Economic Integration and Political Accountability

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Abstract

This paper studies to what extent economic integration, or globalization, influences the accountability of politicians. Assuming that politicians are controlled by the voters through reelection rules, we analyze to what extent economic integration affects the form of those rules and the efforts made by politicians. We define economic integration by the existence of policies and shocks interdependences between countries. Then, from a political point of view, this integration is shown to be a two-sided phenomenon. Shock-interdependence allows yardstick comparison, increases political accountability and therefore efforts while policy-interdependence induces a lack of responsibility and harms the extent to which politicians can be controlled.

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1 Introduction

For now more than a half of century, the world has witnessed a trend of trade globalization (see Feenstra (1998)). In 1950, the volume of foreign trade[1] of the USA accounted for 3% of their GDP whereas it now more than 12%. This movement has been even more substantial in the European countries where the ratio of exports to GDP is now about 25% for countries like Germany or France. The analysis of the economic impact of this sharp transformation has been studied in depth by economists [2]. What we rather aim at doing is to concentrate on the political impact of globalization. More precisely, we will see to what extent the change in the economic conditions induced by globalization influences the nature of the relationship between citizens and their government and therefore the constraints the former can impose on the behavior of the latter

The motivation for this analysis is twofold. First, we believe that the control of governmental activities is one the main problems faced by citizens. It leads us to analyze the actual behavior of politicians as the consequence of a *contract* (implicit or explicit) with the citizens of their country. In situations where the actions really chosen by the politicians are not observable, the knowledge of the economic environment is then fundamental to assess the compatibility of those actions with the contract. The second and joint motivation for this paper originates in that, with the recent trend of globalization, the economic environment of many countries has changed. The existence of business cycles, the interdependence of policies have generated the development of economic areas of countries facing, at the same time, similar economic conditions. The objective of our paper is then to express the link between several aspects of this economic integration and the degree of control voters can have on their politicians.

We will use a specific definition of economic integration which covers many (but not all) of the features of globalization. We define economic integration by two types of interdependence : the similarity in the exogenous economic conditions between countries and the links between the actions or the policies taken by the politicians.

[1]The volume of trade is here given by exports plus imports divided by two.

[2]See Rodrick (1998) for a global introduction to the economic issues induced by globalization, Feenstra (1998) for the impact on employment and wages, Neumeyer (1998) for the gobal welfare analysis of Monetary Union in a general equilibrium model and Corsetti-Pesenti (2001) for the study of the monetary and fiscal transmission in interdependent economies.

The first effect analyzed, called *shock-interdependence,* reflects the similarities between the economic cycles of integrated countries. For example, France and Germany (or the USA and Canada) are more likely to be in the same cycle than the USA and France. Thus, we assume that economic integration goes hand in hand with a positive correlation of shocks (see Backus-Kehoe-Kydland (1994) for empirical evidences).
The second effect taken into account, the *policy-interdependence,* encompasses two ingredients we chose to treat jointly. The first one is related to the existence of externalities between countries. The budgetary policy of Germany has a major influence on the welfare of, say, France not only because those two countries are close geographically but also because they belong to the same economic area. Similarly, the efforts made to control the quality (or security) of the goods in a country have an impact on all the countries importing these goods. The second ingredient is the dillution of policy effectiveness arising in an integrated environment. In a globalized economy, many policies lack effectiveness because of standard eviction effects.

Taking those two types of interdependence as the essential features of economic integration, we focus on the following problem. Consider an economic area with several countries. In each of those countries, a government must choose an effort level, costly and unobservable, to increase the welfare of its citizens. In fact, the *ex post* level of welfare is also influenced by an unobservable (at least before the election) exogenous shock. We study then whether the inclusion of a country in an integrated economic area limits or extends the ability voters have to control their governments. In this work, we do not study the potential economic benefits from the integration. The core questions in our environment caracterized by informational asymmetries are then : 1) How is it possible to assess the quality of the policy chosen in a country? 2) Does economic integration increase the accountability of politicians?

The approach used in the paper follows the steps of Barro (1973) and Ferejohn (1986) in that we consider the relationship between governments and voters as a simple Principal-Agent relationship. Of course, the type of "contract" considered here is much simpler than in a real complete contract framework. Indeed, the benefits arising out of political activities are simple and given. Either the politician is reelected and gains the associated private benefits; or he is fired and gains nothing. As in Ferejohn (1986), we focus on the moral hazard aspect of this relationship, trying to find the maximal level of effort the

voters can expect from their politicians. But our study differs from the previous work by the analysis a series of voters/government couples (one in each country). Using yardstick comparison methods (see Holmström (1982) or Mookherjee (1984)), we study the impact of economic integration on the moral hazard problem faced by the voters in each country.

Our paper rests on two assumptions concerning the behavior of the voters, both connected with the idea of full rationality. The first one is that agents use retrospective economic voting. This assumption is in fact quite general in the theoretical literature but also confirmed by many empirical studies (see for example Lewis-Beck (1988)). The second assumption is that voters may use all types of information to infer the action of their politician. In particular, they are able to use yardstick competition mechanisms if those methods appear to be optimal. This implication of rationality may seem relatively strong but some empirical studies have shown that voters are using roughly this type of reasoning to cast their ballot (see Besley-Case (1995) or Wolfers (2000)).

In our model, the politicians are only controlled through reelection rules. One part of our work has been to clarify the form of the optimal reelection rules in different economic environments. But more importantly, from a political normative point of view, we have shown that economic integration is a two-sided phenomenon. On the one hand, the accountability of politicians benefits from the similarities between the economic cycles of integrated countries. On the other hand, it induces a lack of accountability because of the reduced effectiveness of policies.

To our knowledge, Mukand (1998) is the only paper close enough to be connected to our work on the political implications of globalization. This article tries to show how globalization may induce politicians to choose sub-optimal policies. The work relies on the idea that, even though a government may possess a more precise information on the state of the world than financial markets, a policy which would go against the general belief would not be favored by the financial community and may trigger a currency crisis. In other words, in a globalized world where the desire to attract foreign capital is strong, governments may choose inappropriate policies to conform the whims of the market. Contrarily to our approach, Mukand still considers benevolent governments, even though they faces new contraints created by the increased volatility of capital, and therefore neglects any real political game within the country.

After a short presentation of the model (section 2), we study a benchmark case in which

there is no economic integration (section 3). Then (section 4) we analyze the two effects of integration, the shock-interdependence and the policy-interdependence. We compare the degree of accountability of politicians with economic integration and without. In the last section, we propose some extensions and conclude.

2 The Model

We consider a setting with two countries, 1 and 2. In each country, there are two types of agents: the voters (or citizens) and the politicians (incumbent and potential) and we call politician i the incumbent politician in country i. Since we want to focus on the relationship between voters and politicians, we ignore any heterogeneity within the set of voters in each country. The objective of incumbent politicians is to be reelected. They derive a private benefit B from their office. To ensure their position, they can make a non observable costly effort (a in country 1, b in country 2) which increases the voters' welfare. This effort is restricted to non-negative values. The cost of effort is assumed to be linear in the level of effort.

In addition to this effort, the welfare (denoted W_i in country i) is a function of a non-observable random shock (ϵ_i). We mean by this that the actions taken by any government do not always result in the same outcome. Many unforeseen and often unobservable contingencies influence the actual outcome. We also consider the possibility that the welfare in a given country be influenced by the actions (i.e. the policies) chosen in the neighboring countries. So, social welfare[3] is defined (for example for country 1) by the following expression :

$$W_1 = \frac{a + \gamma_2 b}{1 + \gamma_2} + \epsilon_1$$

with $\gamma_2 \in (0, 1)$ a measure of the policy interdependence induced by the policies in country 2 on the first country's welfare. Remark that with this functional form, if the countries are symmetric and if the actions chosen by governments are fixed, the introduction of

[3]We do not take into account the utility of the politician in the welfare function.

policy-interdependance does not alter social welfare[4]. In the main part of this paper, we assume that both countries have approximately the same size. We therefore assume that the policy-interpendence factors are equal, hence $\gamma_1 = \gamma_2 = \gamma$.

As explained before, social welfare depends on the actions taken in each country but also on the value of an exogenous random shock. Since the two countries may be in the same economic cycle, we define the random shocks jointly for both countries. Thus, we assume that (ϵ_1, ϵ_2) follows a normal law with mean 0 and a variance-covariance matrix Σ where

$$\Sigma = \sigma^2 \begin{pmatrix} 1 & C \\ C & 1 \end{pmatrix}$$

Here, C is the correlation coefficient and measures the amount of the shock-interdependence.

To control their politicians, voters can only use very simple mechanisms. In fact, we focus on the design of optimal *retention rules* based on cut-off strategies. The control mechanisms will be based on a series of observable variables, in particular the level of welfare reached in each country. Some statistics, such as the unemployment rate, the growth rate or the median wage are usually public, and can be used as good proxies for the welfare of a country. Informally, voters use a reelection rule of the following form: "the incumbent is reelected if at the end of the period, a function (to be specified) of the observable variables is greater then a given level; otherwise, the contract is proposed to another politician". This type of implicit contract follows the tradition started Barro (1973) and used quite frequently since[5].

The fundamental departure from the mechanism designed by Barro (1973) and Ferejohn (1986) lies in the existence of several voters/politician relationships. In Ferejohn's paper, which extends Barro's analysis to the case of asymmetric information, voters can only use one signal to infer the actions taken by their politicians and therefore to decide whether to reelect him or not. In our case, the existence of two potentially interdependent countries and for both the same type of moral hazard problem potentially enlarges the set of instruments. The reelection rule chosen, say, in country 1 can be a function

[4]Our results do not depend on the choice of an additive specification. For example, a multiplicative alternative, $W = (ab^\gamma)^{\frac{1}{1+\gamma}}\epsilon$, leads to equivalent results for well chosen cost effort function and law for the random variable.

[5]See Ferejohn (1986) and Seabright (1996) for examples.

of the realized level of welfare in country 1 but also in the other country, provided this information is a signal (direct or indirect) on the effort chosen in the first country. In fact, we will show that the optimal retention rule inducing the politicians to work will depend on many observable variables and will be Nash-implementable.

As a conclusion of the presentation of the model, the timing of the game is presented on Figure 1.

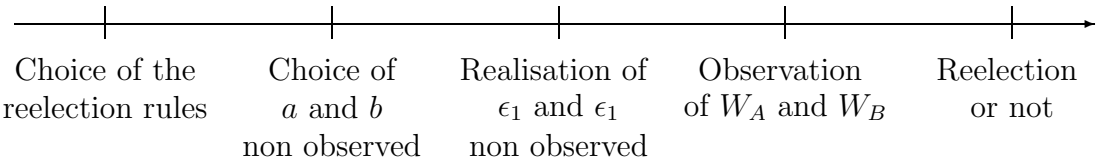

Figure 1: Timing of the game.

3 The Benchmark: No-Integration

3.1 Presentation

The no-integration case can be seen either as a one-country framework or as a multi-country framework in which there is no interdependence between the countries. In any case, we only focus on one country (say, country 1). Therefore, we assume that $C = \gamma = 0$. The voters' welfare is then given by:

$$W_1 = a + \epsilon_1.$$

Voters focus on a simple retention rule based on the estimation of the effort. Let $\widehat{a}$ be the inferred level of effort once all the relevant variables have been observed. We take for given that the voters set a rule of the cut-off type. This amounts to choose a level $\overline{a}$ and

propose at the beginning of the period the following contract:

$$\begin{aligned} \text{If } \widehat{a} &\geq \overline{a}, \text{ then the incumbent is reelected,} \\ \text{If } \widehat{a} &< \overline{a}, \text{ then the incumbent is not reelected.} \end{aligned}$$

In the simple case considered here, the estimated level of effort only depends on the level of welfare in country 1 since the actions of the politician in this country do not influence any other variable. Even more precisely, given the assumptions on the shock, the best estimator of a is directly given by the level of welfare realized in country 1, i.e. W_1. Therefore, the rule proposed at the beginning of the period takes a familiar form: "the incumbent is reelected if the realized level of welfare in his country is greater than a fixed level, i.e., if $W_1 \geq \overline{a}$".

We now turn to the sequential study first of the actions chosen by the politicians conditional on the reelection rule chosen by the voters and then of the cut-off value voters choose knowing the best response of their politician.

3.2 Behavior of the Politician

At the second stage of the game, the politician knows the cut-off level $\overline{a}$ and the way voters will infer the level of effort he chooses. How hard does the politician choose to work? He knows that he will be reelected if and only if, given his effort level a,

$$W_1 \geq \overline{a} \Longleftrightarrow \epsilon_1 \geq \overline{a} - a$$

Let Φ be the cumulative function of the standard normal law. The probability that the incumbent is reelected, as a function of the effort chosen, is given by:

$$1 - \Phi(\frac{\overline{a} - a}{\sigma})$$

Using the assumption of linear cost of effort, the program of the politician is then:

$$\text{Max}_a \quad B\left(1 - \Phi(\frac{\overline{a} - a}{\sigma})\right) - a$$

The following lemma details the politician's best response to a cut-off level $\overline{a}$.

Lemma 1 *Let* $A = 2\sigma^2 \ln(\frac{B}{\sqrt{2\pi}\sigma})$ *and* $\overline{\sigma} = \frac{B}{\sqrt{2\pi}}$. *Let us define condition* $IC(A, \sigma)$ *by*

$$B\Phi(\frac{-\sqrt{A}}{\sigma})) - \sqrt{A} \geq \overline{a} - B\Phi(\frac{\overline{a}}{\sigma}))$$

- If $\sigma \geq \overline{\sigma}$ *then* $a^* = 0$.

- If $\sigma \leq \overline{\sigma}$ *then, if the level of effort required by the voters* ($\overline{a}$) *is not too high, i.e., if the condition* $IC(A, \sigma)$ *is satisfied, the politician chooses an effort level defined by* $a^* = \overline{a} + \sqrt{A}$. *Otherwise, the politician chooses to shirk and* $a^* = 0$.

Proof: see Appendix 1.

This first lemma describes the optimal behavior of the incumbent politician conditional on the voters' requirement. In fact, his behavior depends both on the cut-off level of effort and on the nature of the economic environment (the variance of the shock). Indeed, the effort chosen is the sum of the cut-off level chosen by the voters and of another term ($\sqrt{A}$) which depends on the variance of the shock. When the environment is very uncertain (the variance of shocks is very large), the politician knows that his action has a limited impact on the welfare of the voters. It is indeed the random shock which, *in fine*, determines this welfare. In this case, the marginal benefits are always smaller than the marginal cost. So, the rational choice for the politician is to shirk and hope for a favorable random shock[6]. Now, if the environment is relatively stable (if the variance is not too large), the politician really chooses his effort as a function of the cut-off $\overline{a}$. If the cut-off level is very high, the politician chooses to shirk since the personal cost to reach this level is too high and the expected benefits too low. In other words, the incentive condition $IC(A, \sigma)$ which states that the politician is better off working (choosing $a^* > 0$) than shirking is not satisfied. If this cut-off level if no too high, the politician chooses a positive level of effort. More precisely, the politician is induced to choose an effort level strictly greater than the cut-off level ($\overline{a}$) chosen by the voters. Indeed, if he makes exactly the minimum level of effort required, his reelection probability is 1/2. But since the variance is small, by slightly increasing his effort, he can almost secure his reelection.[7]

[6]This particular result comes form our choice of a a linear cost of effort. In a model with quadratic cost, the level of effort is always positive but this level is all the smaller that the variance is large.

[7]This behavior does not come from any risk-aversion but may be seen as an example of self-protection activities (see Briys-Schlesinger (1991)).

3.3 Behavior of the voters

Since for a given level of $\overline{a}$, the behavior of the politician is known, we can solve the first period problem, i.e. determine the voters' optimal reelection rule.

The welfare of those voters is an increasing function of the effort made by the politician. Therefore, the reelection rule is such that the politician chooses the maximum possible level of effort. Since the voters' choice is only relevant if the variance of shocks is not too large, we focus on this case (so $\sigma \leq \overline{\sigma}$). The program is then written as:

$$\begin{array}{rcll} & & \text{Max}_{\overline{a}} \quad a^* & \\ \text{subject to} \quad a^* & = & \overline{a} + \sqrt{A} & \text{if IC}(A, \sigma) \text{ is satisfied} \\ a^* & = & 0 & \text{otherwise.} \end{array}$$

The voters' optimal reelection rule can then be defined as follows.

Proposition 1 *The optimal reelection rule is such that:*

- If $\sigma \leq \overline{\sigma}$, $\overline{a}^*$ is the only positive solution of the following equation

$$\overline{a} - B\Phi(\tfrac{\overline{a}}{\sigma}) = -\sqrt{A} - B\Phi(\tfrac{-\sqrt{A}}{\sigma}).$$

- If $\sigma \geq \overline{\sigma}$, the reelection rule does not matter and the politician always shirks.

Proof : see Appendix 2.

The voters' best response to the politician strategy consists in binding the incentive constraint. The politician can always choose to shirk and hope for favorable economic conditions. To avoid this, the voters are driven to set a cut-off value leaving the politician just indifferent between shirking and making a positive level of effort.

The equilibrium outcome can be more precisely analyzed. In particular, it is useful to see how this best response reacts to changes in the environment.

Corollary 1 *The cut-off level of effort chosen by the voters and the effort made by the incumbent are increasing in the benefits of the reelection and decreasing in the variance of the random shock.*

Proof : see Appendix 3.

When the economic situation varies sharply (when the variance of the shock is large but smaller than $\overline{\sigma}$), it is very hard to infer the effort of the politician from the value of the end-of-period welfare. Indeed, the result can always come from elements out of the scope of control of the politician. In addition, suppose that the reelection rule is tough ($\overline{a}$ high). Then, the politician knows that, even by working hard, his effort are unlikely to be noticed. His incentives to work are then too small. To avoid shirking, the voters must then choose a low cut-off level. On the contrary, when the economic environment is stable (the variance of the shock is small), voters can relatively easily infer the extent to which their politician has worked. Therefore, they can easily choose a high cut-off level.

A last remark can be made at this stage. The equilibrium effort is the sum of the cut-off level chosen by the voters, always decreasing with the variance, and of another term ($\sqrt{A}$) which depends of the variance of the shock. This last term is first increasing and then decreasing in the variance of the shocks. In spite of this second effect, one can show that the dominant effect is always generated by the variation of $\overline{a}$. Therefore, $a^*(\overline{a}^*)$ decreases with the variance.

4 Economic Integration

4.1 Presentation

This part aims at reconsidering the relationships between the voters and their politician in a different economic environment. When some countries become interdependent as a consequence of economic integration, the actions taken in one country tend to influence not only the outcome in this country but also in the other countries of the area. How does the existence of economically integrated countries modify then the relation between voters and theirs politicians in those countries? What is the link between the inter-country characteristics and the intra-country relationships between voters and politicians?

Using our simple definition of economic integration, the shock-interdependence and the policy interdependence, we will compare the degree of control the citizens can have on their politicians in absence of integration and with integration. The next section consists of a separate analysis of the two features defining integration while the following proposes

a more general study.

4.2 Specific effects of economic integration

4.2.1 The Shock-Interdependence effect

We now assume that the economic conditions between economically integrated countries are rather similar. We do not believe that this similarity is permanent but, on average, if one country faces favorable conditions, the other one should face the same type of conditions. This shock-interdependence is modeled by assuming that the the random shocks are positively correlated across countries. What does this new feature change in the analysis of political accountability? Let us first describe loosely the new possibilities offered to the voters and then derive the new equilibrium outcome formally.

The voters want to induce their politicians to work. As described above, they propose a contract such that the incumbent reelection is conditional on the *ex post* estimation of the effort being above a threshold level. But now, the similarity in the economic conditions changes the way this estimation is made. What really matters for the voters is, at the end of the period, to separate in the economic results what comes from the effort of their politician and what comes from the general economic conditions. In this respect, voters in country 1 (resp. 2) will use the situation in country 2 (resp. 1), the equilibrium outcome in this country, to improve their estimation of the economic conditions in their own country. Indeed, even if there is no formal link between the contracts signed between voters and politicians in the two countries, each group of voters is able to use the equilibrium situation in the other country to control its own politician. To sum up, even though politician 1 is controlled by a different set of voters than politician 2, it is possible to use yardstick competition methods exactly the same way as if there was only a unique set of voters controlling both politicians.

More precisely, let us consider the choice of reelection made by country 1 voters at the end of the period. The key point of the analysis is to consider a Nash equilibrium in which the actions of the agents in the two countries have the same structure. Since we assume that country 1 voters know, at the end of the period the reelection rule of country 2, they

are able to infer the equilibrium effort of politician 2, $f_2(\overline{b})$[8]. Thus after the observation of W_2, they can infer the value of the shock in country 2 (ϵ_2). Then, voters update their beliefs on the shock in their own country and, using the observation of W_1, evaluate the level of effort made by their politician.

Let us turn to the formal evaluation of the equilibrium outcome. The shock-interdependent case corresponds to parameter values $C > 0$ and $\gamma = 0$. Here, the law of ϵ_1 conditional on ϵ_2 is normal with mean $\epsilon_2.C$ and variance $\sigma^2(1 - C^2)$. Of course, the value of ϵ_2 is not really known; it is only inferred. Indeed, country 1 voters use the values of $\overline{b}$ and W_2 to infer, taking into account the equilibrium behavior of politician 2, the value of ϵ_2.

Since the knowledge of W_2 and $\overline{b}$ allows the inference of ϵ_2 and $a = W_1 - \epsilon_1$, the effort of the politician is estimated the following way:

$$\widetilde{a} = W_1 - E(\epsilon_1 \ /\epsilon_2). \tag{1}$$

The reelection rule is then defined by

$$W_1 - E(\epsilon_1 \ /\epsilon_2) \geq \overline{a} \qquad\qquad (R').$$

Then the politician knows that he is reelected if

$$(R') \Longleftrightarrow \epsilon_1 - C.\epsilon_2 \geq \overline{a} - a. \tag{2}$$

$\epsilon_1 - C.\epsilon_2$ follows a normal law with zero mean and variance $v^2 = \sigma^2(1 - C^2)$. Therefore, the choice of the optimal level of effort is the solution of the following program

$$\text{Max}_a \quad B(1 - \Phi(\frac{\overline{a} - a}{v})) - a$$

Since this program has the same form as in the previous section, we can use the same method to derive the following lemma where $IC(Z, v)$ is the analogous of $IC(A, \sigma)$.

Lemma 2 *Let* $Z = 2v^2 \ln(\frac{B}{\sqrt{2\pi}v})$ *and* $\overline{\sigma} = \frac{B}{\sqrt{2\pi}}$.

- If $v \geq \overline{\sigma}$ *then* $a^* = 0$.

- If $v \leq \overline{\sigma}$ *then, if the level of effort required by the voters* ($\overline{a}$) *is not too high, i.e., if the condition* $IC(Z, \nu)$ *is satisfied, the politician chooses an effort level defined by* $a^* = \overline{a} + \sqrt{Z}$. *Otherwise, the politician chooses to shirk and* $a^* = 0$.

[8] Of course, at the equilibrium, $f_2(\overline{b}) = b^*$.

Now, we derive the voters' optimal choice. As before, they must induce the politician to work. Knowing the politician's best response function and taking the equilibrium outcome in the other country as given, their optimal strategy is given by the following proposition.

Proposition 2 *1) If $v \leq \overline{\sigma}$, $\overline{a}^*$ is optimally chosen as the only positive solution to the following equation*

$$\overline{a} - B\Phi(\tfrac{\overline{a}}{v}) = -\sqrt{Z} - B\Phi(\tfrac{-\sqrt{Z}}{v}).$$

The reelection rule is defined by:

$$W_1 - C.W_2 \geq \overline{a}^* - C(\overline{b}^* + \sqrt{Z}).$$

2) If $v \geq \overline{\sigma}$, the reelection rule does not matter and the politician always shirks.

The first point to notice is the form of the reelection rule. When the two countries are in the same economic cycle , the reelection rule in country 1 depends strongly on the results in country 2. It depends also on the level of effort required in country 2. Indeed, for an unchanged level of realized welfare in country 2, a low equilibrium level of effort in country 2 means that the economic conditions were probably favorable (the random shock was positive). Since the shocks are positively correlated, politician 1 has probably also benefited from favorable conditions. In this case, the voters are more demanding to reelect the incumbent.

Another point of this equilibrium outcome lies in the fact that the equilibrium level of effort required in country 1 *does not depend* on the equilibrium effort level in the other country. Indeed, let us suppose that in country 2 the equilibrium level of effort required by the voters decreases. Then it is clear for everyone that politician 2's effort will decrease. It means in particular that voters will change the way they infer the value of ϵ_2 after having observed W_2. Since they still perfectly infer the value of ϵ_2, the change in the level of effort required in country 2 should not influence the quality of their *ex post* estimation of the effort of their politician and the politician will be aware of this change. This is why the value $\overline{b}$ does not enter equation (2) which determines the equilibrium behavior of politician 1.

The important question is then to know whether the shock-interdependence increases or decreases the effort of the politicians.

Proposition 3 *When economic integration induces a shock-interdependence, the cut-off level chosen by the voters and the effort level of the politician increase.*

Proof : see appendix 4.

The existence of shock-interdependence creates a favorable setting to induce politicians to work. This is mainly due to the fact that the voters in country 1 have two clear signals to construct their incentive scheme instead of one in the no-integration benchmark. Using the realization of the welfare in country 2, they will make their inference with a much higher precision. More technically, the variance v^2 is an inverse measure of the ease with which the effort of the politician can be inferred. This variance in the shock-interdependent case is smaller than in the benchmark case. Therefore the voters can assess more precisely the level of effort made by the politician and they can, at the first stage, set a higher cut-off level. Similarly, the politician knows that by making a higher effort, he increases significantly his chances of reelection since his effort will be easily differentiated from the random shock. As a consequence, one can directly state the following corollary.

Corollary 2 *Social welfare is higher with shock-interdependence than without.*

Proof : it follows from the fact that social welfare is increasing with the level of effort.

It must be clear from the previous results that the utility of the politician is smaller in this case than in the previous case. Indeed, since the IC condition is binding, his utility is equal to his gains if he shirks. These gains are defined, in the case of shock-independence, by

$$U_0 = B(1 - \Phi(\frac{\overline{a}^*}{\sigma}))$$

In the shock-interdependent case, it is defined by

$$U_0' = B(1 - \Phi(\frac{\overline{a}'^*}{v}))$$

where $\overline{a}'^*$ is the new cut-off level set by the voters. Since $\overline{a}'^* > a^*$ and $\sigma > v$, one can easily see that $U_0' < U_0$. In other words, the reservation utility of the politician depends

on his probability of reelection if he shirks. This probability increases as the fluctuations (or more exactly as the uncertainty) of the economic conditions increase. Since $\sigma > v$, the uncertainty is reduced when the shocks are interdependent and thus the reservation utility of the politicians is lower.

4.2.2 The Policy-Interdependence effect

The second effect corresponds to the case in which the cross-countries effects concern the chosen policies (the efforts). Externalities and dillution effects induce the following problem. On the one hand, each politician knows that his effort has only a limited influence on the welfare of his constituents. Compared to the benchmark case without interdependence, the politician is less accountable for the end-of-period welfare since his action is only one of the several causes of this welfare. On the other hand, since the effort made by politician 1 influences the welfare in both countries, voters may use both welfare values to infer the true level of effort chosen by their politician. Loosely speaking, in the shock-interdependent case the additional signal was useful to infer the true economic conditions (the realization of the random shock) while now it is directly useful to infer the level of effort chosen by the politician.

More precisely, this case can be analyzed using the general model with parameter values $C = 0$ and $\gamma > 0$. The effort made by politician 1 is evaluated using W_1, W_2 and the inferred value of b, $f_2(\overline{b})$. The voters observe both welfares, knowing that the first is drawn from a normal law with mean $(a + \gamma f_2(\overline{b}))/(1 + \gamma)$ and variance σ^2, the second drawn from a normal law with mean $(f_2(\overline{b}) + \gamma a)/(1 + \gamma)$ and variance σ^2. From this information, they infer the value of the effort of politician 2. Then, using the likelihood method, they can derive an estimator of a.

Lemma 3 *The best estimator of a knowing W_1, W_2 and $\overline{b}$ can be written :*

$$\widehat{a} = \frac{1+\gamma}{1+\gamma^2}(W_1 + \gamma W_2) - \frac{2\gamma f_2(\overline{b})}{1+\gamma^2} \tag{3}$$

Proof : see appendix 5.

The reelection rule is then written

$$\frac{1+\gamma}{1+\gamma^2}(W_1 + \gamma W_2) - \frac{2\gamma f_2(\overline{b})}{1+\gamma^2} \geq \overline{a}.$$

Therefore, the politician knows that he is reelected if and only if:

$$(\epsilon_1 + \gamma\epsilon_2)\frac{(1+\gamma)}{(1+\gamma^2)} \geq \overline{a} - a$$

Since ϵ_1 and ϵ_2 are independent, $(\epsilon_1+\gamma\epsilon_2)(1+\gamma)/(1+\gamma^2)$ follows a normal law with mean 0 and variance $\omega^2 = \sigma^2\frac{(1+\gamma)^2}{(1+\gamma^2)}$.

For the politician, the optimal choice of effort is the solution of the following program:

$$\text{Max}_a \quad B\left(1 - \Phi(\frac{\overline{a}-a}{\omega})\right) - a$$

Since this program has the same form as before, we obtain the following lemma.

Lemma 4 *Let* $E = 2\omega^2\ln(\frac{B}{\sqrt{2\pi}\omega})$ *and* $\overline{\sigma} = \frac{B}{\sqrt{2\pi}}$

- If $\omega \geq \overline{\sigma}$ *then* $a^* = 0$

- If $\omega \leq \overline{\sigma}$ *then, if the level of effort required by the voters* $(\overline{a})$ *is not too high, i.e. if the condition* $IC(E,\omega)$ *is satisfied, the politician chooses an effort level defined by* $a^* = \overline{a} + \sqrt{E}$. *Otherwise, the politician chooses to shirk and* $a^* = 0$.

We can then derive the following proposition:

Proposition 4 *1) If* $\omega \leq \overline{\sigma}$, $\overline{a}^*$ *is optimally chosen as the only positive solution to the following equation*

$$\overline{a} - B\Phi(\frac{\overline{a}}{\omega}) = -\sqrt{E} - B\Phi(\frac{-\sqrt{E}}{\omega}).$$

The reelection rule is defined in the first period by :

$$W_1 + \gamma W_2 \geq \frac{1+\gamma^2}{1+\gamma}\overline{a}^* + \frac{2\gamma(\overline{b}+\sqrt{E})}{1+\gamma},$$

2) If $\omega \geq \overline{\sigma}$, *the reelection rule does not matter and the politician shirks.*

In this case, the realized welfare values in the two countries are substitute to assess the performance of the politicians. This substitutability is all the stronger that the policy interdependence is strong. The effect of the toughness of a rule (the value of $\overline{b}$) in the second country on the reelection rule of the first country is reversed compared with the previous case. Indeed, a high required level of effort in country 2 helps a politician in country 1 to reach a high level of welfare for his country. Therefore, the levels of welfare

ensuring the reelection of country 1 politician must be higher. As before, even if the cut-off chosen in the second country ($\overline{b}$) influences the reelection rule, it has no impact of the required level of effort in the first country. This level is always given by the indifference condition of the politician between shirking and working.

We show also this additional result.

Proposition 5 *When economic integration induces policy interdependence, the effort of the politician and the cut-off level set by the voters decrease.*

Proof: remark that $\omega = \sigma \frac{(1+\gamma)}{\sqrt{1+\gamma^2}} > \sigma$ and use corollary 1.

The decrease in the level of effort made by the politician in the policy-interdependent case does not originated from free-riding behaviors since we saw before that the equilibrium level of effort in a given country does not influence the equilibrium effort in the other country. It comes much more from the smaller importance of his effort in the determination of the welfare compared with the random shock. When policy-interdependence is strong, the relative importance of the actions of the politician for the welfare of the voters is small. Therefore, a high level of effort does not have a large positive impact on the welfare of the voters and can do little for the reelection of the incumbent. It is thus a lack of transparency which limits the ability to set a high cut-off level in this case in spite of using two signals to infer the effort chosen by the politician. The direct consequence of the previous proposition is then :

Corollary 3 *Social welfare in lower with policy-interdependence than without.*

Proof : it follows from the fact that the welfare is increasing with the level of effort.

Finally, since the cut-off level decreases and that the variance increases compared to the autarkical case, the utility of the politician is higher in this case than in the previous cases.

4.3 General Study of Economic Integration

This part proposes a complete analysis taking into account the two types of interdependence. As before, the voters of country 1 want to evaluate the effort made by their

politician. To this end, they use the information provided by the welfare values W_1 and W_2 either directly to infer the level of effort a or to infer first the level of the shock (ϵ_1) and then the level of effort chosen by their politician.

(W_1, W_2) follows a normal law with mean $\frac{1}{1+\gamma}\begin{pmatrix} a+\gamma b \\ b+\gamma a \end{pmatrix}$ and variances-covariances matrix $\Sigma = \sigma^2 \begin{pmatrix} 1 & C \\ C & 1 \end{pmatrix}$. Knowing W_1, W_2 and $\overline{b}$, a can be evaluated as follows:

Lemma 5 *The best estimator of a knowing W_1, W_2 and $\overline{b}$ can be written:*

$$\widehat{a}' = \frac{1}{1+\gamma^2-2\gamma C}\left((1+\gamma)(W_1(1-\gamma C)+W_2(\gamma - C)) + f_2(\overline{b})((1+\gamma^2)C - 2\gamma)\right) \quad (4)$$

Proof : see appendix 6.

Since C is always less than 1, the estimate of a is always increasing with the observed value of W_1. On the contrary, the impact of W_2 and of $f_2(\overline{b})$ (the inference of b) depends on the relative importance of the two type of interdependence.

When the shock-interdependence effect dominates, a high value of $f_2(\overline{b})$ (for a fixed W_2) is used to infer that the shock in country 2 has been small. Since the shocks in both countries are positively correlated, the one in country 1 is likely to be either positive and small or negative. In this case, a high value of W_1 is very likely to be the consequence of a high effort of politician 1. To sum up this case, if the inferred value of b is high, the voters in country 1 believe that their politician can be given the credit for a high level of W_1. Let us suppose now that the policy-interdependence effect is dominant. In this case, if the inferred value of b (for a given W_1) is high, the voters in country are driven to believe that politician 1 has chosen a low level of effort.

In a situation where the two types of interdependence coexist, inferring the effort made by the politicians is a difficult matter. Voters have at their disposal two signals but *those signals must be used differently* according to the situation. For example, a good economic result in one country is a positive signal of the effort for the other country politician if policy-interdependence is strong while it is a negative signal when shock-interdependence dominates. To assess the quality of the work made by the politicians, it then necessary to study in details the nature of the economic relationships between the countries.

Using the formula (4), we write the problem faced by the politician in country 1. He is reelected if and only if :

$$\frac{(1+\gamma)}{(1+\gamma^2-2\gamma C)}\left(\epsilon_1(1-\gamma C)+\epsilon_2(\gamma-C)\right) \geq \overline{a}-a$$

The left hand side is a random variable following a normal law with mean 0 and variance $\widehat{v}^2 = \sigma^2\frac{(1+\gamma)^2}{(1+\gamma^2-2\gamma C)}(1-C^2)$. We know from the previous section that the extent to which the politician makes a high effort depends on the value of the variance. Indeed, the lower the variance, the higher the level of effort. How do the shock and policy interdependence parameters jointly affect the ease with which politician can be controlled?

Proposition 6 *Increasing policy-interdependence always decreases the equilibrium level of effort chosen by the politician whereas increasing shock-interdependence leads to higher effort only if the policy-interdependence factor is small (if $\gamma < C$).*

Proof : see Appendix 7.

Even if most of the effects studied previously remain on aggregate, there is an important difference. An increase in the degree of shock-interdependence does not uniformly drive a higher level of effort. Indeed, consider a situation where policy-interdependence is strong while shock-interdependence is small. What matters then for the voters is to use as many *different* signals as possible on the effort made by their politician. Increasing shock-interdependence makes the two signals much more the same which is harmful for the voters. Of course, if this interdependence becomes very high, the voters will use the signals to infer indirectly the effort by focusing on the direct inference of the shock and in this respect, increasing shock-interdependence is useful. But as long as policy-interdependence dominates shock-interdependence, an increase in the amount of shock-interdependence decreases the precision of the information structure and leads to a decrease in the equilibrium level of effort.

In spite of this effect, if there is a dominant type of interdependence, it is possible to rank integration and autarchy from a welfare perspective.

Proposition 7 *If shock-interdependence is strong (resp. weak) and policy-interdependence weak (resp. strong), economic integration (resp. non-integration) is socially preferable to non-integration (resp. economic integration).*

Proof : the analysis of formula (4) shows that if $\gamma = 0$, we are back to the expression (1) whereas if $C = 0$, we can get the expression (3). Using the continuity of the function leads to the results.

The previous proposition states that the welfare effects of integration depend on the way countries interact with each other. If integration mainly coordinates the economic cycles (such as demand or productivity shocks), it increases the degree of control voters have of their politicians. If it mainly mixes and dilutes the consequence of the policies chosen in both countries, integration reduces the degree of control and is socially harmful.

5 Extensions and Conclusions

5.1 Integration and choice of politicians

Shock-interdependence may provide useful pieces of information to increase the accountability of the politicians whereas policy-interdependence has an opposite effect. In our framework we have focused on a moral hazard problem: the possibility of yardstick competition influences, using the term coined by Banks and Sundaram (1998), the *performance effect*, i.e. the incentives to work. We could also consider the polar case in which politicians do not have any action to choose and where the welfare of the voters depends on the unknown quality (or type) of their politician.

More precisely, let $\beta^i \in \{0, \overline{\beta}\}$ with $\overline{\beta} > 0$ be the type of the politician in country i. In country i, the politician can be good ($\beta^i = \overline{\beta}$) with a probability λ or bad ($\beta^i = 0$) with a probability $1 - \lambda$. The welfare of the citizens of country i is now :

$$W_i = \frac{\beta^i + \gamma\beta^j}{1+\gamma} + \varepsilon_i.$$

Whereas in a hazard moral framework, it is very important that the voters announce credibly a reelection rule, it is not the case anymore. At the end of the period, the voters simply decide to keep their politician if his updated expected type is higher than the average type of a randomly chosen politician ($\lambda\overline{\beta}$). The problem is then to assess the quality of the *selection effect*, i.e. the quality of the screening at the end of the period in different environments.

One can easily show that the new problem is only statistical since politicians do not choose any actions. And the results obtained in a hazard moral framework still apply when one focuses on adverse selection.

5.2 Asymmetric Countries

We go back to the main analysis where we focus on a moral hazard problem but we drop the assumption of symmetric countries. There may be two consequences of size differences: the policy-interdependence factors can be different between countries and there may be a leading country in the sense that this country is first to face, say, a productivity shock while the other faces it only one period after.

We first concentrate on the difference in the policy-interdependence factors. Let us then assume that country 1 is larger than country 2 and model this new situation by setting the following parameter values: $\gamma_1 = 1$ and $0 \leq \gamma_2 < 1$. Therefore, the actions chosen by politician 1 affects country 2's social welfare the same way as politician 2's actions. In this situation, it is easier to control political behavior in country 1 than in country 2[9]. To control the first politician, W_1 and W_2 provide useful pieces of information since both results strongly depend on the action chosen by this politician. The comparison with the second politician reveals that even if W_2 is a useful signal, W_1 is not as good a signal of his action as W_2 is a good signal of the actions of the first politician (because $\gamma_2 < \gamma_1$). There is nevertheless one case where both politicians can be controlled with the same precision. Indeed, if the shocks are perfectly correlated, one signal is enough to control both politicians so country 2 does not suffer from the lack of precision of the second signal.

Consider now the possible delay in the way shocks affect countries 1 and 2. In this case, country 1 voters can control its politician using only its own results whereas country 2 can use three signals: the past performance in country 1 to assess the value of the present shock, its present performance and the present performance of country 1 since this signal contains some information on the present action. It is then clear that politicians in small countries, here in country 2, will be more easily controlled than in large countries.

[9]This results can be shown formally by computing the precision of the estimation in both cases with the technics used in this paper.

5.3 Conclusions

This paper analyzes how voters can control the effort made by their politicians in different economic situations. In the setting developed above, voters cannot observe (at least exactly) the amount of effort their politicians have chosen and they do not know when they observe the economic performances of their country which part comes from this effort and which part is due to exogenous factors. To disentangle the different elements, voters can use several signals whose numbers and precision vary with the nature of the economic links between the countries. For example, in the integrated case, voters can use more signals to control the behavior of their politicians than without integration but each signal may contain a smaller amount of relevant information.

More precisely, we have shown that economic integration could generate the two types of effect and then affects positively or negatively the ease with which politicians can be controlled. Indeed, economic integration appears as a two-sided phenomenon. On the one hand, it allows yardstick comparison which is good for the control of politicians when integration induces some interdependence in the shocks, i.e. some similarities in the economic cycles. On the other hand, with policy-interdependence, it dilutes the responsibility of politicians by bluring the impact of their actions. These two effects go in opposite directions and it is hard to guess which one is the more important. But in any case, the extent to which economic integration or any other change in the economic organization of a group of countries increases political accountability is inversely proportional to the *real* degree of uncertainty on the economic conditions.

One of the postulates of this work has been to consider politicians as self-interested agents, without any preference or ideology. Even if this view, which follows the steps of the *Public Choice* school (see Buchanan and Tullock (1962)), is probably extreme, it simplifies the analysis and stresses the problem of accountability when the only possible contract between voters and politicians is a reelection rule. A natural development of this paper would be to introduce different possible preferences in the country as well as between countries. From a fiscal federalism perspective, it could also be interesting to analyze the impact of a political union with only one decision maker for all the countries. Those future extensions will probably be useful to deepen our understanding of the political impact of globalization.

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Appendices

Appendix 1: proof of lemma 1.

For an interior solution, the first order condition is

$$\frac{B}{\sqrt{2\pi}\sigma}e^{-\frac{(\overline{a}-a^*)^2}{2\sigma^2}}-1=0.$$

We can easily see that, for $a \geq 0$, there is an interior solution if $\frac{B}{\sqrt{2\pi}\sigma} > 1$. In the other cases, we get $a^* = 0$.

The second order condition is

$$\frac{B}{\sqrt{2\pi}\sigma^3}(\overline{a}-a)e^{-\frac{(\overline{a}-a)^2}{2\sigma^2}} \leq 0.$$

• If $\overline{a} \geq a$, the objective function is convex.

The politician must choose between $a = 0$ and $a = \overline{a}$. Let U_a be the utility of the politician if his action is a.

If $a = 0$, $U_0 = B(1 - \Phi(\frac{\overline{a}}{\sigma}))$.

If $a = \overline{a}$, $U_{\overline{a}} = B(\frac{1}{2}) - \overline{a}$.

$$U_0 \geq U_{\overline{a}} \Longleftrightarrow \overline{a} - \Phi(\frac{\overline{a}}{\sigma})) + B(\frac{1}{2}) \geq 0.$$

Let $f(\overline{a}) = \overline{a} - \Phi(\frac{\overline{a}}{\sigma})) + B(\frac{1}{2})$.

$f'(\overline{a}) = 1 - \frac{B}{\sqrt{2\pi}\sigma} e^{-\frac{\overline{a}^2}{2\sigma^2}}$; $f''(\overline{a}) = \frac{B}{\sqrt{2\pi}\sigma^3} \overline{a} e^{-\frac{\overline{a}^2}{2\sigma^2}} > 0$.

If $f'(0) \geq 0$, then $f'(\overline{a}) \geq 0$ for $\overline{a} \geq 0$. Since $f(0) = 0$, we would have $f \geq 0$.

$$f'(0) \geq 0 \Longleftrightarrow \sigma \geq \frac{B}{\sqrt{2\pi}}.$$

Therefore if $\sigma \geq \frac{B}{\sqrt{2\pi}}$, $a^* = 0$

If $\sigma \leq \frac{B}{\sqrt{2\pi}}$, the optimal value between 0 and $\overline{a}$ is 0 if $f(\overline{a})$ is positive (for a high $\overline{a}$) and $\overline{a}$ if $f(\overline{a})$ is negative (for a small $\overline{a}$).

• If $\overline{a} \leq a$, the objective function is concave.

Using the first order condition, we obtain

$$a^* = \overline{a} + \sqrt{2\sigma^2 \ln(\frac{B}{\sqrt{2\pi}\sigma})}.$$

If $\sigma \geq \frac{B}{\sqrt{2\pi}}$, $a^* = 0$.

Otherwise, one must compare the utility in the two cases. If, in the case $\overline{a} \geq a$, $\overline{a}$ is the optimum, we know that the global optimum is given by the first order condition since the maximization space includes also $\overline{a}$. Otherwise, one must compare the utility without effort and the utility with a^*.

The politician chooses a^* rather than 0 if and only if :

$$U_{a^*} \geq U_0 \Longleftrightarrow -B\Phi(\frac{-\sqrt{A}}{\sigma}) - \sqrt{A} \geq \overline{a} - B\Phi(\frac{\overline{a}}{\sigma})$$

with $A = 2\sigma^2 \ln(\frac{B}{\sqrt{2\pi}\sigma})$.

Q.E.D.

Appendix 2 : proof of proposition 1.

A simple look at the objective function of the voters shows that the incentive constraint will bind. Let us then define $F(\overline{a}) = -\overline{a} + B\Phi(\frac{\overline{a}}{\sigma}) - B\Phi(\frac{-\sqrt{A}}{\sigma})) - \sqrt{A}$. This function is convex for $\overline{a} \leq 0$ and concave otherwise. It is also easy to see that there are 2 optima when $\overline{a} = -\sqrt{A}$ and $\overline{a} = \sqrt{A}$

Now, since F is convex for $\overline{a} \leq 0$, reaches its minimum for $\overline{a} = -\sqrt{A}$ and since $F(-\sqrt{A}) = 0$, it is direct to conclude that F is positive for $\overline{a} \leq 0$.

From above, we know that $F(0) > 0$. Since F is strictly concave for $\overline{a} \geq 0$ and tends to minus infinity, there is a unique positive solution to the equation $F(\overline{a}) = 0$, and this solution is greater than $\sqrt{A}$.

Q.E.D.

Appendix 3 : proof of corollary 1 .

The cut-off level of effort set by the voters is defined by:

$$\overline{a}^* - B\Phi(\frac{\overline{a}^*}{\sigma}) = -\sqrt{A} - B\Phi(\frac{-\sqrt{A}}{\sigma}).$$

From the previous appendix, we know that $\frac{\partial F}{\partial \overline{a}} \leq 0$ around the optimal value.

- $\frac{\partial F}{\partial \sigma}$

$$\frac{\partial F}{\partial \sigma} = -\frac{B}{\sqrt{2\pi}\sigma^2}\overline{a}e^{-\frac{\overline{a}^2}{2\sigma^2}} - \frac{A'(\sigma)}{2\sqrt{A(\sigma)}} - \frac{1}{\sqrt{2\ln(\frac{B}{\sqrt{2\pi}\sigma})}}.$$

$A'(\sigma) = 2\sigma(2\ln(\frac{B}{\sqrt{2\pi}\sigma}) - 1)$. Therefore,

$$\begin{aligned}
\frac{\partial F}{\partial \sigma} &= -\frac{B}{\sqrt{2\pi}\sigma^2}\overline{a}e^{-\frac{\overline{a}^2}{2\sigma^2}} - \frac{2\sigma(2\ln(\frac{B}{\sqrt{2\pi}\sigma}) - 1)}{2\sqrt{A(\sigma)}} - \frac{1}{\sqrt{2\ln(\frac{B}{\sqrt{2\pi}\sigma})}} \\
&= -\frac{B}{\sqrt{2\pi}\sigma^2}\overline{a}e^{-\frac{\overline{a}^2}{2\sigma^2}} - \frac{2\sigma(2\ln(\frac{B}{\sqrt{2\pi}\sigma}) - 1)}{2\sqrt{2\sigma^2\ln(\frac{B}{\sqrt{2\pi}\sigma})}} - \frac{2\sigma}{2\sqrt{2\sigma^2\ln(\frac{B}{\sqrt{2\pi}\sigma})}} \\
&= -\frac{B}{\sqrt{2\pi}\sigma^2}\overline{a}e^{-\frac{\overline{a}^2}{2\sigma^2}} - \sqrt{2\ln(\frac{B}{\sqrt{2\pi}\sigma})} < 0.
\end{aligned}$$

- $\frac{\partial F}{\partial B}$

$$\frac{\partial F}{\partial B} = +\Phi(\frac{\overline{a}}{\sigma}) - \frac{A'(B)}{2\sqrt{A(B)}} - \Phi(-\frac{\sqrt{A(B)}}{\sigma}) + \frac{B}{\sqrt{2\pi}\sigma}\overline{a}.e^{-\frac{(A(B))^2}{2\sigma^2}}\frac{A'(\sigma)}{2\sqrt{A(\sigma)}}.$$

Since $A'(B) = \frac{2\sigma^2}{B}$ and $e^{-\frac{(A(B))^2}{2\sigma^2}} = \frac{\sqrt{2\pi}}{B}\sigma$, we can find

$$\frac{\partial F}{\partial B} = +\Phi(\frac{\overline{a}}{\sigma}) - \Phi(-\frac{\sqrt{A(B)}}{\sigma}) > 0$$

Using the implicit function theorem, we find that

$$\frac{\partial \overline{a}}{\partial \sigma} = -\frac{\frac{\partial F}{\partial \sigma}}{\frac{\partial F}{\partial \overline{a}}} < 0; \frac{\partial \overline{a}}{\partial B} = -\frac{\frac{\partial F}{\partial B}}{\frac{\partial F}{\partial \overline{a}}} > 0.$$

Moreover,

$$\frac{\partial a}{\partial \sigma} = \frac{\partial \overline{a}}{\partial \sigma} + \frac{A'(\sigma)}{2\sqrt{A(\sigma)}}.$$

If $A'(\sigma) < 0$, both effects go in the same direction therefore $\frac{\partial a}{\partial \sigma} < 0$.

If $A'(\sigma) > 0$,

$$\begin{aligned}
\frac{\partial a}{\partial \sigma} &= -\frac{1}{\frac{\partial F}{\partial \overline{a}}}(-\frac{\partial F}{\partial \sigma} + \frac{\partial F}{\partial \overline{a}}.\frac{A'(\sigma)}{2\sqrt{A(\sigma)}}) \\
&= \frac{1}{\frac{\partial F}{\partial \overline{a}}}\left(\frac{B}{\sqrt{2\pi}\sigma^2}\overline{a}e^{-\frac{\overline{a}^2}{2\sigma^2}} + \frac{A'(\sigma)}{2\sqrt{A(\sigma)}} + \frac{\sigma}{2\sqrt{A(\sigma)}} - \frac{A'(\sigma)}{2\sqrt{A(\sigma)}}(1 - \frac{B}{\sqrt{2\pi}\sigma}e^{-\frac{\overline{a}^2}{2\sigma^2}})\right) \\
&= \frac{1}{\frac{\partial F}{\partial \overline{a}}}\left(\frac{B}{\sqrt{2\pi}\sigma^2}\overline{a}e^{-\frac{\overline{a}^2}{2\sigma^2}} + \frac{\sigma}{2\sqrt{A(\sigma)}} + \frac{A'(\sigma)}{2\sqrt{A(\sigma)}}\frac{B}{\sqrt{2\pi}\sigma}e^{-\frac{\overline{a}^2}{2\sigma^2}}\right) < 0.
\end{aligned}$$

Finally,

$$\frac{\partial a}{\partial B} = \frac{\partial \overline{a}}{\partial B} + \frac{A'(B)}{2\sqrt{A(B)}} > 0.$$

Q.E.D.

Appendix 4 : proof of proposition 3.

From corollary 1, we know that $\frac{\partial a^*}{\partial \sigma} < 0$ and $\frac{\partial \overline{a}^*}{\partial \sigma} < 0$. Therefore, in order to know whether shock interdependence, correlation, induces an increase or a decrease in the level of a^* and $\overline{a}^*$, one must just compare σ and v. If $v \leq \sigma$ (resp. $v \geq \sigma$), correlation lead to an increase in the levels of effort.

$$\sigma^2 - v^2 = \sigma^2 C^2 > 0.$$

Therefore, for a positive level of correlation, the level of effort chosen by the politician increases.

Q.E.D.

Appendix 5 : proof of lemma 3

We try to find an estimation $(\widehat{a})$ of a using the likelihood method. After the observation of W_1 and W_2, the likelihood function can be written

$$\begin{aligned} f(W_1, W_2) &= f(W_1).f(W_2) \\ &= \frac{e^{-H(a)}}{2\pi\sigma^2} \end{aligned}$$

With $H(a) = \frac{1}{2\sigma^2}\left((W_1 - \frac{a + \gamma f_2(\overline{b})}{1+\gamma})^2 + (W_2 - \frac{f_2(\overline{b}) + \gamma a}{1+\gamma})^2\right)$.

Maximizing $f(W_1, W_2)$ amounts to the maximization of $-H(a)$. Since $H(a)'' > 0$, the study of the first order condition is sufficient.

$$H'(\widehat{a}) = 0 \Longleftrightarrow \frac{1}{(1+\gamma)\sigma^2}((W_1 - \frac{\widehat{a} + \gamma f_2(\overline{b})}{1+\gamma}) + \gamma(W_2 - \frac{f_2(\overline{b}) + \gamma\widehat{a}}{1+\gamma})) = 0$$

therefore,

$$\widehat{a} = \frac{1+\gamma}{1+\gamma^2}(W_1 + \gamma W_2) - \frac{2\gamma f_2(\overline{b})}{1+\gamma^2}.$$

Q.E.D.

Appendix 6 : proof of lemma 5.

We try to find an estimation $(\widehat{a})$ of a using the likelihood method. After the observation of W_1 and W_2, the likelihood function can be written

$$f(W_1, W_2) = f(W_1 \ / \ W_2).f(W_2)$$

$W_1 \ / \ W_2$ follows a normal law with mean $m(a)$ and variance $\sigma^2(1-C^2)$ where $m(a) = \frac{a+\gamma f_2(\overline{b})}{1+\gamma} + C(W_2 - \frac{f_2(\overline{b})+\gamma a}{1+\gamma})$.

The likelihood function can be written

$$f(W_1, W_2) = \frac{1}{2\pi\sigma^2\sqrt{(1-C^2)}} e^{-G(a)}$$

with $G(a) = \frac{1}{2\sigma^2(1-C^2)} \left((W_1 - m(a))^2 + (1-C^2)(W_2 - \frac{f_2(\overline{b})+\gamma a}{1+\gamma})^2 \right)$.

Maximizing $f(W_1, W_2)$ amounts to the maximization of $-G(a)$. Since $G(a)'' > 0$, the study of the first order condition is sufficient.

$$G'(\widehat{a}') = 0 \Longleftrightarrow (m'(\widehat{a}')(W_1 - m(\widehat{a}')) + \frac{\gamma}{1+\gamma}(1-C^2)(W_2 - \frac{f_2(\overline{b}) + \gamma\widehat{a}'}{1+\gamma})) = 0.$$

$m'(\widehat{a}') = \frac{1}{1+\gamma}(1-\gamma C)$ thus we get:

$$\begin{aligned}((1-\gamma C)(W_1 - \frac{\widehat{a}' + \gamma f_2(\overline{b})}{1+\gamma} - C(W_2 - \frac{f_2(\overline{b}) + \gamma\widehat{a}'}{1+\gamma})) \\ + \gamma(1-C^2)(W_2 - \frac{f_2(\overline{b}) + \gamma\widehat{a}'}{1+\gamma})) = 0\end{aligned}$$

After simplifications, we find:

$$\widehat{a}' = \frac{1}{1+\gamma^2-2\gamma C} \left((1+\gamma)(W_1(1-\gamma C) + W_2(\gamma - C)) + f_2(\overline{b})((1+\gamma^2)C - 2\gamma) \right).$$

Q.E.D.

Appendix 7 : proof of proposition 6.

Let $h(\gamma, C) = \frac{(1+\gamma)^2}{(1+\gamma^2-2\gamma C)}(1-C^2)$.

$$\frac{\partial h}{\partial \gamma} = \frac{2\,(1+\gamma)\,(1-C^2)}{(1+\gamma^2-2\gamma C)^2}(1-\gamma)(1+C)$$

Since $0 < \gamma < 1, \dfrac{\partial h}{\partial \gamma} > 0$

$$\frac{\partial h}{\partial C} = -\frac{2(C-\gamma)(1+C\gamma)\,(1+\gamma)^2}{(1+\gamma^2-2\gamma C)^2}$$

So $\dfrac{\partial h}{\partial C} \geq 0 \Leftrightarrow C \leq \gamma$.

Q.E.D.