contributes to the appearance of the asymmetric effect of monetary policy. This analysis requires that investment and consumption is highly sensitive to change in the interest rate, \((a_i + i)\) is relatively large.

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\(^5\) This tax form is widely used in the macroeconomics texts and has the following formula \(T = ty\). In this kind of tax system both injections and leakages have a linear form.

\(^6\) Marginal Leakage Rate = \(\frac{\partial Ap}{\partial Y}\).

\(^7\) The multiplier in this model is less than one.

\(^8\) This effect is not related to a certain policy.
As for the IS curve, it is apparent from equation (12) that the relationship between the interest rate and the output is negative. Equations (14) and (15) introduce the slope of the IS curve. The second derivative, equation (16), proves it is concave. The same result is derived graphically from equation (11) in figure (1) in appendix A. Equation (14) provides a different way of analysis. This equation demonstrates the difference between the slope of the IS curve in both progressive and proportional tax systems. The slopes of both curves are the same if \( Y = 0 \). As the economy expands, slope of the IS curve in the case of progressive tax system tends to be steeper. Figure (2) illustrates the relative comparison of IS curves in both progressive and proportional tax systems. Moreover, it shows the enormous output decline because of the progressive tax and pessimistic view effects in such economy. Consequently, equation (14) says that an expansionary monetary policy (decline in the policy rate) drives the economy toward the relatively steep portion of the IS curve. However, a tight monetary policy moves the economy to the relatively flat portion. Figure (3) in appendix A shows the asymmetric effect of monetary policy.

In sum, the existence of progressive income tax creates a concave IS curve. This concavity indicates that the expansion in such economy is limited, and investors have a pessimistic vision to the expansion of their economy. In the case of a decline in the interest, the final decision relies on two powers working in opposite direction. The first, the effects of the progressive tax system and pushes the private sector not to expand their expenditures. Second, the effect of a lower interest rate, this action motivates the private sector to engage in more economic activities. However, in the case of an increase in the interest rate those two outcomes working in the same direction which is to dishearten the private sector. Therefore, the reaction to a tight monetary policy would be larger than the reaction to an easy monetary policy.

\[
\frac{\partial r}{\partial Y} = \frac{-2ct_c Y + (1 - c + ct_o)}{(a_i + i)} \tag{14}
\]

By using equation (12), we can write equation (14) as:

\[
\frac{\partial r}{\partial Y} = \frac{-\left(\sqrt{1 - c + ct_o}^2 + 4ct_c \left(a_o + I_o + G_o \right) - (a_i + i)\right)}{(a_i + i)} < 0 \tag{15}
\]

\[
\frac{\partial^2 r}{\partial Y^2} = \frac{-2ct_c}{(a_i + i)} < 0 \tag{16}
\]

6. The Multiplier Analysis

The multipliers in the economy applying a progressive tax system differ from the economy applying a proportional tax system. The multiplier analysis is useful because it confirms the abovementioned findings. Equation (17) illustrates the multiplier of the government spending as an example. It proves that the multiplier is less than one and has a negative relation with the output. The ability of the economy to expand over time is limited because the marginal leakage rate is a function of the output level; as output (income) raises marginal leakage rate increases.

\[
\frac{\partial Y}{\partial G_o} = \frac{1}{\sqrt{1 - c + ct_o}^2 + 4ct_c \left(a_o + I_o + G_o \right) - (a_i + i)r} = \frac{1}{2ct_c Y + (1 - c + ct_o)} \tag{17}
\]

Further, the multiplier has a positive relationship with the interest rate over the IS curve. The value of the multiplier becomes relatively larger if the level of interest rate becomes higher. And, its value reaches its maximum level when the value of real GDP is equal to zero or the interest rate is at its maximum level. At this point the value of the multiplier is equal to:

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9 For more details see Chiang (1984) pp 241-244.
10 Because Equation (14) shows that as the income \( Y \) increases the slope becomes larger.
11 It is greater than one if \( Y > 0 \)
This conclusion implies that the shift of the IS curve in such model is imbalanced. The amount of the shift at vertical axis is relatively larger than the horizontal axis. The empirical implication of this conclusion is that the effect of fiscal policy would be asymmetric too. But, the asymmetric effect of fiscal policy would not subject to the difference between boom and recession but it would be rather between high and low level of interest rate.

\[
\frac{\partial Y}{\partial G_0} = \frac{1}{(1 - c + c t_o)} \tag{18}
\]

7. Conclusions

Literature shows that most research concerning the asymmetric effect of monetary policy is devoted to the empirical work. Efforts devoted to give explanations are limited. The current paper attempts to fill a gap in the literature. Our paper examines the statement which says that the progressive tax system leads to the asymmetric effect of monetary policy. We adopted the IS-LM model to investigate this relation. This adoption is supported by two main reasons; first, leading macroeconomists confirm that this model is an important element of practical core. Second, it has a crucial link between monetary and fiscal policy.

This paper concludes that a progressive tax system with high consumption and investment sensitivity to change in interest rate are sufficient conditions to generate an asymmetric effect of monetary policy. Progressive tax system restricted the expansion capacity of the economy and creates a pessimistic feeling among investors. These results produces a concave IS curve. Concavity implies the slope of the IS curve become steeper as output increases. In addition, this paper confirms that decreasing the interest rate creates an optimistic factor against the pessimistic view of the investors. On the contrary, increasing the policy rate creates additional pessimistic view contributes to a more decline in the output. As a result, monetary policy is asymmetric.
References


Appendix A

Figure 1: Derivation of a Concave IS Curve

\[ (c_t)Y^2 + (1 - c + c_t)Y \]

- \( A_P_0 = f(r_0) \)
- \( A_P_1 = f(r_1) \)
- \( A_P_2 = f(r_2) \)
- \( A_P_3 = f(r_3) \)

\( r \)

\( r_0 \)
\( r_1 \)
\( r_2 \)
\( r_3 \)

\( r \)

\( IS \) curve
**Figure 2**: The Difference Between the IS Curve of Proportional Tax and Progressive Tax System

**Figure (3)**: The Asymmetric Effect of Monetary Policy