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Pure Theories of Policy Mix: Nordhaus's Destructive Game and the Case of High Inflation

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Nordhaus's theory of the "destructive game" (1994) is a central analysis of the policy mix. His theory showed that a lack of cooperation between the central bank and the fiscal authorities would result in the budget deficit being higher and the inflation rate lower than either of the authorities would want. It explains indeed why Central Bank independence can lead to these suboptimal results even when the goals of monetary policy are set by the fiscal authority. But the construction of this model was based on the existence of a Phillips-type relationship between the inflation rate and the unemployment rate, which has lost its relevance in the contemporary economy. Today, the prospect of a rise in the inflation rate leads to an increase in interest rates and a subsequent rise in the unemployment rate. This paper intends to show that the main conclusions of the Nordhaus model are preserved, with a model based on an increasing relationship between the inflation rate and the unemployment rate. Moreover, as in traditional macroeconomic theory, according to this version of the model, the unemployment rate is the same in steady states for different strategic equilibria.

Keywords: policy mix; Nordhaus's destructive game; monetary and fiscal policy

JEL classification: E10, E52, E58, E62

Introduction

In most Western countries, the central bank is independent from the fiscal authorities, and at least since the publication of the important paper by Alberto Alesina and Lawrence Summers (1993), many macroeconomists have considered central bank independence as an effective way to control inflation. Some even consider that central bank autonomy is a necessary condition for it to achieve its inflation rate targets. However, as William Nordhaus (1994) showed, in certain circumstances, the lack of cooperation between the monetary authorities and the government leads to a suboptimal policy mix for the two powers. Today, the return of inflation has revived the interest in William Nordhaus's model of the destructive game. This is a situation in which the government judges the inflation rate to be too low and reacts by increasing the

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budget deficit to prevent a decline in activity. The central bank then fears resistance in inflation and tightens its monetary policy. A cumulative process is then in motion. The government and the central bank lose because they both move away from their objectives. It is in this sense that the game is destructive. The fight against the high inflation that appeared in 2022 is at the origin of a well-known dilemma for central banks: Should we accept a sharp slowdown in growth to obtain the return of inflation to the level desired? As for the government, the problem is to support activity without excessively increasing the public deficit.

Nordhaus's article had the merit of proposing a very clear classification of possible situations in terms of policy mix, but the construction of this model was based on the existence of a Phillips-type relationship between the inflation rate and the unemployment rate. However, in the contemporary economy, this relationship has lost its relevance (Gopinath, 2022, Hazell et al., 2022, Smith et al., 2023). Indeed, when there is a supply and energy price shock, inflation and unemployment increase in parallel, as we saw during the two oil shocks of the 1970s. In such a context, the prospect of a rise in the inflation rate leads to an increase in interest rates and in the unemployment rate, that does not mean positive relationship between inflation and unemployment, only between expected inflation and future unemployment (Friedman, 1976). It is therefore interesting to determine whether the main conclusions of the Nordhaus model are preserved when this model is reconstructed based on an increasing relationship between the inflation rate and the unemployment rate.

Five essential points are developed through:

1. We propose a version of the Nordhaus model, highlighting all the policy-mix situations similarly to how they might be presented in a textbook.

2. We propose that this extension of the Nordhaus model should not only allow the integration of the case of quantitative easing but also the calculation of the inflation rate as well as the public deficit associated with each situation.

3. In a second step, we rebuild the model by replacing the Phillips curve with a non-decreasing relationship between the inflation rate and the unemployment rate, as can be observed after a supply shock or energy shock.

4. We show that the situation of the destructive game highlighted 40 years ago by William Nordhaus still exists from a theoretical point of view after the modification of his model. Indeed, this model reinforces the result obtained by Nordhaus.

5. We determine the value of the unemployment rate associated with each of the policy mixes.

The starting point of the analysis, is a simplified version of the Nordhaus model similar to that proposed by Lavigne and Villieu (1996). There are two economic independent authorities: the government and the central bank. Each of them seeks the optimal combination rate of unemployment–rate of inflation while endeavoring to minimize a loss function. In his model, Nordhaus (1994, p. 144) assumes that: « both authorities desire levels of unemployment and inflation that are lower than are simultaneously feasible given the inflation–unemployment constraints ». Moreover, he supposes that the fiscal authority (we quote him again) « has a penchant for high deficits » and that « the monetary authority has no intrinsic interest in the government surplus. »

From this perspective, it will be supposed that the government has a loss function that can be written as:

$$L^g(u,\pi) = \frac{1}{2}(u - u^g)^2 + \frac{1}{2}(\pi - \pi^g)^2 \tag{1}$$

In this formula, the variable u is the unemployment rate, u^g the objective of the government concerning unemployment rate, π the rate of inflation, π^g the implicit target level of inflation of the fiscal authority.

The government acts directly on a budgetary and fiscal variable d, which is its unique tool of economic policy. A positive value of d corresponds to a deficit, a negative value to a surplus. The fiscal variable d is the amount of expansionary fiscal policy that would reduce the unemployment rate by 1%.

The independent central bank controls the rate of inflation perfectly, which is its unique instrument of economic policy. The rate of inflation represents the monetary policy. It is assumed that the central bank has a different loss function from the preceding one:

$$L^m(u,\pi) = \frac{1}{2}(u - u^*)^2 + \frac{1}{2}(\pi - \bar{\pi})^2 \tag{2}$$

where $u^* > u^g$ is the natural rate of unemployment and $\bar{\pi}$ the target of inflation of the monetary authorities. It is also assumed that $\bar{\pi} < \pi^g$.

Two versions of the model are shown below. The first version is close to the Nordhaus model in that it incorporates a negative relationship between the unemployment rate and inflation. The second version assumes that there is a positive relationship between inflation and unemployment when the inflation rate is high following an energy shock.

1. The Nordhaus's case

It will be supposed that unemployment rate obeys the relation:

$$u = \bar{u} - d - a(\pi - \pi^*) + \varepsilon; \bar{u} > u^* > u^g > 0 \text{ and } a > 0 \tag{3}$$

π^* is the expected rate of inflation and ε denotes a random variable with zero mean. We are dealing here with a "Phillips curve" logic.

To simplify the computations, it is assumed in this study that one percentage point of increase in *d* results in a drop of a point in the unemployment rate. The relation (3) also means that an increase in the rate of inflation raises the real interest rate and unemployment because of its adverse effect on the aggregate demand. Indeed, the increase in interest rates causes a reduction in aggregate demand, and therefore in activity, which is at the origin of the rise in unemployment. The coefficient a is a measurement of the relative effectiveness of the monetary policy compared to the fiscal policy. If this coefficient exceeds one, it means that an additional point of inflation has more impact on unemployment than an additional point of deficit. This coefficient a is also the inverse of the slope of the Phillips curve. From an empirical point of view, this coefficient is well above unity (Blanchard, 2016) and probably between 2 and 7 in a country like the United States (Hooper et al., 2019). Equation (3) expresses the short-term positive impact of the deficit of public finances and the expansive monetary policy on the level of employment when the workers underestimate the inflation rate. There is a trade-off between u and π only when the expectations upon the inflation are wrong (Friedman, 1968). As the model is a short-term analysis, the variables are not dated. The short term here is a period during which agents' expectations (particularly regarding the inflation rate) are stable.

1.1 The reaction functions

To determine the reaction functions of the government and the central bank, one expresses the loss functions in terms of policy instruments, namely *d* for the government and π for the central bank. Thus, one can write:

$$L^g(d,\pi) = \frac{1}{2}[\bar{u} - d - a(\pi - \pi^*) + \varepsilon - u^g]^2 + \frac{1}{2}(\pi - \pi^g)^2 \tag{4}$$

$$L^m(u,\pi) = \frac{1}{2}[\bar{u} - d - a(\pi - \pi^*) + \varepsilon - u^*]^2 + \frac{1}{2}(\pi - \bar{\pi})^2 \tag{5}$$

The reaction function of the government is then obtained by setting the partial derivative of $L^g(d, \pi)$ with respect to *d* equal to zero. Thus:

$$d = \bar{u} - a(\pi - \pi^*) + \varepsilon - u^g \tag{6}$$

Setting the partial derivative of L^m (δ, π) with respect to π equal to zero yields the central bank's reaction function:

$$\pi = \frac{\bar{\pi} + a^2\pi^*}{1 + a^2} + \frac{a}{1 + a^2}[(\bar{u} - u^*) - d + \varepsilon] \tag{7}$$

1.2 The equilibria

There are five possible equilibria: the Nash equilibrium; monetary rule; the inflation targeting equilibrium; monetary dominance; and cooperation. To these situations must be added the specific case of unconventional monetary policy measures. The case of "monetary dominance" may seem surprising. Indeed, government authorities are elected, and they set the objectives of the central bank. However, there are circumstances where central bank policy is dominant. We will give two examples here. A first case is where the loss of the independence of the central bank would have such negative consequences that the government can hardly call into question the choices of the central bank. It is a situation of this type that we find in the countries of the euro zone. A second case is where straying too far from the official inflation target would result in such a loss of competitiveness that the government would be unable to limit the increase in unemployment and would diverge too far from its own objectives...

The values of π and d corresponding to each of these situations will be indicated by the letter appearing as an exponent (N for the Nash equilibrium, R for the monetary policy rule, etc.).

1. The Nash equilibrium is obtained by simultaneously solving equations 6 and 7. Thus, the Nash equilibrium is (point N on Figure 1):

$$\pi^N = \bar{\pi} + a(u^g - u^*) \tag{8}$$

$$d^N = \bar{u} + a^2 u^* - (1 + a^2)u^g + a(\pi^* - \bar{\pi}) + \varepsilon \tag{9}$$

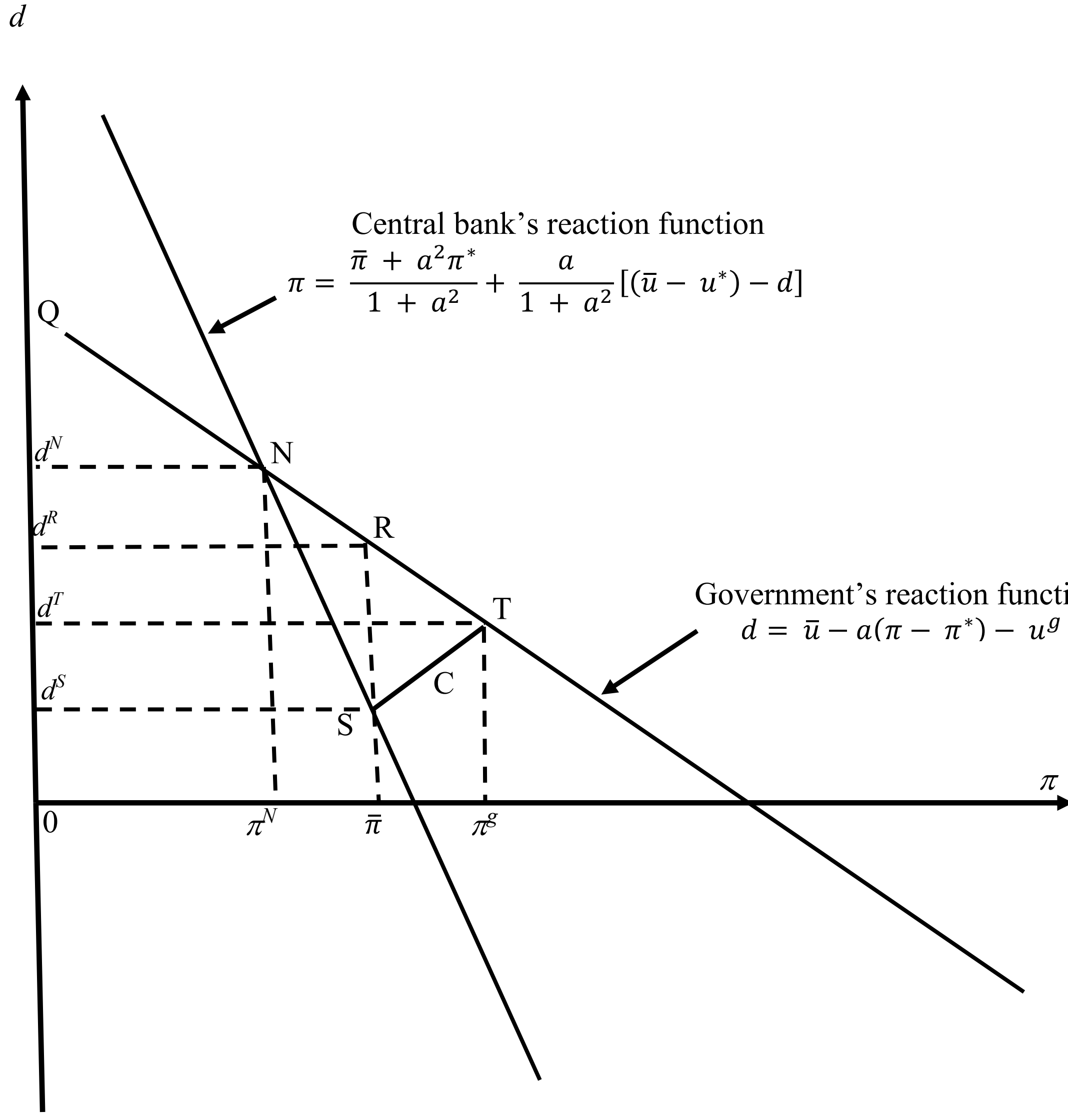
A first important result appears in the case of noncooperation between the government authority and the central bank. *We find that at the Nash equilibrium, the inflation rate π^N is below the central bank's target* $\bar{\pi}$ because $u^* > u^g$. We will later prove that d^N (the deficit in the Nash equilibrium) is greater than the deficit d^T desired by the tax authorities.

How can we explain the fact that the rate of inflation obtained in noncooperative equilibrium is lower than the central bank target? The government reacts to the initial rate of inflation that it considers too low by trying to stimulate the activity again through increasing in d. The central bank then strengthens its monetary policy by choosing an adjustment even more restrictive of its policy and so on… The final rate of inflation in the Nash equilibrium, π^N, will be too low and the real interest rate too high to avoid a strong increase in unemployment, and the deficit d will have increased appreciably. This "monetary-fiscal game" is in this sense "destructive." It leads the economy towards a suboptimal Nash equilibrium. Moreover, if the relative efficiency of the monetary policy is strong, i.e., if the coefficient a is high, the slopes of the two reaction functions are almost the same. In such a case, the Nash equilibrium is characterized by very high deficits and a very low rate of inflation.

Noncooperation of the authorities is, then, particularly costly for the economy. What are the other possible cases of the policy mix? Five of them will be studied: the monetary policy rule; inflation targeting; capitulation of the government; cooperation; and quantitative easing.

These different situations are represented in Figure 1 below. This figure is constructed by confronting the reaction functions of the government and the central bank on the plane (π, d).

Figure 1. Policy mix equilibria in the Nordhaus model



2. *In the case of a monetary policy rule, it will be assumed in this paper that the central bank is led by a "conservative central-banker*" in the sense that he places a greater weight on inflation stabilization than on society as a whole (Rogoff, 1985 and 2021). In this monetary rule scenario (point R on Figure 1), the realized rate of inflation is the target of the central bank:

$$\pi^R = \bar{\pi} \tag{10}$$

Since $\pi^R = \bar{\pi}$, we deduct the realized deficit d^R:

$$d^R = \bar{u} - a(\bar{\pi} - \pi^*) + \varepsilon - u^g \tag{11}$$

We notice that $d^R < d^N$because $u^* > u^g$.

3. At the inflation targeting equilibrium (point T on Figure 1), the inflation target is either set by the government or negotiated by the central bank and the government (Walsh, 2011) as was the case in the past with countries such as Australia, New Zealand, Canada, and the United Kingdom. This can also occur where a *de jure* independent central bank is under government pressure to accept a higher rate of inflation. It is known that, in the real world, in an average year, around 10% of central banks experience such pressures (Binder, 2020, 2021). Thus:

$$\pi^T = \pi^g \tag{12}$$

The realized deficit is:

$$d^T = \bar{u} - a(\pi^g - \pi^*) + \varepsilon - u^g \tag{13}$$

We notice that $d^T < d^R < d^N$ because $u^* > u^g$.and $\pi^g > \bar{\pi} > \pi^N$.

4. If the government "capitulates" to the choices of the central bank, we find a Stackelberg equilibrium in the sense that the fiscal authorities adopt the central bank's preferences (point S on Figure 1). Thus, in this case:

$$\pi^S = \bar{\pi} \tag{14}$$

and the deficit is (as can be checked by replacing π with its value of $\bar{\pi}$ in the central bank's reaction function):

$$d^S = \bar{u} - a(\pi^* - \bar{\pi}) + \varepsilon - u^* \tag{15}$$

It can be verified that in this case, the deficit takes a minimal value. Indeed, $d^S < d^T < d^R < d^N$ because $u^* > u^g$.

5. If the government has a preferred policy mix (π^g, d^T) and the monetary authorities an absolute preference for the values $\bar{\pi}$, and d^S, the outcome of a cooperative strategy of the two policymakers (point C in Figure 1) would be as follows: One would obtain a rate of inflation higher than $\bar{\pi}$ (the target of inflation of the monetary authorities) and a budget deficit lower than d^T but higher than d^S. This last deficit, d^C, is easily calculated starting from the reaction function of the central bank, that is to say:

$$d^c = \lambda d^s + (1-\lambda)d^T \, ; 0 \leq \lambda \leq 1 \tag{16}$$

The cooperation area is defined by a rectangle whose north-eastern top (point T) is determined by the targets of the government and the south-western top (point S) by those of the central bank. This area is at its widest when the targets of the two authorities are divergent. We can conclude that:

$$\pi^S < \pi^C < \pi^T$$

$$d^S < d^C < d^T$$

6. A last special case is made up of "alternative monetary policy instruments." These techniques are only used when the economy is operating in a deflationary environment as was the case for many years after the "Great Recession." After the fall of the Lehman Brothers, the central banks quickly arrived at the "zero lower bound" of interest rates. They then used "quantitative easing," which allowed them to considerably increase bank liquidity without generating an inflationary process. Such a situation corresponds to a point Q on Figure 1, characterized by zero (or very low) inflation and a very high budget deficit to support economic activity. Moreover, these instruments are considered by some (Rogoff, 2019, 2021) as quasi-fiscal instruments. Thus, in the case of quantitative easing, we have:

$$\pi^Q = \bar{\pi} = 0 \tag{17}$$

$$d^Q = \bar{u} + a\pi^* + \varepsilon - u^g \tag{18}$$

From all the above we can deduce the following hierarchies of deficits and inflation rates associated with the six cases previously studied.

$$\pi^Q < \pi^N < \pi^R (= \pi^S = \bar{\pi}) < \pi^c < \pi^T \text{ and (since } \bar{u} > u^* > u^g)$$

$$d^Q > d^N > d^R > d^T > d^C > d^S$$

1.3 The unemployment rate

By using the equation (3) of the model, we can calculate the unemployment rate associated with each policy mix. Note that, in the case of quantitative easing, we naturally assume that $\pi = 0$ to perform the calculations. The calculations are very simple but tedious. They show that the unemployment rate is in equilibrium equal to u^g, the rate desired by the government, both in the case of the Nash equilibrium and in the instances of monetary rule or inflation targeting.

In the model studied, this result is explained by the fact that the government systematically offsets the interest rates that it deems too high with a deficit that maintains an acceptable level of activity.

It is only in the case of government capitulation to the central bank that the unemployment rate reaches its natural value $u*$.

Naturally, in the case of cooperation between the monetary authorities and the fiscal authorities, the unemployment rate u^c will take an intermediate value between its natural value and the value initially sought by the government: $u^g < u^c < u^*$.

Thus, the Nordhaus model led to two essential conclusions:

According to him, *the independence of the central bank led to a situation dominated by the monetary rule since the latter made it possible to achieve the target inflation rate and a lower public deficit than in the Nash equilibrium. However, cooperation between an independent central bank and the government may yield still better results than the monetary rule if the negotiated inflation rate is close to the central bank's target.*

The unemployment rate reaches its natural value in all cases of policy mix except in the case of cooperation between the two authorities and in the case of government capitulation.

Are these conclusions preserved by the "high inflation" model?

2. The high inflation case

The Phillips curve played an important role in the Nordhaus model. But if recent studies show that the Phillips curve is not dead, it is clear that it has been "dormant" for several years (Blanchard, 2016; Hooper et al., 2019). The slope of the Phillips curve has become very low (Del Negro et al., 2020), and according to a recent study by the International Monetary Fund, the appearance of rising inflation from the second quarter of 2021 was in no way driven by the unemployment rate but by a combination of a very sharp rise in energy costs, raw material prices (Gopinath, 2022) and of very expansionary demand conditions (Eickmeier and Hofmann, 2022). In developed-market economies, episodes of high inflation comparable to the current surge in price increases are old. It is necessary to go back essentially to the 1970s to find such phenomena of supply and energy shocks in these economies (Blanco et al., 2022). However, in this paper, we are studying situations that do not happen often but are possible after supply shocks like the recent episode. These situations are rare but very important from the point of view of their macroeconomic consequences.

What modifications should be made to the previous model to take into account this phenomenon of high unexpected inflation?

The first obvious implication is that the “quantitative easing” situation disappears from the new model since alternative monetary policies are implemented when the inflation rate is close to zero.

In the new version of the model, the relationship linking the unemployment rate to the inflation rate must be modified. It will be supposed that unemployment rate obeys the relation:

$$u = \bar{u} - d - b(\bar{\pi} - \pi) + \varepsilon; b \geq 0 \qquad (1')$$

As before, $\bar{\pi}$ is the target of inflation of the monetary authorities and ε denotes a random variable with zero mean. How to explain this new form of the relationship between the inflation rate and the unemployment rate? We are dealing here with an “anti-Phillips” logic insofar as unemployment and inflation are linked this time by a *non-decreasing* relationship. Indeed, in the contemporary economy, a rise in inflation beyond the central bank’s target $\bar{\pi}$ encourages the latter to increase its rates. If b is a non-null coefficient, this decision causes an increase in the unemployment rate due to the inertia of the inflation rate, which in turn allows a rise in the real interest rate. Likewise, when the positive gap between the observed inflation rate and the target inflation rate decreases, the unemployment rate falls because the central bank lowers its key rate. It should also be noted that when the inflation rate is "high", this means that it exceeds the central bank's objective. It is therefore no longer the gap between anticipated inflation and the actual inflation rate that is relevant (relation in (3)) but the difference between the latter and the central bank's target (relation in 1’)... Finally, if b is null, the unemployment rate is independent of the inflation rate.

To simplify the computations, it is assumed in this study that one percentage point of increase in d results in a drop of *one* point in the unemployment rate. The increase in the public deficit reduces unemployment due to its positive effect on aggregate demand. The relation in (1’) also means that an increase in the rate of inflation raises the real interest rate and unemployment because of its adverse effect on this aggregate demand. The coefficient b directly measures the sensitivity of the unemployment rate to the inflation rate and indirectly to changes in monetary policy since it was assumed that the monetary authorities perfectly control the inflation rate through their action on the rate of interest. If the coefficient b is higher than the unit, it means that an additional point of inflation has more impact on unemployment than an additional point of d.

2.1 The reaction functions

To determine the reaction functions of the government and the central bank, one expresses the loss functions in terms of policy instruments, namely d for the government and π for the central bank. As before, u^g is the objective of the government concerning unemployment rate and π^g the implicit target level of inflation of the fiscal authority.

The loss functions can thus be expressed as follows:

$$L^g(d,\pi) = \frac{1}{2}[\bar{u} - d - b(\bar{\pi} - \pi) + \varepsilon - u^g]^2 + \frac{1}{2}(\pi - \pi^g)^2 \quad (2')$$

$$L^m(d,\pi) = \frac{1}{2}[\bar{u} - d - b(\bar{\pi} - \pi) + \varepsilon - u^*]^2 + \frac{1}{2}(\pi - \bar{\pi})^2 \quad (3')$$

As in the first part of this paper, it is assumed that $u^* > u^g$ and that $\bar{\pi} < \pi^g$.

The reaction function of the government is then obtained by setting the partial derivative of $L^g(d, \pi)$ with respect to d equal to zero. Thus:

$$d = \bar{u} - b(\bar{\pi} - \pi) + \varepsilon - u^g \quad (4')$$

Setting the partial derivative of $L^m(d, \pi)$ with respect to π equal to zero yields the central bank's reaction function:

$$\pi = \bar{\pi} + \frac{b}{1 + b^2}[d - (\bar{u} - u^*) - \varepsilon] \quad (5')$$

2.2 The equilibria

1. A first case which can be described as trivial is that where the coefficient b is zero. Fiscal and monetary policies then no longer have any interaction. In this case, the Government's reaction curve becomes horizontal and the Central bank's reaction curve is a vertical one. Thus, the Nash equilibrium merges with point R of the monetary rule:

$$\pi^N = \pi^R = \bar{\pi} \quad (6')$$

$$d^N = d^R = \bar{u} - u^g + \varepsilon \quad (7')$$

Furthermore, when the coefficient b is zero, the points C, S and T disappear for obvious reasons. The central bank then easily achieves its inflation target, $\bar{\pi}$.

On the other hand, when the coefficient b is different from zero, we find that in this "anti-Nordhaus" case, the reaction functions of the government and the central bank are this time increasing on the plane (π, d). This will modify the characteristics of the Nash equilibrium.

In this scenario, the unconventional monetary policy situation disappears because the inflation rate is assumed to be “high.”, that is to say, significantly higher than the central bank's objective.

In Figure 2 below, which represents the various policy mix equilibria based on the new hypotheses that have just been made, there is therefore not the equivalent of the point Q in Figure 1.

2. The Nash equilibrium is (point N on Figure 3):

$$\pi^N = \bar{\pi} + b(u^* - u^g) \tag{8'}$$

$$d^N = \bar{u} + b^2u^* - (1 + b^2)u^g + \varepsilon \tag{9'}$$

In this case, $\pi^N > \bar{\pi}$ since $u^* > u^g$. This is a first important difference with the previous analysis. How do we explain that, this time, the Nash equilibrium results in a higher inflation rate than the central bank’s target? The government reacts to a monetary policy that it considers too restrictive by increasing its budget deficit. But the increase in the latter causes an increase in the inflation rate, which is a source of unemployment because of the increase in the interest rate induced by the monetary policy. This causes a new increase in the public deficit and so on. Thus, the dynamics of the policy mix remain “destructive” since the uncoordinated interaction of the fiscal authorities and the central bank leads the economy towards a more inflationary equilibrium and generates high deficits.

3. Moreover, in the monetary rule case (point R), the inflation rate and the fiscal deficit are as follows:

$$\pi^R = \bar{\pi} \tag{10'}$$

$$d^R = \bar{u} - u^g + \varepsilon \tag{11'}$$

Thus, $d^R < d^N$.

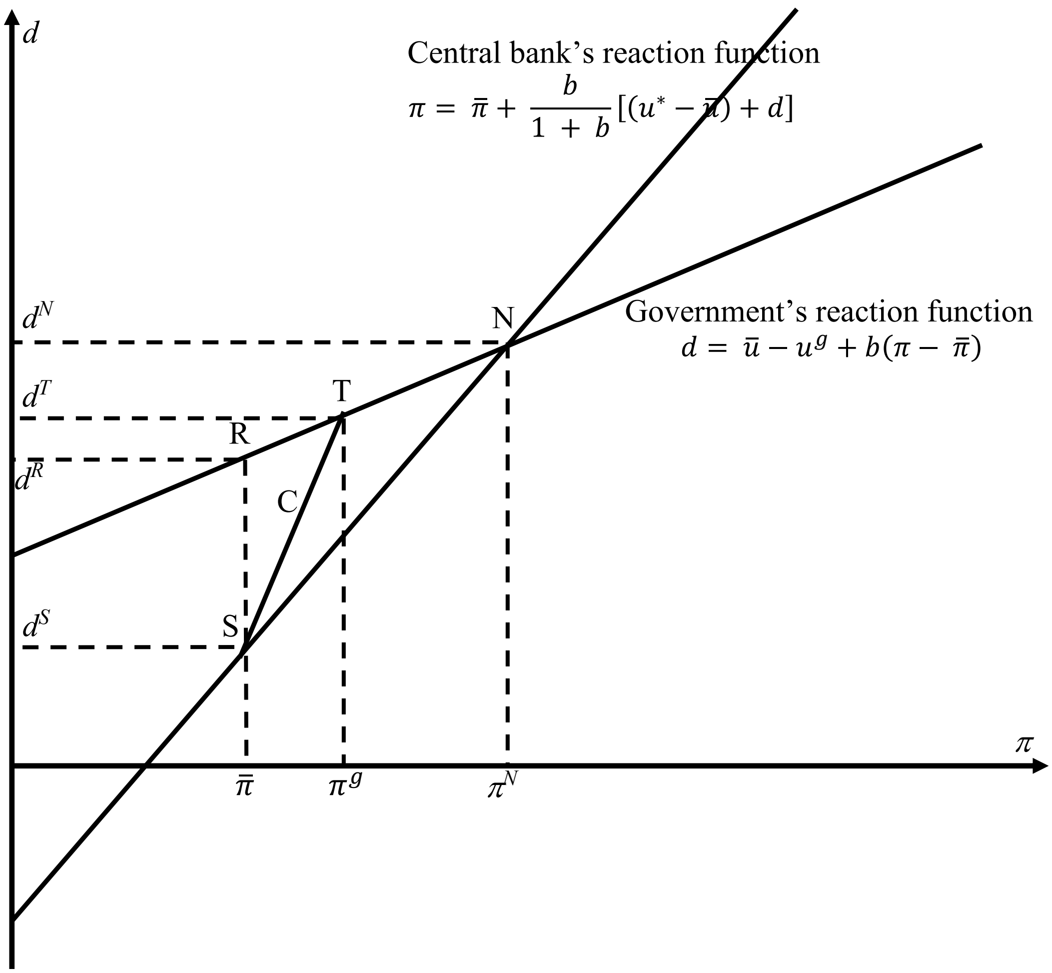
4. In the inflation targeting case (point T):

$$\pi^T = \pi^g \tag{12'}$$

$$d^T = \bar{u} - u^g + b(\pi^g - \bar{\pi}) + \varepsilon \tag{13'}$$

Thus, $d^T > d^R$ since $\pi^g > \bar{\pi}$.

Figure 2. Policy mix equilibria with a "moderate" government inflation target ($\pi^g < \bar{\pi} + b(u^* - u^g)$).



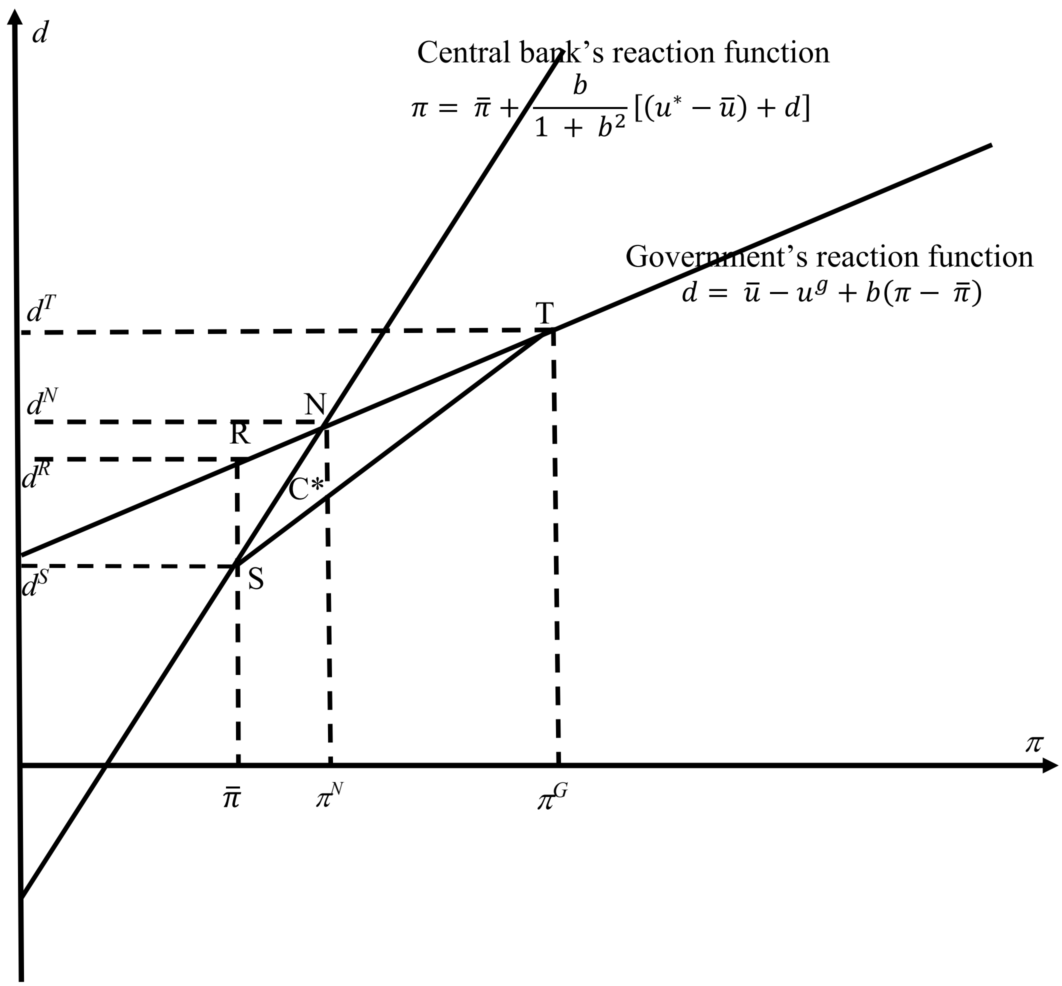
However, it is possible for d^T to be greater than the deficit in the Nash equilibrium, d^N, provided that the Nash equilibrium rate of inflation, π^N, is such that: $\pi^N < \pi^g$**.** Indeed, $d^T > d^N$ if $b(\pi^g - \bar{\pi}) > b^2(u^* - u^g)$. Now, $u^* - u^g = \frac{\pi^N - \bar{\pi}}{b}$, which implies that the inequality $b(\pi^g - \bar{\pi}) > b^2(u^* - u^g)$ is true if $\pi^g > \pi^N$. This last condition will occur if $\pi^g > \bar{\pi} + b(u^* - u^g)$. This case is shown in Figure 3.

5. If the previous inequality applies, the cooperation between the two authorities is no longer the guarantee of lower inflation and lower deficit than in the case of a Nash equilibrium. The virtuous result $d^T < d^N$ and $\pi^N > \pi^T$ will only be obtained if the agreement between the

government and the central bank is close to the preferences of the latter. Thus, the situation corresponding to point C is Pareto superior to the Nash equilibrium only when $\pi^g < \bar{\pi} + b(u^* - u^g)\pi^g < \pi^N$ (i.e., $\pi^g < \pi^N$) because in this situation, the cooperation implies both less inflation and less deficit.

Otherwise, the central bank has no interest in trying to cooperate. Indeed, why would it do so since, without cooperation, it would obtain a better result than by negotiating its choices with the government? Therefore, in Figure 4, point C is close to point S... An asterisk above the letter C indicates that the positioning of this point further to the right is not relevant from an economic point of view.

Figure 3. Policy mix equilibria with a "high" inflation target ($\pi^g > \bar{\pi} + b(u^* - u^g)$).



6. In the event of central bank dominance (point S), central bank preferences dominate policy choices. Hence:

$$\pi^S = \bar{\pi} \tag{14'}$$

$$d^S = \bar{u} - u^* + \varepsilon = d^R \tag{15'}$$

In summary, the macroeconomic performance hierarchies are as follows:

1) If $\pi^g > \bar{\pi} + a(u^* - u^g), \pi^R (= \pi^S = \bar{\pi})(< \pi^c?) < \pi^T < \pi^N < \pi^G$ and

$$d^T > d^N > d^S (= d^R)$$

2) If $\pi^g < \bar{\pi} + a(u^* - u^g), \pi^R (= \pi^S = \bar{\pi}) < \pi^c < \pi^T < \pi^G < \pi^N$ and

$$d^N > d^T > d^C > d^S (= d^R)$$

2.3 The unemployment rate

The use of equation (1') makes it possible, as before, to determine the value of the unemployment rate associated with each policy mix. As in the first version of the model, in macroeconomic equilibrium, the unemployment rate is equal to the rate desired by the government, u^g, except in the event of cooperation between the authorities or in the case of the capitulation of the fiscal authority. As before, such a result is due to the systematic government compensation of high interest rates by large deficits, which maintain the level of activity. But the model being static, it is hardly possible to precisely determine the path of the unemployment rate towards the equilibrium.

Therefore, in all cases of policy mix, we find a tendency for the unemployment rate to become independent of the inflation rate (as in the old theory of Milton Friedman and Edmund Phelps) once the macroeconomic equilibrium has been reached.

2.4 The special case of the European Central Bank

The case of the European Central Bank (ECB) is special because it acts not within a national framework but within a framework of monetary union between different countries that share the same currency. It is natural to think that the framework of a European Monetary Union changes the nature of the Nordhaus model because the monetary authority is confronted with as many budget policies as there are participating countries. It will thus be necessary to distinguish the reaction function of the central bank to the government financial balance of a country and its reaction function to the policy pursued by the overall area. But other specificities must be integrated into the analysis. In a more precise way, it is necessary to modify two elements of the preceding model to take account of the characteristics of the euro area.

First, the loss function of the ECB gives a supremacy to the price stability target compared to that of the activity and unemployment. In contrast to the US Federal Reserve, whose mandate is maximum employment, stable prices, and moderate long-term interest rates, the objective function of the ECB thus ascribes a much stronger weight to the inflation gap than to the output gap. This asymmetry could easily be accounted for by formulating the central bank loss function in this way:

$$L^m(u,\pi) = \frac{\alpha}{2}(u - u^*)^2 + \frac{(1-\alpha)}{2}(\pi - \bar{\pi})^2;\text{ with } \frac{1}{2} > \alpha > 0 \tag{16'}$$

Integrating (1') into L^m *(u, π)* and setting the partial derivative of L^m *(d, π)* with respect to *π* being equal to zero yields the central bank's reaction function:

$$\pi = \bar{\pi} + \frac{\alpha b}{1-\alpha+\alpha b^2}[d - (\bar{u} - u^*) - \varepsilon] \tag{17'}$$

Secondly, if the currency of the countries of the euro area is the same, their public finances remain national. This institutional asymmetry has consequences on the implementation of the fiscal policy in each country.

In this context, there are two kinds of reaction functions of the central bank. It is necessary to distinguish the reaction function of the ECB with respect to the public finances policy of a country and its reaction function with respect of the overall Monetary Union's fiscal situation.

On a countrywide scale, this reaction function is clearly perceived as a vertical line (or at least near to a vertical line in the case of a big country). Indeed, the budget balance of only one country hardly has any influence (or very little, in the case of a "big country") on the monetary policy choices of the central bank. In addition, on this same country scale, *the contract curve [S, T] disappears* since a country could not be the only interlocutor of the central bank. Let us note that on this level, there is no monetary-fiscal game in the sense of the first part of this study. *The Nash equilibrium merges with point R of the monetary rule*. The reason for this is that the central bank does not tighten its monetary policy when a European Monetary Union country has a fiscal policy leading to an aggravation of its deficit or a fall of its surplus.

But the analysis changes if the level of the overall Monetary Union is considered. Indeed, the slope of the central bank's reaction function in the plan (*d*, *π*) is no more infinite. This result is explained by the fact that a modification of the financial balance of the euro area affects the activity and the unemployment. However, the cooperation equilibrium (point C) disappears if, like in the euro area, there is not an economic government or an actual coordination between the national fiscal policies adopted by the various governments of the European Monetary Union. For the same reason, T is only a virtual point. The less the employment level is taken into account by the central bank, the higher the slope of the reaction function (in absolute value). Such an outcome means that in this case, the behavior of the central bank is akin to that of a "conservative banker" (Rogoff, 1985). In other words, in the limitation case where the central bank adopts the only target of inflation, it will not deviate from it, whatever the macroeconomic cost of that strategy. In this extreme case, the coefficient α tends towards a zero value. The central bank reaction function is then a vertical line starting from $\pi = \bar{\pi}$ and the Nash equilibrium N is the same one as the monetary rule equilibrium R.

In the general case where the parameter α is different from zero, the reaction function has a more accentuated slope than in figures 1, 2 and 3. The strong weighting of the price stability objective, like in the euro area, leads to the Nash equilibrium drawing closer to the monetary rule equilibrium. In this case, the points N and R are close to each other (for instance, π^N= 3%, *d* = 4% in point N and $\bar{\pi}$ = 2 % and *d* = 3 % in point R). Furthermore, the virtual point T merges with point R because inflation targeting cannot be distinguished from the situation of pure monetary rule. *This means that the effective policy mix will not be too far away from the central bank preferences…*

Conclusions

The conclusions of the Nordhaus model in a context of high inflation confirm the existence of a destructive game. However, the inferiority of the Nash equilibrium with respect to the monetary rule is reinforced. Indeed, an independent central bank that does not cooperate with the fiscal authorities would bring the economy to an equilibrium characterized by a high public deficit but also (contrary to the conclusion of the first model) by high inflation.

Moreover, when the government's inflation targets are tight enough (i.e., $\pi^g < \bar{\pi} + \mathrm{a}(u^* - u^g)$), the Nash equilibrium is dominated by all the other equilibria since it leads to worse results for both the inflation rate and the public deficit.

Finally, as in traditional macroeconomic theory, the unemployment rate is the same for different strategic equilibria once the macroeconomic equilibrium has been reached.

References

Alesina, Alberto and Laurence Summers (1993), Central Bank Independence and Macroeconomic Performance: Some Comparative Evidence, *Journal of Money, Credit and Banking*, 25, 151-162.

Binder, Carola (2020), De facto and De Jure Central Bank Independence, in Ernest Gnan and Donato Mascandiaro (eds.), *Populism, Economic Policies and Central Banking*, Vienna: SUERF Conference Proceedings 1/2020, the European Money and Finance Forum., 129-136.

Binder, Carola (2021), Political Pressure on Central Banks, *Journal of Money, Credit and Banking*, 53, 715-744.

Blanco, Andrés, Pablo Ottonello and Tereza Ranosova (2022), The Dynamics of Large Inflation Surges, NBER Working Paper 30555.

Blanchard, Olivier Jean (2016), The Phillips Curve: Back to the '60s? *American Economic Review*, *Papers & Proceedings*, 106, 31-34.

Del Negro, Marco, Michele Lenza, Giorgio E. Primiceri and Andrea Tambalotti (2020), What's Up with the Phillips Curve? NBER Working Paper 27003.

Eickmeier, Sandra and Boris Hofmann (2022), What Drives Inflation? Disentangling Demand and Supply Factors, BIS Working Paper 1047.

Friedman, Milton (1968), The Role of Monetary Policy, *American Economic Review*, 58, 1-17.

Friedman, Milton (1976), Inflation and Unemployment, *Nobel Memorial Lecture*, December 13, 1976, 267-286.

Gopinath, Gita (2022), How Will the Pandemic and War Shape Future Monetary Policy? Presentation at the Jackson Hole Conference, August 26.

Hazell, Jonathon, Juan Herreño, Emi Nakamura and Jon Steinsson (2022), The Slope of the Phillips Curve: Evidence from U.S. States, *The Quarterly Journal of Economics*, 137, 1299-1344.

Hooper, Peter, Frederic S. Mishkin and Amir Sufi (2019), Prospects for Inflation in a High Pressure Economy: Is The Phillips Curve Dead or Is It Just Hibernating? NBER Working Paper 25792.

Lavigne, Anne and Patrick Villieu (1996), La politique monétaire : nouveaux enjeux, nouveaux débats, *Revue d'économie politique,* 106, 491-567.

Nordhaus, William (1994), Policy Games: Coordination and Independence in Monetary and Fiscal Policies, *Brookings Papers on Economic Activity*, 2, 139-199.

Rogoff, Kenneth (1985), The Optimal Degree of Commitment to an Intermediate Monetary Target, *Quarterly Journal of Economics*, 100, 1169-1189.

Rogoff, Kenneth (2019), How Central-Bank Independence Dies, *Project-Syndicate*, May 31.

Rogoff, Kenneth (2021), Risks to Central Bank Independence, in Ernesto Pastén and Ricardo Reis (eds), *Independence, Credibility and Communication of Central Banking*, Santiago: Central Bank of Chile, 27-54.

Smith, Simon C., Alan Timmermann and Jonathan Wright (2023), Breaks in the Phillips Curve: Evidence from Panel Data, *Finance and Economics Discussion Series* 2023-015, Federal Reserve Board, Washington, https://doi.org/10.17016/FEDS.2023.015.

Walsh, Carl E. (2011), Central Bank Independence Revisited, *Economic Papers*, 30, 18-22.