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The Impact of Economic Policy on the Business Cycle: Theoretical Model and Empirical Evidence from the U.S.

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The objective of this paper is to determine whether economic policy can increase GDP volatility. The authors try to assess, more particularly, if the actions of the monetary authority following a negative tax shock could amplify the business cycle. The starting point is a balanced GDP growth path in a neoclassical growth model to which is added an income tax. This tax rate will reduce output and thus, in the presence of wage rigidities, will lead to an increase in unemployment. The authors show that if the Central Bank implements an expansionary monetary policy to try and curb unemployment by boosting output, this policy mix could originate (or at least amplify) the business cycle. The relationship between GDP volatility and economic policy is then tested in the United States over the 1980-2010 period. The authors show that, in accordance with the theoretical model, economic policy contributed to increase GDP volatility in the US between 1980 and 2010.

Field of Research: Economic Policy and Business Cycles

Keywords: Economic growth, business cycle, tax policy, monetary policy.

1. Introduction

Historically, the business cycle was considered as inherent to economic activity and economists used to focus mainly on actions (mainly economic policy actions) to smooth economic activity. This was mainly the case of the Keynesian vision of the business cycle. However, more recently, several papers have studied the determinants of the business cycle in order to find more appropriate actions to reduce GDP volatility, leading to different conclusions. Some studies conclude that the business cycle is essentially due to the behavior of economic agents (Hall (1991), Aghion & Howitt (1998) …), while others (Alesina (1987) and Alesina & Sachs (1988)) only to name a few) show that the business cycle is not due to economic activity itself, but rather to the behavior of political parties or the government as a whole. The latest batch of papers, (namely Lucas (1975), Kydland & Prescott (1977) and other authors from the New Classical Macroeconomics) argue that the business cycle might stem from economic policy itself, which was historically treated as a stabilization tool for GDP volatility in most Keynesian models.

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However, the majority of economic literature that deals with economic policy as a source of disturbances to economic activity takes into account either the tax policy alone, or the monetary policy alone. Most papers usually deal either with the way an isolated tax policy can generate disturbances in economic activity (Summers (1981), Rebelo (1991), Barro (1990), Nickell (2004), among others), or with GDP volatility generated by monetary policy alone (Lucas (1972), Lucas (1975), Kydland & Prescott (1977), only to name a few). Very few papers use both policies to capture their combined impact on GDP volatility. The target of this research paper is to fill this gap by analyzing the disturbances that a combination of a tax and a monetary policy can generate on economic activity.

This paper, hence, aims at capturing the impact of economic policy (the mix of a tax policy and a monetary policy) on the cyclicality of GDP. The conclusions drawn are based on both a theoretical model and an empirical study on the United States from 1980 to 2010.

The theoretical model relies on a set of simple assumptions, such as rational expectations and the delay in the propagation of information across all agents. These assumptions, largely inspired by Lucas (1975), will allow the authors to analyze economic policy and its consequences on GDP volatility in a different way than most other papers. The theoretical model is two-fold. First, the authors capture the consequences of the implementation of a tax policy in a neoclassical growth model. In details, the starting point is a balanced growth state, described by a standard neoclassical growth model (as first developed by Solow (1956)), to which an income tax is added, resulting in the contraction in output. In the presence of wage rigidities (minimum wage…), this contraction in production leads to an increase in unemployment.

Second, the authors model the reaction of the monetary policy to this increase in unemployment. The assumption here is that the Central Bank has a dual mandate (i.e. its reaction function depends on both inflation and unemployment). The intervention of the Central Bank, in an attempt to boost economic activity (that was hindered by the introduction of an income tax), will generates cyclicality in economic activity. Hence, the authors manage to show that the combination of both a tax and a monetary policy can generate (or at least amplify) GDP volatility.

In the empirical part of this paper, the authors capture the relationship between economic policy (tax and monetary policies) in the U.S. The United-States constitute a good ground for the empirical study because the Federal Reserve (Fed) is very active in money markets and frequently implements expansionary monetary policies following a slowdown in economic growth. The Fed thus seems to be the perfect example of a Central Bank trying (more or less successfully) to stabilize cyclical fluctuations. In details, a VAR (Vector Autoregression) model is built using U.S. data over the 1980-2010 period, in order to determine whether the combination of a tax policy and a monetary policy can generate (or amplify) GDP volatility in the United States.

Capturing the consequences of economic policy on the business cycle will thus require answering a series of questions as follows: What is the impact of introducing an income tax on the balanced growth path and on unemployment (in the presence of a minimum wage ...)?

What will be the reaction of monetary authorities if they try to reduce the level of unemployment? Can this reaction trigger fluctuations in the level of GDP?

Traditionally, economic policy was perceived in economic literature as a stabilization tool of economic activity. However, by combining the implications of a tax policy and a monetary policy in a neoclassical growth model, the authors show, in this paper, that economic policy can originate GDP volatility. The conclusions drawn from this model are very interesting for the analysis of the trade-off between discretionary economic policy and the adoption of clear and strict economic policy rules. These findings contribute to changing the historical perception of economic policy. The latter cannot be seen anymore as the ultimate tool to stabilize economic activity because, as shown in this paper, discretionary economic policy can, under certain circumstances, amplify or even trigger cyclicality in GDP growth. The authors argue that setting strict economic policy rules can reduce GDP volatility and lead to more stable long term growth.

The remainder of this paper is organized as follows: in the second section the authors present a literature review of the business cycle. In section 3, a theoretical model that captures the impact of economic policy on GDP volatility is developed. Section 4 describes, in detail, the methodology used in the empirical analysis, while section 5 provides the main conclusions of the empirical model. Finally, section 6 concludes.

2. Literature Review

One of the first papers that discusses the business cycle is that of Samuelson (1939), in which he analyzes GDP cyclicality within the framework of a Keynesian model. In his paper, Samuelson describes, using both the multiplier and the accelerator effects, how economic activity oscillates around a constant steady growth path. The oscillations can either be convergent or divergent depending on the relative size of the multiplier effect compared to that of the accelerating. However, two major limitations are often addressed to this model. First, it is purely a mathematical model that has no microeconomic foundations. Second, in order for the multiplier effect to work, production factors utilization should be below full employment levels, whereas for the accelerating effect to work, the economy must be close to full employment. Therefore, the accelerator and multiplier effects cannot work simultaneously.

Hicks (1950) tries to broaden the scope of Samuelson's oscillator model by taking into account GDP growth, and reaches the same conclusions. However, Hick's model still lacks microeconomic foundations.

Schumpeter (1949) focuses on the beneficial impact of GDP cyclicality on economic growth. In fact, according to him, during a recession, tighter credit conditions and lower global demand force low-productivity firms out of the market. These bankruptcies allow a reallocation of resources to more productive companies that managed to survive this tough economic environment. Thus, by eliminating the least productive companies, the recession helps increase total factor productivity, which, in turn, lifts long-term growth. Concurrently, Hall (1991) shows that agents face a permanent trade-off between production of goods and

services and production of organizational capital. During a recession, production decreases, reducing the opportunity cost of accumulating organizational capital. Thus, during this period, companies are able accumulate higher levels of organizational capital, which in turn, increase long-term productivity and total production.

Nordhaus (1975) introduces political behaviors to describe the business cycle. According to him, the business cycle is not generated by characteristics of economic activity, rather, it mainly stems from to the behavior of politicians who seek to maximize their own utility, which depends on their chances of re-election. In fact, immediately before political elections, the ruling politicians try to reduce unemployment by implementing an expansionary monetary policy which has an instant impact on unemployment. Its impact on inflation, however, is delayed due to the agents' adaptive (rather than rational) expectations. Then, when politicians are re-elected, and when inflation increases, politicians will implement a monetary tightening to curb inflation, without worrying about its impact on unemployment. The cycle is generated, in this model by the behavior of politicians.

Alesina (1987) and Alesina & Sachs (1988) also develop a business cycle model based on political behaviors. However, unlike Nordhaus (1975), they consider the interaction between two political parties with different objectives in terms of inflation and unemployment. In this case, it is the political alternation of both parties that generates cyclicality in economic activity. When a political party that has a strong aversion to unemployment is elected, it will implement an expansionary monetary policy that reduces unemployment in the short run and increases inflation. Conversely, when a political party with a strong aversion to inflation is elected, it will pursue a restrictive monetary policy to reduce inflation, generating as such an increase in unemployment.

More recently, Aghion & Howitt (1998) use Schumpeter's framework to determine the interactions between GDP growth and the business cycle. In their model, growth depends on both capital accumulation and innovation. The adoption of a new technology allows, in the long run, to increase total factor productivity and the level of production. However, in the short term, the implementation of this technology requires adjustments including the restructuring of the production process. Thus, in the short term, companies will have to reduce their output levels in order to adapt their production process to the new technology. The emergence of a new technology, which has a positive impact on the long-term level of production, can lead thus lead to a recession in the short term. The frequency of the cycle thus depends on the frequency of innovations, while the magnitude of the recession depends on the importance of said innovations.

Lucas (1975) establishes a business cycle model founded on microeconomic hypotheses, thus allowing to better understand all the mechanisms involved in the business cycle. Lucas assumes that agents are rational, but that the information available to them is imperfect. It is this specific hypothesis that favors the emergence of the business cycle. In fact, according to Lucas, the business cycle is caused by monetary or fiscal shocks, which have an impact on economic activity because of the delay in the propagation of information. In the short run, a monetary expansion has a positive impact on economic activity, whereas in the long run, when the agents' expectations adjust to this new monetary situation, production falls back to

its initial level. The cycle is thus caused in this model by a monetary or fiscal shock, coupled with a delay in the propagation of information.

Kydland & Prescott (1977) use the same framework and add rational expectations to the analysis. They show that the adoption of an economic policy decision that aims to maximize a certain objective function (i.e. optimal planning) will not be able to achieve its objective and will lead to a deterioration in the initial economic conditions. If expectations are rational, and the monetary authority increases money supply to reduce unemployment, this will immediately result in an increase in inflation and the expansionary monetary policy will have no impact on unemployment.

Kydland & Prescott (1982) build a real business cycle model with hypotheses similar to those of Lucas (1975). In their model, the business cycle is triggered by exogenous technological shocks, imperfect measurement of productivity indicators and the delay required for the production of a capital good. When a positive technological shock occurs, the accumulation of capital increases and, as it takes a certain time to produce capital goods, production decreases in the short term before increasing back in the long run. When they observe a positive productivity shock, agents will decide to invest more in the production of capital goods. However, since this investment is only operational in period t+1, production does not increase immediately. This delay between the investment decision and the increase in output levels generates GDP volatility.

Several papers subsequently adopted the rational expectation hypothesis to capture the consequences of the monetary policy on the business cycle. Barro & Gordon (1983) develop a monetary policy model in which the Central Bank permanently faces an arbitrage decision between reducing unemployment and stabilizing inflation. Alesina & Grilli (1992) adapt this model to the European Union to determine whether the ECB's statutes will improve the European Union’s macroeconomic conditions. The two models lead to similar conclusions: if expectations are rational, an increase in money supply, supposed to lower real wages and boost output levels, will result only in an increase in inflation without having any impact on unemployment and production. In fact, if expectations are rational, agents immediately adjust their behavior according to this change in money supply. Inflation expectations increase, resulting in an increase in nominal wages that prevents real wages from falling. The increase in money supply has, therefore, no impact on unemployment, yet leads to an increase in inflation. In this paper, the authors use this type of models to capture the impact of monetary policy on economic activity.

King & Rebelo (2000) try to asses, empirically, whether the real business cycle explains GDP volatility in the United States. Their analysis relies on a neoclassical growth model including technological change. Their goal is to determine whether the Solow residual (i.e. the share of output growth that is not explained production factors) can generate GDP cyclicality. They measure the business cycle using a Hodrick-Prescott filter. They show that, in the US, the Solow residual and the real business cycle provide a satisfactory explanation of GDP volatility. Hence, in most real business cycle models, cyclical fluctuations are driven by a transitional technology shock, which leads to a temporary increase in investments, boosting output growth in the short run until the technology shock dissipates. King & Rebelo (2000) also show

that a change in taxation levels (whether it levied on capital or on labor) generates the same impact as a productivity shock, and can therefore cause GDP volatility, just as a productivity shock. However, they also show that since tax shocks are less frequent than GDP shocks, this variable, alone, is not a satisfactory determinant of the business cycle.

The paper is based on the main hypotheses of the new classical macroeconomics and the aim is to show that economic policy does not allow to increase output levels over the long run. Similarly to the New Classical Macroeconomics school of thought (Lucas (1975), Kydland & Prescott (1982) …) the authors show that economic policy is a source of disturbances to the economy. However, the originality of the paper stems from the fact that the model takes into account the interactions between tax and monetary policies, a subject that was rarely studied in existing economic literature. The authors also show that economic policy can be a source of GDP volatility.

3. Theoretical Underpinnings

3.1 Tax Policy and Exogenous Growth

The authors model, in this section, the impact of an income tax in a neoclassical growth framework. The starting point is a standard Cobb-Douglas production function, as is the case in most neoclassical growth models.

An income tax (τ) is introduced, modifying the production function as follows:

$$Y' = (1-\tau).K^{\alpha}.L^{1-\alpha} \quad (1)$$

In the exogenous growth model, the evolution of capital is written as follows:

$$\dot{K}_t = s.Y_t - \delta.K_t \quad (2)$$

Thus, the output growth rate (outside the equilibrium path) is derived from the Cobb-Douglas production function:

$$g_Y = \alpha g_K + (1-\alpha) g_L \quad (3)$$

Hence, output growth remains unchanged when introducing an income tax rate. However, the equilibrium levels of the variables in the model are modified after the introduction of an income tax. The introduction of a tax rate (τ) on the income level modifies the production function in the following way:

$$y' = (1-\tau) f(k) \quad (4)$$

The modified growth path of the economy corresponds to lower capital per capita equal to:

$$k^{*\prime} = \left[\frac{s(1-\tau)}{n+\delta}\right]^{1/(1-\alpha)} \quad (5)$$

Production is equal to:

$$y^{*\prime} = [\frac{s(1-\tau)}{n+\delta}]^{\alpha/(1-\alpha)} \quad (6)$$

Similarly, return on capital is lower:

$$r' = \alpha.\left[\frac{s(1-\tau)}{n+\delta}\right]^{-1} - \delta \quad (7)$$

As well as wage levels:

$$w' = (1-\alpha).[\frac{s(1-\tau)}{n+\delta}]^{\alpha/(1-\alpha)} \quad (8)$$

As shown above, the marginal productivity of labor (and hence wages), drops after the introduction of an income tax, because of the decrease of the capital stock per capita. However, most developed countries have adopted regulations that prevent wages to fall below a certain threshold (eg. SMIC in France, and other minimum wage rules in other countries). Consequently, wage levels cannot always adapt, which might generate an increase in unemployment because of the gap between Labor's marginal productivity and the minimum wage. This increase in unemployment (that is quantified in the following section) triggers an intervention from the Central Bank. In fact, a Central Bank with a discretionary mandate will try and reduce unemployment after the adoption of the income tax. The impact of the income tax on unemployment in the presence of wage rigidities is measured in the section below.

3.2 Minimum Wage and Unemployment

As already stated, in many countries, there are some rigidities preventing nominal wages from adjusting automatically after a shock (SMIC ...). Hence, wages in the economy might not be able to reach the new marginal productivity w'. The change in the growth path thus results in the appearance of unemployment.

To calculate this change in the level of employment, the minimum wage is assumed to be equal to the wage level before taxation:

$$w = (1-\alpha).[\frac{s}{n+\delta}]^{\alpha/(1-\alpha)} \quad (9)$$

Following the implementation of an income tax, the marginal productivity of labor (which has decreased following the introduction of the income tax) needs to return to its pre-tax level in order for wages to get back to their pre-tax level and prevent unemployment from increasing. The marginal productivity of labor depends on the level of capital per capita (k), as shown in the following equation:

$$PmL = (1-\alpha).k^{\alpha}$$

Following the introduction of income tax, and since the minimum wage level is set by the authorities at the pre-tax wage level, the marginal productivity of labor must remain unchanged. It is therefore necessary that the level of capital per worker remains unchanged so that the remuneration of labor remains the same following the introduction of the income tax.

The level of capital per worker (k) is equal to the level of total capital (K) divided by the number of workers (L). And since the capital level in the economy (K) has decreased, the volume of employment (L) must decrease, so that the level of capital per worker remains constant, and hence the wage level after the implementation of the tax also remains unchanged.

$$k' = K'/L \qquad (10)$$

$$\left[\frac{s(1-\tau)}{n+\delta}\right]^{1/(1-\alpha)} = K'/L \qquad (11)$$

$$\left[\frac{s}{n+\delta}\right]^{1/(1-\alpha)} . (1-\tau)^{1/(1-\alpha)} = K'/L \qquad (12)$$

As already demonstrated, for the marginal productivity of labor to remain unchanged before and after taxes the following condition should be met: $k' = k = \left[\frac{s}{n+\delta}\right]^{1/(1-\alpha)}$ (13)

$$\left[\frac{s}{n+\delta}\right]^{1/(1-\alpha)} = K'/\left[L.(1-\tau)^{1/(1-\alpha)}\right] \qquad (14)$$

Hence, for the following equation to be verified: $k' = k = \left[\frac{s}{n+\delta}\right]^{1/(1-\alpha)}$, the new level of employment should be equal to : $L.(1-\tau)^{1/(1-\alpha)}$.

Therefore, in order for the wage level to remain unchanged after the implementation of the income tax, the marginal productivity of labor must remain unchanged. Thus, the level of capital per worker must return to its pre-tax level. Since the total level of capital has decreased in the economy following the implementation of the tax, the number of workers must decrease and become equal to: $L' = L.(1-\tau)^{1/(1-\alpha)}$.

Hence, the combination of an income tax and minimum wage leads to an increase in unemployment, which will generate a reaction from a Central Bank with a dual mandate.

3.3 The Monetary Policy Response to the Introduction of an Income Tax

As previously stated, a Central Bank with a discretionary mandate will react to the change in unemployment in the economy by implementing an expansionary monetary policy (following the introduction of an income tax). The authors analyze monetary policy within the framework initially developed by Barro & Gordon (1983) and Alesina & Grilli (1992). Both models assume that the Central Bank's reaction function depends both on the output gap and inflation.

Loss function of the Central Bank:

Min $(y_i - \tilde{y}_i)^2 + \Theta\pi^2$ (15)
Under the constraint : $y_i = (\pi_i - \pi_i^e)$ (16)
With : $\tilde{y}_i = y^* - y^{*\prime} = \left(\frac{s}{n+\delta}\right)^{\frac{\alpha}{1-\alpha}} - (1-\tau)^{\frac{\alpha}{1-\alpha}} . \left(\frac{s}{n+\delta}\right)^{\frac{\alpha}{1-\alpha}}$ (17)

(according to the model in the previous section).
$\tilde{y}_i$ is the target output set by the Central Bank (in this model it is the difference between the output level before tax (y^*) and after the implementation of the tax ($y^{*\prime}$)).

$$\tilde{y}_i = \left(\frac{s}{n+\delta}\right)^{\frac{\alpha}{1-\alpha}} . \left[1 - (1-\tau)^{\frac{\alpha}{1-\alpha}}\right] \qquad (18)$$

This equation therefore represents the deviation of output from the Central Bank's target.

As already pointed out, the Central Bank seeks to minimize the previous loss function (equation (31)), under the constraint already exposed (equation (32)). Replacing y_i in the loss function with its value as a function of inflation and expected inflation ($y_i = (\pi_i - \pi_i^e)$), leads to the following Lagrange function:

$$L = \theta\pi_i^2 + (\pi_i - \pi_i^e - \tilde{y}_i)^2 \qquad (19)$$

This function is minimized in π to obtain the Central Bank's reaction function, which is as follows:

$$\pi_i = \frac{\pi_i^e}{\theta+1} + \frac{\tilde{y}_i}{\theta+1} \qquad (20)$$

Moreover, expectations are considered to be rational in the model, implying that at equilibrium:

$$\pi_i = \pi_i^e .$$

By replacing π_i by π_i^e in the previous equation the equilibrium value of expected inflation is obtained:

$$\pi_i^e = \frac{1}{\theta}\tilde{y} \qquad (21)$$

The Central Bank knows this value and integrates it into its reaction function:

Thus:

$$\pi = \frac{1}{\theta}\tilde{y} = \pi^e .$$

This is the equilibrium value of inflation.

By replacing $\tilde{y}$ by its value:

$$\pi = \frac{1}{\theta}\left(\frac{s}{n+\delta}\right)^{\frac{\alpha}{1-\alpha}}\left(1-(1-\tau)^{\frac{\alpha}{1-\alpha}}\right) \qquad (22)$$

Hence, inflation depends positively on the level of taxation. In fact, the higher the tax level, the more output level will move away from its equilibrium value, the greater the Central Bank's response, and the higher the resulting inflation rate.

However, under the assumption of rational expectations, economic agents adapt to inflationary changes initiated by the Central Bank, and the gap between inflation and expected inflation, which increases total output in the short term, will eventually vanish when the information concerning the monetary shock spreads across all agents. Hence, the output level will decrease back to its new equilibrium level (the level of production resulting from the introduction of an income tax).

In this case, cyclical activity stems from the successive interventions of the Central Bank in an attempt to increase output level and to boost employment by lowering interest rates. Thus, and given that this economic policy is only efficient in the short run, a business cycle emerges from the interaction of both the tax and the monetary policy.

The authors analyze this mechanism within a framework similar to that of Alesina & Grilli (1992) to which a delay in the adjustment of inflation expectations is introduced (as describe by Lucas (1975)). In fact, following a positive monetary shock, if inflation expectations remain unchanged (due to a delay in the diffusion of information), the (positive) gap between inflation and expected inflation will allow monetary policy to boost production in the short run. As long as inflation expectations don’t adjust to this monetary shock, economic activity is boosted: agents increase their labor supply and accumulate more capital. The economic downturn occurs when all the information concerning this monetary shock is diffused across the economy, prompting economic agents to upwardly revise their inflation expectations, the thing which neutralizes the short term impact of monetary policy.

In fact, as soon as agents realize that the productivity shock they observed was in fact a monetary shock, they reduce the additional capital accumulated as a result of the shock and reduce their labor supply, which triggers the reversal of the economic expansion generated from the monetary policy. This is the beginning of the downward phase of the cycle. The amplitude of the business cycle depends on the speed at which information flows across the economy.

3.4 The Impact of the Policy Mix on Economic Activity

The model developed in the previous sections allows to understand the impact of a policy mix on economic activity. The introduction of an income tax (tax policy), weighs negatively on production and employment. As a result, and as shown in the second part of the model, this will lead to the adoption of an expansionary monetary policy from the Central Bank. The United States provides a striking illustration of this analysis. In fact, in the late 1990s and early

2000s the US Federal Reserve (FED) was pursuing an expansionary monetary policy (low interest rates environment), leading to a financial bubble in the onset of the years 2000 (in particular the shares of several companies linked to the Internet or to new technologies). Thus, in order to limit the impact on real activity of this financial bubble, the Fed had to trim down its money supply by increasing interest rates. This led to the bursting of the Internet bubble in 2001, with the known consequences (stock market crisis, which then spread to the real economy). During the recession period that followed, the Fed again pursued an expansionary monetary policy in an attempt to curb the downturn that followed the bursting of the Internet bubble by lowering interest rates and accelerate the recovery (at least in the short term). However, this low interest rates policy has favored the creation and expansion of another financial bubble, the housing bubble. This bubble grew until the Central Bank raised its interest rates again, which in turn led to the bursting of the housing bubble.

In this case, the crisis allows to destroy the excess liquidity created by the Central Bank and return to a healthy functioning of the economy (i.e. to have a level of investment that corresponds to household savings, through interest rates equilibrium). In turn, all new economic activities that developed following the increase in the money supply, and which do not prove to be profitable at the equilibrium interest rate, will disappear. The bubble, or excess investment in the economy will thus disappear, ultimately leading to a decline in economic activity and a reversal of the economic expansion.

The authors have thus shown that the business cycle has been generated by economic policy. Even though, in the example above, the initial shock was not generated by an income tax, but rather from the burst of a financial bubble, an income tax would have the same consequences on economic activity. Also, assuming a delay in the dissemination of information, the monetary expansion that followed the shock led, in the short term, to an accumulation of additional capital. This is the expansion phase of the cycle. However, in the medium term, once the agents got the information concerning this monetary expansion, and once they realized that the positive shock they have observed was not a real shock but rather a monetary shock, they destroyed all additional capital stock accumulated, bringing the economy back to its post taxation equilibrium path. This is the downward phase of the cycle.

4. Empirical Model

The objective in this section is to capture the impact of economic policy on GDP volatility (as described in the theoretical model) in the United-States over the 1980-2010 period, using annual data. The analysis of the impact of economic policy on the cyclicality of GDP in the United-States is relevant because the Fed proved to be historically very active on money markets (its reaction function depends on both inflation and unemployment). The most recent examples are the "Quantitative easing" policies undertaken several times by the Fed since the onset of Subprime crisis in 2007. Moreover, corporate tax rates (that are used here as a proxy for the tax rate) were rather volatile over the 1980-2010 period. The United-States thus offer an interesting economic framework to test the theoretical findings of this paper.

In the empirical literature on the impact of economic policy on economic activity and the business cycle, the fiscal and monetary policies are often analyzed separately and very few

papers take into account the interactions between both policies to explain GDP volatility. The aim of this empirical model is to capture the interactions between both policies and to isolate their combined impact on GDP volatility. This would give a broader idea on the impact of economic policy on the business cycle. Also, if economic policy proves to amplify the business cycle in the United-States, as expected from the theoretical model, comprehensive recommendations (i.e. concerning both the fiscal and monetary policies) could follow regarding future policy actions.

4.1 Variables[i]

The objective is now to determine the impact of economic policy (particularly tax and monetary policies) on the business cycle in the United States. The authors thus regress a variable capturing the tax policy, and another one capturing monetary policy, on different measures of GDP volatility. This should allow to capture the relationship between economic policy and the cyclicality of GDP in the United States and to determine whether, as was shown in the theoretical model, economic policy may impulse GDP volatility.

In order to capture tax policy in the US, the corporate income tax is used as a proxy of the income tax. In fact, the income tax is progressive in the United States, which makes it difficult to account for in empirical models. For the monetary policy, money supply M2 is used. As for GDP volatility in the United States, three different methods are used to calculate it. All three methods are detailed in the following section.

Table 1: Variables

Variable	Description	Source
lnGDP	Natural Logarithm of real GDP	IMF World Economic Outlook database
lnK	Natural Logarithm of investment	UN Stats
Ln (L)	Natural Logarithm of total population	UN Stats
M2	Money Supply M2	US Federal Reserve (Fed)
T	Corporate Income Tax	OECD Tax Foundation
Vol_GDP	Volatility of real GDP, calculated using three different methods	Author calculations

4.2 Methodology

4.2.1 Measures of GDP Volatility

The first method used to estimate GDP fluctuations is the standard deviation compared to moving averages: the difference between observed growth rates and the average growth rate over the sub-period (4 years rolling) is calculated. The result obtained is the standard deviation of GDP growth rates. The difference with the traditional standard deviation is that here it is calculated compared to 4 years moving averages.

The second method consists of isolating the cycle using a Hodrick-Prescott filter. The Hodrick-Prescott filter allows to calculate the trend of the series. The cycle is the difference between observed GDP and the trend calculated using the filter.

In the third method, potential GDP is etimated using a Cobb-Douglas production function. Investment and labor force are regressed on GDP as shown in the equation below:

$$lnGDP_t = \alpha lnK_t + (1-\alpha) lnL_t + \varepsilon_t$$

This gives the potential GDP in the United States: $lnGDP_t = \alpha lnK_t + (1-\alpha) lnL_t$. The difference between the observed GDP and this potential GDP (i.e. ε_t) represents the US business cycle. The squares of these values represent GDP volatility.

4.2.2 VAR Models

For the three models tested, vector auto regression models (VAR models) introduced by Sims (1980) are used. This type of model has the advantage of not imposing any constraint on the relationship that governs the different variables in the model. In fact, unlike the traditional macro econometric models that impose constraints on variables, the VAR models make it possible to study the relationship between two or more variables without imposing a theoretical a priori on this relationship. This is the main advantage of VAR models, and the reason why the authors rely on this method to estimate the relationship between economic policy and GDP volatility.

This method of analysis consists of regressing the variables of the model on their own past values and on the past values of other variables in order to determine the relationship that prevails between them. This makes it possible to treat all the variables alternately as dependent and independent variables.

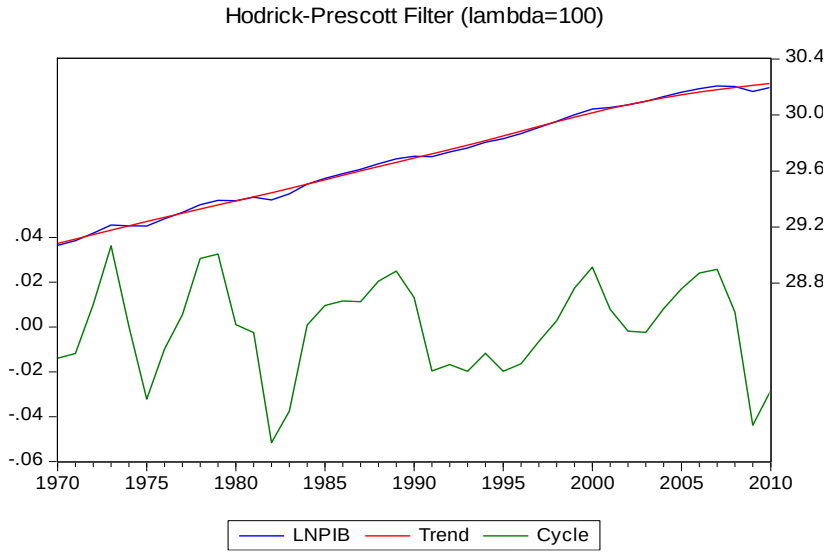
This will ultimately allow to capture the relationship between economic policy and the cyclicality in GDP in order to determine whether economic policy amplifies the business cycle in the U.S.

5. Regressions and Results

1st Method: The Hodrick-Prescott Filter:

The Hodrick-Prescott filter is used here to estimate the GDP trend. The difference between the observed GDP and its trend portrays the business cycle (the output gap).

Chart 1: The US business Cycle Calculated by the Hodrick-Prescott Filter Method



The chart above depicts the observed values of the natural logarithm of GDP and its trend, estimated using the Hodrick-Prescott filter. The gap between these two variables represents the output gap, i.e. the business cycle over the 1980 to 2010 period. The squared values of this cycle gives GDP volatility in the United States. Once GDP volatility is measured, the authors explain it using the variables capturing economic policy: M2 and the corporate tax.

A VAR model is thus generated using these three variables. The results of the VAR model show that the corporate tax has a negative impact on GDP volatility, while money supply has a positive impact, which is not entirely consistent with the results of the theoretical model. However, neither the coefficient relative to money supply (M2) nor that relative to the corporate tax are significant under this configuration. Therefore, no valid conclusions can be drawn from this model.

On the other hand, present GDP volatility seems to be positively impacted by past GDP volatility, yet again the coefficient is not significant. Similarly, none of the independent variables has a significant impact on corporate tax, when the latter is taken as the dependent variable. This result is consistent with the theoretical model, since corporate tax is an exogenous variable, and is not supposed to depend on GDP volatility or money supply.

Conversely, when money supply is the dependent variable in the model, it appears to be negatively impacted by its own past observations. The coefficients of GDP volatility and corporate tax, however, are not significant. In conclusion, this model does not allow to draw reliable conclusions concerning the impact of economic policy (M2 and corporate tax) on GDP volatility. In the section below GDP volatility is measured using a Cobb Douglas production function.

2nd Method: Cobb Douglas Production Function

The relationship between GDP and production factors (capital and labor) is estimated here. This regression gives the potential GDP in the United States over the 1980-2010 period:

$$lnGDP_t = 0.16lnK_t + 0.54lnL_t + 0.018.$$ [ii]

The difference between observed GDP and potential GDP (i.e. the error terms of the equation estimated above) is the output gap, and hence the business cycle in the US over the 1980-2010 period.

Chart 2: The Business Cycle Calculated Using the Theoretical Trend (Cobb-Douglas Production Function)

The chart above depicts the natural logarithm of GDP, as well as its estimate using the Cobb-Douglas production function. The gap between both variables is the business cycle. The values of the business cycle, squared, give GDP volatility in the United States. The authors now capture the impact of economic policy on this measure of GDP volatility. A VAR model is generated using the following variables: GDP volatility, corporate tax and M2.

The results show that corporate tax has a positive impact on GDP volatility, while money supply has a negative impact. That is, an increase in money supply would reduce GDP volatility. These observations are conflicting with the findings of the theoretical model. However, the coefficients are not significant, so no reliable conclusion can be drawn from these results. This method for computing the GDP volatility in the US economy therefore does not allow to validate or refute the theoretical model on the impact of economic policy on GDP volatility.

These observations can be explained by the fact that the US potential GDP, estimated by the Cobb-Douglas production function, is the GDP measure controlled for capital and labor. In this regression, the level of capital can be perceived as a control variable, which means that the residual of the GDP estimate, which was used as a measure of the business cycle in the

US, has no longer any component linked to the level of Capital and labor. The residual includes all variables that influence GDP, but which are not related to capital or labor. Under these conditions, if the economic policy impacts GDP volatility indirectly through investment or employment, it would not be captured in this model. In other words, if economic policy (corporate tax or M2 money supply) has an indirect impact on GDP volatility through a change in production factors, this relationship would not be captured in the model. This may explain why economic policy has no impact on GDP volatility when the latter is estimated using Cobb Douglas production function.

Money supply, on the other hand, depends negatively on its lagged observations. The other coefficients are not significant, so no reliable conclusion can be drawn on the impact of the other variables on money supply. The results obtained using this method are thus not very conclusive, and GDP volatility is now estimated using another method: the standard deviation compared to GDP growth moving averages.

3rd Method: Moving Averages

This section is based on GDP volatility calculated using the standard deviation of GDP growth compared to 4-year moving averages. The moving averages of GDP growth rates are calculated over 4-year periods, i.e. the moving average of GDP growth in year t is the average of the growth rates in years t-3, t-2, t -1 and t. GDP volatility is the standard deviation of GDP growth rates compared to the corresponding four-year moving average. GDP volatility is measure this way for each year from 1980 to 2010.

The aim is again to estimate the impact of economic policy on GDP volatility. As in the previous models, M2 is used to capture monetary policy and corporate tax is used as a proxy for the tax policy. Once again, a VAR model is built (with 2 lags this time) using the corporate tax rate, money supply M2, and GDP volatility calculated using the standard deviation compared to the four-year moving averages. The results are shown in the table on the following page:

Table 2: GDP Volatility Measured Using Moving Averages and Economic Policy Variables

Vector Autoregression Estimates
Standard errors in ( ) & t-statistics in [ ]

	DVOLATILITY_EX	DCORP_TAX	D2M2
DVOLATILITY_EX(-1)	-0.545863	-0.003658	-42.13487
	(0.19662)	(0.00552)	(23.2542)
	[-2.77627]	[-0.66264]	[-1.81192]
DVOLATILITE_EX(-2)	-0.182043	-0.010253	-1.059100
	(0.21849)	(0.00613)	(25.8409)
	[-0.83320]	[-1.67161]	[-0.04099]
DCORP_TAX(-1)	4.118020	-0.101786	-695.1662
	(8.40033)	(0.23582)	(993.518)
	[0.49022]	[-0.43162]	[-0.69970]
DCORP_TAX(-2)	18.08504	-0.356309	1731.155
	(7.82500)	(0.21967)	(925.472)
	[2.31119]	[-1.62202]	[1.87056]
D2M2(-1)	0.005270	2.36E-06	-0.600475
	(0.00259)	(7.3E-05)	(0.30676)
	[2.03194]	[0.03240]	[-1.95747]
D2M2(-2)	0.005312	-7.21E-05	0.162457
	(0.00314)	(8.8E-05)	(0.37129)
	[1.69200]	[-0.81825]	[0.43755]
R-squared	0.373229	0.199345	0.437468
Adj. R-squared	0.223997	0.008713	0.303532
Sum sq. resids	20.89105	0.016464	292226.0
S.E. equation	0.997403	0.028000	117.9641
F-statistic	2.501008	1.045705	3.266242
Log likelihood	-34.84838	61.62141	-163.7189
Akaike AIC	3.025806	-4.120104	12.57177
Schwarz SC	3.313769	-3.832140	12.85973
Mean dependent	-0.019062	-0.002963	-1.366667
S.D. dependent	1.132241	0.028123	141.3511
Determinant resid covariance (dof adj.)		7.400127	
Determinant resid covariance		3.481815	
Log likelihood		-131.7760	
Akaike information criterion		11.09452	
Schwarz criterion		11.95841	

The equation below describes the relationship between GDP volatility and economic policy variables (M2 and the corporate tax rate):

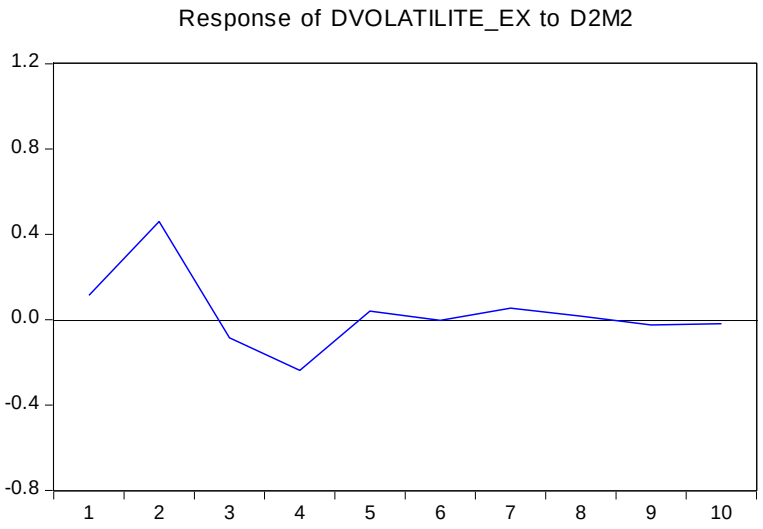
$$dvolatility_t = -0{,}55 * dvolatility_{t-1} + 0{,}0053 * d2M2_{t-1} + 18{,}09 * dcorp\_tax_{t-2}$$

GDP volatility in period t depends negatively and significantly (at the 5% level) on past GDP volatility in period t-1 (Column 1). But the most interesting results are that GDP volatility in period t depends positively on money supply in t-1 and corporate tax in t-2. Both results are significant at the 5% level. Money supply has a direct impact on GDP volatility after one period, while the corporate income tax has an impact on GDP volatility after two periods.

Moreover, money supply in period t depends negatively on money supply in t-1 (Column 2), and positively on corporate tax in t-2. Conversely, an increase in corporate tax in period t-2 leads to an increase in money supply in period t. The corporate tax thus has a positive impact on money supply, which confirms the predictions of the theoretical model: when the taxation increases, the Central Bank reacts by increasing money supply in an attempt to curb the negative impact of the tax on economic growth and unemployment. This mechanism triggers cyclical fluctuations in GDP.

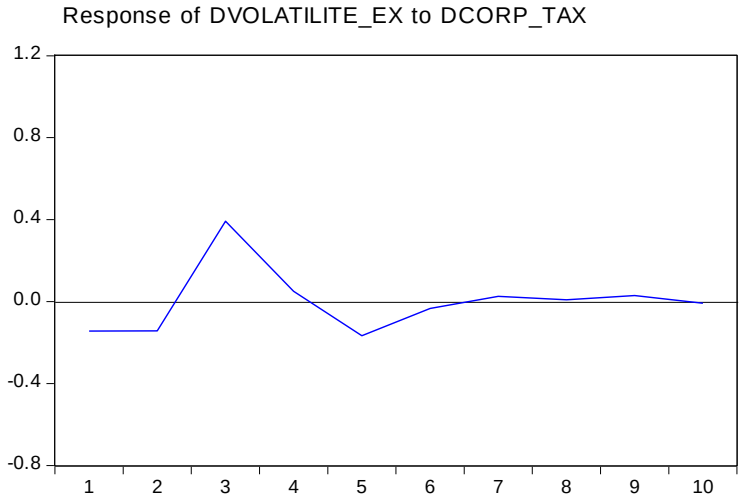
The impulse response functions on the following page confirm these results:

Chart 3: Impact of a Shock on Money Supply on GDP Volatility



The chart above represents the change in GDP volatility following a one standard deviation shock on the level of money supply (M2). First, the shock on money supply has a positive impact on GDP volatility. The impact is maximal two periods after the shock. Then, the impact on GDP volatility decreases over time, until GDP volatility returns to its pre-shock level, after about eight periods.

Chart 4: Impact of a Shock on the Tax Rate on GDP Volatility



The chart above depicts the change in GDP volatility following a corporate tax increase by one standard deviation. The rise in corporate income tax has a negative impact on GDP volatility after one period. Then, as of the second period, the tax increase leads to a surge in GDP volatility, with a peak in the third period. After the third period, the impact of the tax shock on GDP volatility begins to fade and GDP volatility returns to its pre-shock level after approximately eight periods.

Granger causality tests didn't allow to confirm that GDP volatility was caused by the two economic policy variables. Therefore, the variance decomposition of the variables was used to quantify the causality between them. In fact, the variance decomposition tables allow to capture the effect on the dependent variable of a shock on the independent variables. The results of GDP volatility variance decomposition show that 12.61% of GDP volatility's variance (after the 5th period) is explained by a corporate tax shock. Similarly, 16.21% of the variance of GDP volatility after 5 periods is explained by monetary shocks (on M2). This confirms the impact of economic policy on GDP volatility in the United States between 1980 and 2010.

Concurrently, the impact of corporate tax on money supply is also confirmed by the variance decomposition tables. In fact, the table shows that 25.34% of the variance of money supply is explained by a shock on the corporate tax rate. This confirms the intermediate results concerning the interaction between monetary policy and tax policy. The Central Bank tries to reduce the negative impact of a tax increase by implementing an expansionary monetary policy.

All in all, the empirical results indicate that the theoretical model developed above is verified for the United States over the period 1980-2010, when GDP volatility is calculated using the standard deviation compared to moving averages. The corporate tax rate has a positive impact on money supply, meaning that the Fed reacts to an increase in the corporate tax rate by implementing an expansionary monetary policy. This result confirms the findings of the theoretical model concerning the interaction between fiscal and monetary policies. The

authors have thus demonstrated that both policies are interconnected, and that they can be considered simultaneously in the analysis of business cycles.

Concurrently, the authors have shown that the tax rate and money supply both have a positive impact on GDP volatility. GDP volatility can thus be attributed (at least in part) to economic policy. The latter should, therefore, not always be perceived as a stabilizing element of economic activity. These findings thus contradict the Keynesian theory (and particularly the Hicks-Hansen model) that sees economic policy as a stabilizing tool.

The results are, however, in line with the latest works of the New Classical Macroeconomics that show the disruptions generated by the intervention of economic policy. However, unlike most of the existing papers (Lucas (1975), Kydland & Prescott (1980) …) that isolate the impact of either fiscal or monetary policy (following an exogenous shock) on the business cycle, this paper shows that the interaction of tax policy and monetary policy can initiate GDP volatility. These results can thus be used to issue a new type of policy recommendations based on stricter rules concerning both the tax and the monetary policies.

6. Conclusion

The authors have studied throughout this paper the impact of economic policy on GDP volatility. First, the authors show how the implementation of a tax policy hinders economic activity, reducing total output and increasing unemployment in the presence of wage rigidities. The contraction in economic activity triggers the implementation of an expansionary monetary policy by the Central Bank in an attempt to reduce unemployment. Given the hypothesis of rational expectations, the expansionary monetary policy is inefficient and will only generate inflation in the long run. Nonetheless, the delay in the diffusion of information assumed in the model (hypothesis first adopted by Lucas (1975)), allows the expansionary monetary policy to increase output and reduce unemployment in the short run. In the long run, however, when information spreads throughout the economy, the effects of this monetary expansion fade out and both output falls back to its initial (post-tax) level.

In this model, it is the recurrence of this pattern that generates cyclicality in GDP growth. The business cycle is generated by repeated interactions between rational agents and the Central Bank. The latter takes advantage of the delay in the transmission of information to revive economic activity in the short term. However, in the longer term, when all the information spreads into the economy, agents will adjust their expectations, thus canceling out the positive effects of the expansionary monetary policy. In response, the Central Bank increases again the stock of money in circulation to boost back the activity and so on...

The empirical tests carried out on US data over the 1980-2010 period allowed to validate these theoretical findings. In fact, even though the results based GDP volatility calculated using the Hodrick-Prescott filter and the Cobb-Douglas production function were inconclusive, the results obtained when GDP volatility is measured using moving averages are significant and confirm the findings of the theoretical model. More particularly, the authors showed that, in the United States, over the 1980-2010 period, GDP volatility (calculated using the standard

deviation compared to four-year moving averages) is amplified by economic policy (i.e. the combination of a tax and a monetary policy).

The corporate tax rate in t-2 had a direct, positive and significant impact on GDP volatility in period t. Money supply (M2), concurrently, has a more immediate impact on GDP volatility since an increase in money supply in t-1 leads to an increase in GDP volatility in period t. The empirical tests also show a positive relationship between corporate tax and money supply, and confirms out theoretical findings concerning the interaction between the tax and monetary policies. An increase in taxation leads to a contraction in production levels, prompting an intervention from the Central Bank.

The conclusions drawn from both the theoretical and empirical models are very interesting for the analysis and implementation of economic policy rules. First and foremost, economic policy should no longer be seen as a tool for stabilizing economic activity as was the case in the Keynesian approach of economic policy. In order to reduce GDP volatility, governments will have to limit the use of economic policy and reduce their interventions on the markets in order to avoid aggravating fluctuations by trying to stabilize economic activity. In fact, as was shown in this paper, economic policy can itself be source of disturbances and can aggravate GDP volatility. These findings are in line with the works of the New Classical Macroeconomics, and are comparable to the results of Lucas (1975), Kydland & Prescott (1980). However, this paper focuses on the joint impact of tax and monetary policies on the business cycle, whereas most of the existing research on economic policy and business cycles focus on one of the two policies. This allow to issue more comprehensive policy recommendations. This expands the scope concerning the disruptions generated by economic policy. The results could pave the way for future research based on economic policy as a whole and the business cycle.

The main limitation of this paper is that the impact of economic policy on GDP volatility is isolated. However, as widely discussed in economic literature, other factors might also generate GDP volatility. These factors include productivity shocks, political shocks (wars, conflicts ...), institutional shocks (democratization ...) or simply the electoral process. It would be interesting for future research to include economic policy within a broader set of variables, in order to isolate more precisely the impact of each one of them on the business cycle.

Endnotes

[i] Augmented Dickey-Fuller tests were performed to test for the stationary of the variables used in the regressions, and all non-stationary variables were stationarized.

[ii] All coefficients are significant at the 1%, R Squared is equal to 0.91 and the Durbin-Watson statistic is equal to 1.76 (close to 2). This allows the authors to rule out any risk of spurious regressions.

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