Contingent Deficit Sanctions and Moral Hazard with a Stability Pact

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B. Proof that sum of fines and rebates over all countries is zero in each period

In period 1, the sum of the fine paid by country i and all the rebates it receives from the fines paid by the other countries is:

$$-\psi\left(d_{1i}-\bar{d}_{1i}\right)+\tfrac{\psi}{n-1}\sum_{j=1,j\neq i}^{n}\left(d_{1j}-\bar{d}_{1j}\right).$$

Hence, the sum over *all* countries of the fines paid and the rebates received is:

$$\begin{aligned}
&\sum_{i=1}^{n}\left[-\psi\left(d_{1i}-\bar{d}_{1i}\right)+\tfrac{\psi}{n-1}\sum_{j=1,j\neq i}^{n}\left(d_{1j}-\bar{d}_{1j}\right)\right]\\
=\;&\sum_{i=1}^{n}\left[-\psi\left(d_{1i}-\bar{d}_{1i}\right)-\tfrac{\psi}{n-1}\left(d_{1i}-\bar{d}_{1i}\right)+\tfrac{\psi}{n-1}\sum_{j=1}^{n}\left(d_{1j}-\bar{d}_{1j}\right)\right]\\
=\;&-\psi n\left(d_1^a-\bar{d}_1^a\right)-\tfrac{\psi}{n-1}n\left(d_1^a-\bar{d}_1^a\right)+\sum_{i=1}^{n}\left[\tfrac{\psi}{n-1}\sum_{j=1}^{n}\left(d_{1j}-\bar{d}_{1j}\right)\right]\\
=\;&-\tfrac{n^2}{n-1}\psi\left(d_1^a-\bar{d}_1^a\right)+\sum_{i=1}^{n}\left[\tfrac{\psi}{n-1}n\left(d_1^a-\bar{d}_1^a\right)\right]\\
=\;&-\tfrac{n^2}{n-1}\psi\left(d_1^a-\bar{d}_1^a\right)+\tfrac{n^2}{n-1}\psi\left(d_1^a-\bar{d}_1^a\right)=0,
\end{aligned}$$

where the superscript "a" is used to denote a cross-country average. Similarly, one can show that the sum of all fines and rebates is zero for period 2.

C. Derivation of U_{CCB}, equation (6)

The CCB attaches a relative weight of $0 \leq \lambda \leq 1$ to its objective under complete independence and a relative weight of $1 - \lambda$ to the average amount of resources available to the governments in period 2 (i.e., when inflation is decided). Hence, the CCB's objective function is given by:

$$
\begin{aligned}
U_{CCB} &= \lambda\left(-\tfrac{\pi^2}{2\phi}\right) + (1-\lambda)\tfrac{1}{n}\sum_{i=1}^{n}\left[1-(1+\pi^e-\pi)b_{1i} - \psi\left(d_{2i}-\bar{d}_{2i}\right) + \tfrac{\psi}{n-1}\sum_{j=1,j\neq i}^{n}\left(d_{2j}-\bar{d}_{2j}\right)\right] \\
&= (1-\lambda) \\
&\quad \times\left\{-\tfrac{\pi^2}{2\phi(1-\lambda)/\lambda} + \tfrac{1}{n}\sum_{i=1}^{n}\left[1-(1+\pi^e-\pi)b_{1i} - \psi\left(d_{2i}-\bar{d}_{2i}\right) + \tfrac{\psi}{n-1}\sum_{j=1,j\neq i}^{n}\left(d_{2j}-\bar{d}_{2j}\right)\right]\right\} \\
&= (1-\lambda)\left[-\frac{\pi^2}{2\alpha} + 1 - (1+\pi^e-\pi)\,\tilde{b}_1\right],
\end{aligned}
$$

where $\alpha \equiv \phi(1-\lambda)/\lambda \geq 0$, and where we have used that the fines and the rebates cancel out in the aggregate. Ignoring the proportionality factor, $(1-\lambda)$, equation (6) follows.

D. The optimal symmetric equilibrium

Substituting (9), (10) and (7) into (8), using $\epsilon_i = \tilde{\epsilon}$, $\forall i$, and, hence (by uniqueness and symmetry) using that $b_{1i} = \tilde{b}_1, \forall i$, one obtains a first-period government's utility as a function of the common debt choice $\tilde{b}_1$:

$$u\left(1+\tilde{\epsilon}+\tilde{b}_1\right) + pu\left(1-\tilde{b}_1\right) - \left(\alpha\tilde{b}_1\right)^2/(2\phi)\,. \tag{D.1}$$

This expression is a strictly concave function of $\tilde{b}_1$. Hence, each first-period government would prefer the debt level $\tilde{b}_1 = \tilde{b}_1^*$ that solves (12).

E. Proofs of Results (i) - (ii)

E.1. Result (i)

Because shock realizations are equal across countries, $b_{1i} = \tilde{b}_1$, $\forall i$. We focus on $\tilde{b}_1 > 0$.

(a) Use (9) and (10) to write the first-order conditions (11) as

$$u'\left(1+\tilde{b}_1+\tilde{\epsilon}\right)(1-\psi) = pu'\left(1-\tilde{b}_1\right)(1-\psi) + \alpha^2\tilde{b}_1/(\phi n)\,, \quad \forall i. \tag{E.1}$$

It follows immediately that, in the absence of a pact ($\psi = 0$) and with $\tilde{\epsilon} = 0$, if $p \to 1$, then $b_{1i} = \tilde{b}_1 = 0$, $\forall i$. Denote the solution for $\tilde{b}_1 > 0$ by $\tilde{b}_1^*$. Implicit differentiation (E.1) yields

$$\frac{\partial \tilde{b}_1}{\partial p} = \frac{u'\left(\tilde{f}_2^*\right)(1-\psi)}{\Omega(1-\psi) - \alpha^2/(\phi n)} < 0,$$

with $\Omega \equiv u''\left(\tilde{f}_1^*\right) + pu''\left(\tilde{f}_2^*\right) < 0$ and where $\tilde{f}_1^*$ and $\tilde{f}_2^*$ denote the solutions for public spending. Next, one has

$$\frac{\partial \tilde{b}_1}{\partial n} = -\frac{\alpha^2/(\phi n^2)}{\Omega(1-\psi) - \alpha^2/(\phi n)} \tilde{b}_1^*,$$

which is positive for $\alpha > 0$. Finally, one has:

$$\frac{\partial \tilde{b}_1}{\partial \alpha} = \frac{2\alpha/(\phi n)}{\Omega(1-\psi) - \alpha^2/(\phi n)} \tilde{b}_1^*,$$

which is negative for $\alpha > 0$.

(b) Implicit differentiation of (E.1) yields

$$\frac{\partial \tilde{b}_1}{\partial \psi} = \frac{u'\left(\tilde{f}_1^*\right) - pu'\left(\tilde{f}_2^*\right)}{\Omega(1-\psi) - \alpha^2/(\phi n)}.$$

Using (11), we rewrite this as:

$$\frac{\partial \tilde{b}_1}{\partial \psi} = \frac{\alpha^2 \tilde{b}_1^* / [\phi n (1-\psi)]}{\Omega(1-\psi) - \alpha^2/(\phi n)}.$$

This is negative, unless $\alpha = 0$, in which case $\partial \tilde{b}_1 / \partial \psi = 0$.

(c) Implicit differentiation of (E.1) yields

$$\frac{\partial \tilde{b}_1}{\partial \tilde{\epsilon}} = -\frac{u''\left(\tilde{f}_1^*\right)(1-\psi)}{\Omega(1-\psi) - \alpha^2/(\phi n)} < 0.$$

Differentiation of the expression for $\partial \tilde{b}_1 / \partial \tilde{\epsilon}$, and using that $u''' = 0$, establishes that $\partial\left(\partial \tilde{b}_1 / \partial \tilde{\epsilon}\right)/\partial n < 0$ and $\partial\left(\partial \tilde{b}_1 / \partial \tilde{\epsilon}\right)/\partial \psi > 0$.

E.2. Result (ii)

We vary $(\tilde{\epsilon} - \epsilon_i)$ while assuming that $\mathrm{d}(\tilde{\epsilon} - \epsilon_j) = -\frac{1}{n-1}\mathrm{d}(\tilde{\epsilon} - \epsilon_i)$, $\forall j \neq i$. This manipulation keeps $\tilde{\epsilon}$ unchanged. Furthermore, we assume that, initially, $\epsilon_i = \tilde{\epsilon}$.

(a) Total differentiation of country i's first-order condition, (11), yields

$$\mathrm{d}b_{1i} = \frac{u''\left(\tilde{f}_1^*\right)\left(\frac{n}{n-1}\psi\delta - 1\right)}{\left(\frac{n}{n-1}\psi - 1\right)\Omega}\mathrm{d}\left(\tilde{\epsilon} - \epsilon_i\right) + \frac{\frac{n}{n-1}\psi\Omega\left(1-\psi\right) - \alpha^2/\left(\phi n\right)}{\left(\frac{n}{n-1}\psi - 1\right)\Omega\left(1-\psi\right)}\mathrm{d}\tilde{b}_1, \tag{E.2}$$

which is evaluated around the initial, symmetric equilibrium. Similarly, total differentiation of countries j's, $\forall j \neq i$, first-order condition, while using $\mathrm{d}(\tilde{\epsilon} - \epsilon_j) = -\frac{1}{n-1}\mathrm{d}(\tilde{\epsilon} - \epsilon_i)$ and evaluating around the initial equilibrium, implies

$$\mathrm{d}b_{1j} = -\frac{1}{n-1}\frac{u''\left(\tilde{f}_1^*\right)\left(\frac{n}{n-1}\psi\delta - 1\right)}{\left(\frac{n}{n-1}\psi - 1\right)\Omega}\mathrm{d}\left(\tilde{\epsilon} - \epsilon_i\right) + \frac{\frac{n}{n-1}\psi\Omega\left(1-\psi\right) - \alpha^2/\left(\phi n\right)}{\left(\frac{n}{n-1}\psi - 1\right)\Omega\left(1-\psi\right)}\mathrm{d}\tilde{b}_1, \quad \forall j \neq i, \tag{E.3}$$

Note that $\mathrm{d}\tilde{b}_1 = \frac{1}{n}\mathrm{d}b_{1i} + \frac{1}{n}\sum_{j\neq i}\mathrm{d}b_{1j}$ and combine this with (E.2) and (E.3) to imply that $\mathrm{d}\tilde{b}_1 = 0$. Hence,

$$\frac{\partial\left(b_{1i} - \tilde{b}_1\right)}{\partial\left(\tilde{\epsilon} - \epsilon_i\right)} = \frac{u''\left(\tilde{f}_1^*\right)\left(\frac{n}{n-1}\psi\delta - 1\right)}{\left(\frac{n}{n-1}\psi - 1\right)\Omega} > 0,$$

when $0 \leq \psi < \frac{n-1}{n}$.

(b)-(c) Differentiation of the expression for $\partial\left(b_{1i} - \tilde{b}_1\right)/\partial\left(\tilde{\epsilon} - \epsilon_i\right)$, while using that $u''' = 0$ readily establishes that $\partial\left[\partial\left(b_{1i} - \tilde{b}_1\right)/\partial\left(\tilde{\epsilon} - \epsilon_i\right)\right]/\partial\psi > 0$ and $\partial\left[\partial\left(b_{1i} - \tilde{b}_1\right)/\partial\left(\tilde{\epsilon} - \epsilon_i\right)\right]/\partial\delta < 0$.

F. Derivation of the outcomes for e_i, (21), and b_{1i}, (22).

For convenience, we repeat the relevant budget constraints if party F is in power in both periods:

$$f_{1i} = 1 + \tilde{\epsilon} + \tilde{e} + \tilde{b}_1 + \left(\frac{n}{n-1}\psi - 1\right)\left(\tilde{b}_1 - b_{1i}\right) + \left(\frac{n}{n-1}\psi\delta - 1\right)\left[\left(\tilde{\epsilon} - \epsilon_i\right) + \left(\tilde{e} - e_i\right)\right], \tag{F.1}$$

$$f_{2i} = 1 - \tilde{b}_1 + \left(1 - \frac{n}{n-1}\psi\right)\left(\tilde{b}_1 - b_{1i}\right), \tag{F.2}$$

and the expression for inflation

$$\pi = \alpha\tilde{b}_1. \tag{F.3}$$

In period 1, each government selects debt and effort, knowing its own shock but not knowing the other countries' shocks or κ's. Choices are made simultaneously, so we consider a "Cournotian game" for which we want to characterize the (Bayesian) Nash equilibrium. Note that the fact that the governments subsequently can observe the sum of e_i and ϵ_i in all countries is of no importance for the equilibrium outcomes: knowing that you get information about something later is of no use now (by the law of iterated projections).

Government i maximizes

$$U_{Fi} = \mathrm{E}_{|\kappa_i,\epsilon_i}\left[-v_i\left(e_i\right) + u(f_{1i}) + pu(f_{2i}) - \pi^2/(2\phi)\right].$$

over b_{1i} and e_i. (Note that the expectations operator now also operates over the unknown κ's.)

F.1. The equilibrium conditions for a (Bayesian) Nash equilibrium with quadratic utility

Applying the quadratic specifications (19) and (20) for v_i and u, respectively, the first-order conditions (18) and (17) become, respectively,

$$\begin{aligned} \mathrm{E}_{|\kappa_i,\epsilon_i}\left[\xi - (\xi-1)\,f_{1i}\right] &= p\mathrm{E}_{|\kappa_i,\epsilon_i}\left[\xi - (\xi-1)\,f_{2i}\right] + \tfrac{\alpha^2}{\phi n(1-\psi)}\mathrm{E}_{|\kappa_i,\epsilon_i}\left[\tilde{b}_1\right], \quad \forall i, \\ e_i - \kappa_i &= \mathrm{E}_{|\kappa_i,\epsilon_i}\left[\xi - (\xi-1)\,f_{1i}\right](1-\psi\delta), \quad \forall i. \end{aligned}$$

Now define $\mu \equiv \alpha^2/\left[\phi n\,(1-\psi)\right]$. Hence, these conditions become:

$$\begin{aligned} (1-p)\,\xi - (\xi-1)\,\mathrm{E}_{|\kappa_i,\epsilon_i}\left[f_{1i}\right] &= -p\,(\xi-1)\,\mathrm{E}_{|\kappa_i,\epsilon_i}\left[f_{2i}\right] \qquad \text{(F.4)} \\ &\quad +\mu\mathrm{E}_{|\kappa_i,\epsilon_i}\left[\tilde{b}_1\right], \quad \forall i, \\ e_i - \kappa_i &= \xi\,(1-\psi\delta) \qquad \text{(F.5)} \\ &\quad -(\xi-1)\,(1-\psi\delta)\,\mathrm{E}_{|\kappa_i,\epsilon_i}\left[f_{1i}\right], \quad \forall i. \end{aligned}$$

In the Bayesian Nash equilibrium we consider, each government i's strategy will be a function of ϵ_i and κ_i and its estimates about other countries' shocks and preferences, and estimates about other governments' estimates about ϵ_j, κ_j, $\forall j$, and so on. In a n-player game like this one, the algebra would become rather intractable. However, as we have assumed that all the shocks have zero mean, taking this iterative process into account becomes particularly simple, because these estimates simply vanish. As a result, government i's strategy depends only on the realization of ϵ_i and κ_i, but not on the other shocks.

Therefore, we conjecture the following set of equilibrium strategies:

$$b_{1i} = B - B_\epsilon \epsilon_i - B_\kappa \kappa_i, \qquad \text{(F.6)}$$

$$e_i = D - D_\epsilon \epsilon_i + D_\kappa \kappa_i. \qquad \text{(F.7)}$$

If this conjecture is correct, the realizations of cross-country average debt and effort will be given by, respectively,

$$\tilde{b}_1 = B - B_\epsilon \tilde{\epsilon} - B_\kappa \tilde{\kappa}, \tag{F.8}$$

$$\tilde{e} = D - D_\epsilon \tilde{\epsilon} + D_\kappa \tilde{\kappa}. \tag{F.9}$$

Hence, the realizations of public consumption are given by

$$\begin{aligned} f_{1i} &= 1 + \tilde{\epsilon} + D - D_\epsilon \tilde{\epsilon} + D_\kappa \tilde{\kappa} + B - B_\epsilon \tilde{\epsilon} - B_\kappa \tilde{\kappa} \\ &\quad - \left(\tfrac{n}{n-1}\psi - 1\right)\left(B_\epsilon \tilde{\epsilon} - B_\epsilon \epsilon_i + B_\kappa \tilde{\kappa} - B_\kappa \kappa_i\right) \\ &\quad + \left(\tfrac{n}{n-1}\psi\delta - 1\right)\left[\tilde{\epsilon} - \epsilon_i + \left(-D_\epsilon \tilde{\epsilon} + D_\epsilon \epsilon_i + D_\kappa \tilde{\kappa} - D_\kappa \kappa_i\right)\right], \end{aligned} \tag{F.10}$$

$$f_{2i} = 1 - \left[B - B_\epsilon \tilde{\epsilon} - B_\kappa \tilde{\kappa}\right] - \left(1 - \tfrac{n}{n-1}\psi\right)\left(B_\epsilon \tilde{\epsilon} - B_\epsilon \epsilon_i + B_\kappa \tilde{\kappa} - B_\kappa \kappa_i\right). \tag{F.11}$$

To verify the conjectured strategies and to solve for its coefficients, we need to compute the expectations of these expressions, conditional upon government i's information set. From (F.10) we find:

$$\begin{aligned} \mathrm{E}_{|\kappa_i,\epsilon_i}\left[f_{1i}\right] &= 1 + \tfrac{1}{n}\epsilon_i + D - D_\epsilon \tfrac{1}{n}\epsilon_i + D_\kappa \tfrac{1}{n}\kappa_i + B - B_\epsilon \tfrac{1}{n}\epsilon_i - B_\kappa \tfrac{1}{n}\kappa_i \\ &\quad - \left(\tfrac{n}{n-1}\psi - 1\right)\left(B_\epsilon \tfrac{1}{n}\epsilon_i + B_\kappa \tfrac{1}{n}\kappa_i - B_\kappa \kappa_i - B_\epsilon \epsilon_i\right) \\ &\quad + \left(\tfrac{n}{n-1}\psi\delta - 1\right)\left[\tfrac{1}{n}\epsilon_i - \epsilon_i - D_\epsilon \tfrac{1}{n}\epsilon_i + D_\kappa \tfrac{1}{n}\kappa_i - D_\kappa \kappa_i + D_\epsilon \epsilon_i\right], \end{aligned}$$

and thus

$$\begin{aligned} \mathrm{E}_{|\kappa_i,\epsilon_i}\left[f_{1i}\right] &= 1 + B + D + \left(\tfrac{1-B_\epsilon-D_\epsilon}{n}\right)\epsilon_i + \tfrac{D_\kappa - B_\kappa}{n}\kappa_i + \left(\tfrac{n}{n-1}\psi - 1\right)\left(B_\kappa \tfrac{n-1}{n}\kappa_i + B_\epsilon \tfrac{n-1}{n}\epsilon_i\right) \\ &\quad - \left(\tfrac{n}{n-1}\psi\delta - 1\right)\left[\tfrac{n-1}{n}\left(1 - D_\epsilon\right)\epsilon_i + D_\kappa \tfrac{n-1}{n}\kappa_i\right] \\ &= 1 + B + D + \left(\tfrac{1-B_\epsilon-D_\epsilon}{n}\right)\epsilon_i - \left(\tfrac{1}{n} - \left(\tfrac{n}{n-1}\psi - 1\right)\tfrac{n-1}{n}\right)B_\kappa \kappa_i + \tfrac{D_\kappa}{n}\kappa_i \\ &\quad + \left(\tfrac{n}{n-1}\psi - 1\right)B_\epsilon \tfrac{n-1}{n}\epsilon_i - \left(\tfrac{n}{n-1}\psi\delta - 1\right)\left[\tfrac{n-1}{n}\left(1 - D_\epsilon\right)\epsilon_i + D_\kappa \tfrac{n-1}{n}\kappa_i\right] \\ &= 1 + B + D + \left(\tfrac{1-B_\epsilon-D_\epsilon}{n}\right)\epsilon_i - \left(1 - \psi\right)B_\kappa \kappa_i + \tfrac{D_\kappa}{n}\kappa_i \\ &\quad + \left(\tfrac{n}{n-1}\psi - 1\right)B_\epsilon \tfrac{n-1}{n}\epsilon_i - \left(\tfrac{n}{n-1}\psi\delta - 1\right)\left[\tfrac{n-1}{n}\left(1 - D_\epsilon\right)\epsilon_i + D_\kappa \tfrac{n-1}{n}\kappa_i\right] \\ &= 1 + B + D - \left(1 - \psi\right)B_\kappa \kappa_i + \left(1 - \psi\delta\right)D_\kappa \kappa_i \\ &\quad + \left[\tfrac{1-B_\epsilon-D_\epsilon}{n} + \left(\tfrac{n}{n-1}\psi - 1\right)B_\epsilon \tfrac{n-1}{n} - \left(\tfrac{n}{n-1}\psi\delta - 1\right)\tfrac{n-1}{n}\left(1 - D_\epsilon\right)\right]\epsilon_i, \end{aligned}$$

and thus

$$\mathrm{E}_{|\kappa_i,\epsilon_i}\left[f_{1i}\right] = 1 + B + D - \left(1 - \psi\right)B_\kappa \kappa_i + \left(1 - \psi\delta\right)D_\kappa \kappa_i \tag{F.12}$$

$$+\left[\left(1-D_{\epsilon}\right)\left(1-\psi\delta\right)-B_{\epsilon}\left(1-\psi\right)\right]\epsilon_{i}.$$

Similarly, we find the expected public consumption in period two by use of (F.11):

$$\begin{aligned}\mathrm{E}_{|\kappa_i,\epsilon_i}\left[f_{2i}\right] &= 1-\left[B-B_{\epsilon}\tfrac{1}{n}\epsilon_i-B_{\kappa}\tfrac{1}{n}\kappa_i\right] \\ &\quad -\left(1-\tfrac{n}{n-1}\psi\right)\left(B_{\epsilon}\tfrac{1}{n}\epsilon_i+B_{\kappa}\tfrac{1}{n}\kappa_i-B_{\kappa}\kappa_i-B_{\epsilon}\epsilon_i\right),\end{aligned}$$

and thus

$$\mathrm{E}_{|\kappa_i,\epsilon_i}\left[f_{2i}\right]=1-B+\left(1-\psi\right)B_{\kappa}\kappa_i+\left(1-\psi\right)B_{\epsilon}\epsilon_i. \tag{F.13}$$

Finally, we need to find government i's expectation of average debt. This follows by use of (F.8) as

$$\mathrm{E}_{|\kappa_i,\epsilon_i}\left[\tilde{b}_1\right]=B-B_{\epsilon}\tfrac{1}{n}\epsilon_i-B_{\kappa}\tfrac{1}{n}\kappa_i. \tag{F.14}$$

F.2. Verification of conjectures and solution

Insert the expressions for $\mathrm{E}_{|\kappa_i,\epsilon_i}\left[f_{1i}\right]$, $\mathrm{E}_{|\kappa_i,\epsilon_i}\left[f_{2i}\right]$ and $\mathrm{E}_{|\kappa_i,\epsilon_i}\left[\tilde{b}_1\right]$ into the first-order conditions. This yields [also using the conjecture for e_i, equation (F.7)]:

$$\begin{aligned}&\left(1-p\right)\xi-\left(\xi-1\right)\left[1+B+D-\left(1-\psi\right)B_{\kappa}\kappa_i+\left(1-\psi\delta\right)D_{\kappa}\kappa_i\right.\\ &\left.+\left[\left(1-D_{\epsilon}\right)\left(1-\psi\delta\right)-B_{\epsilon}\left(1-\psi\right)\right]\epsilon_i\right]\\ =\;&-p\left(\xi-1\right)\left[1-B+\left(1-\psi\right)B_{\kappa}\kappa_i+B_{\epsilon}\left(1-\psi\right)\epsilon_i\right]\\ &+\mu\left[B-B_{\epsilon}\tfrac{1}{n}\epsilon_i-B_{\kappa}\tfrac{1}{n}\kappa_i\right],\end{aligned} \tag{F.15}$$

and

$$\begin{aligned}&D+D_{\kappa}\kappa_i-D_{\epsilon}\epsilon_i-\kappa_i\\ =\;&\xi\left(1-\psi\delta\right)-\left(\xi-1\right)\left(1-\psi\delta\right)\left[1+B+D-\left(1-\psi\right)B_{\kappa}\kappa_i+\left(1-\psi\delta\right)D_{\kappa}\kappa_i\right.\\ &\left.+\left[\left(1-D_{\epsilon}\right)\left(1-\psi\delta\right)-B_{\epsilon}\left(1-\psi\right)\right]\epsilon_i\right].\end{aligned} \tag{F.16}$$

F.2.1. Solution for shock coefficients

As (F.15) and (F.16) must hold for all values of ϵ_i, we have that the following must hold:

$$-\left(\xi-1\right)\left[\left(1-D_{\epsilon}\right)\left(1-\psi\delta\right)-B_{\epsilon}\left(1-\psi\right)\right]=-p\left(\xi-1\right)B_{\epsilon}\left(1-\psi\right)-\mu B_{\epsilon}\tfrac{1}{n}, \tag{F.17}$$

$$D_{\epsilon}=\left(\xi-1\right)\left(1-\psi\delta\right)\left[\left(1-D_{\epsilon}\right)\left(1-\psi\delta\right)-B_{\epsilon}\left(1-\psi\right)\right]. \tag{F.18}$$

Observe that (F.17) can be rewritten as expression (A.4) in Appendix A. Expressions (F.17) and (F.18) uniquely identify coefficients B_ϵ and D_ϵ. By inserting (F.18)'s implied value for $(1-D_\epsilon)(1-\psi\delta) - B_\epsilon(1-\psi)$ into (F.17), we get

$$-\tfrac{D_\epsilon}{(1-\psi\delta)} = -p(\xi-1)B_\epsilon(1-\psi) - \mu B_\epsilon \tfrac{1}{n},$$

leading to a value of D_ϵ, given B_ϵ,

$$D_\epsilon = B_\epsilon(1-\psi\delta)\left[p(\xi-1)(1-\psi) + \mu\tfrac{1}{n}\right]. \tag{F.19}$$

Inserting this value back into (F.17) then gives

$$\begin{aligned}
& -(\xi-1)\left[\left(1 - B_\epsilon(1-\psi\delta)\left[p(\xi-1)(1-\psi)+\mu\tfrac{1}{n}\right]\right)(1-\psi\delta) - B_\epsilon(1-\psi)\right] \\
= \; & -B_\epsilon\left[p(\xi-1)(1-\psi)+\mu\tfrac{1}{n}\right]
\end{aligned}$$

We isolate B_ϵ on the left-hand-side to get:

$$-B_\epsilon\left[-\left[(\xi-1)(1-\psi\delta)^2+1\right]\left[p(\xi-1)(1-\psi)+\mu\tfrac{1}{n}\right] - (\xi-1)(1-\psi)\right] = (\xi-1)(1-\psi\delta).$$

Hence, the solution is

$$B_\epsilon = \tfrac{(\xi-1)(1-\psi\delta)}{\left[(\xi-1)(1-\psi\delta)^2+1\right]\left[p(\xi-1)(1-\psi)+\mu\frac{1}{n}\right]+(\xi-1)(1-\psi)} > 0. \tag{F.20}$$

Combined with (F.19), we then recover the expression for D_ϵ:

$$D_\epsilon = \tfrac{(\xi-1)(1-\psi\delta)^2\left[p(\xi-1)(1-\psi)+\mu\frac{1}{n}\right]}{\left[(\xi-1)(1-\psi\delta)^2+1\right]\left[p(\xi-1)(1-\psi)+\mu\frac{1}{n}\right]+(\xi-1)(1-\psi)} > 0. \tag{F.21}$$

F.2.2. Solution for average effort and debt

Now, with B_ϵ and D_ϵ given by (F.20) and (F.21), respectively, (F.15) and (F.16) reduce to

$$\begin{aligned}
& (1-p)\xi - (\xi-1)\left[1 + B + D - (1-\psi)B_\kappa\kappa_i + (1-\psi\delta)D_\kappa\kappa_i\right] \\
= \; & -p(\xi-1)\left[1 - B + (1-\psi)B_\kappa\kappa_i\right] + \mu\left[B - B_\kappa\frac{1}{n}\kappa_i\right],
\end{aligned} \tag{F.22}$$

and

$$D + D_\kappa\kappa_i - \kappa_i$$

$$= \xi\left(1-\psi\delta\right) - \left(\xi-1\right)\left(1-\psi\delta\right)\left[1+B+D-\left(1-\psi\right)B_{\kappa}\kappa_{i}+\left(1-\psi\delta\right)D_{\kappa}\kappa_{i}\right].$$

We now want to determine B, D, $B_{\kappa}\kappa_{i}$ and $D_{\kappa}\kappa_{i}$. For this purpose we note that the two equations must hold for all κ_i, including $\kappa_i = 0$. For the computation of B and D, we thus have the following two conditions:

$$\left(1-p\right)\xi - \left(\xi-1\right)\left(1+B+D\right) = -p\left(\xi-1\right)\left(1-B\right)+\mu B, \tag{F.23}$$

and

$$D = \xi\left(1-\psi\delta\right) - \left(\xi-1\right)\left(1-\psi\delta\right)\left(1+B+D\right). \tag{F.24}$$

These equations identify B and D. From (F.24) we obtain the following solution for D:

$$D = \frac{\xi\left(1-\psi\delta\right)-\left(\xi-1\right)\left(1-\psi\delta\right)\left(1+B\right)}{1+\left(\xi-1\right)\left(1-\psi\delta\right)}. \tag{F.25}$$

We then plug the solution for D from (F.25) back into (F.23) so as to identify B:

$$\begin{aligned} & \left(1-p\right)\xi-\left(\xi-1\right)\left[1+B+\frac{\xi\left(1-\psi\delta\right)-\left(\xi-1\right)\left(1-\psi\delta\right)\left(1+B\right)}{1+\left(\xi-1\right)\left(1-\psi\delta\right)}\right] \\ = & -p\left(\xi-1\right)\left[1-B\right]+\mu B. \end{aligned}$$

Isolating the B part gives:

$$\begin{aligned} & \left[-\tfrac{(\xi-1)}{1+(\xi-1)(1-\psi\delta)}-p\left(\xi-1\right)-\mu\right]B \\ = & -\left(1-p\right)\xi+\left(\xi-1\right)\left[1+\tfrac{(1-\psi\delta)}{1+(\xi-1)(1-\psi\delta)}\right]-p\left(\xi-1\right) \end{aligned}$$

$$\begin{aligned} \Leftrightarrow & \left[-\tfrac{(\xi-1)}{1+(\xi-1)(1-\psi\delta)}-p\left(\xi-1\right)-\mu\right]B \\ = & p-\xi+\tfrac{(\xi-1)(1+\xi(1-\psi\delta))}{1+(\xi-1)(1-\psi\delta)}, \end{aligned}$$

and thereby

$$\begin{aligned} B &= \frac{p-\xi+\left[\frac{(\xi-1)(1+\xi(1-\psi\delta))}{1+(\xi-1)(1-\psi\delta)}\right]}{-\left[\frac{(\xi-1)}{1+(\xi-1)(1-\psi\delta)}\right]-p\left(\xi-1\right)-\mu} \\ &= \frac{\left(\xi-p\right)\left(1+\left(\xi-1\right)\left(1-\psi\delta\right)\right)-\left(\xi-1\right)\left(1+\xi\left(1-\psi\delta\right)\right)}{\left(\xi-1\right)+\left(p\left(\xi-1\right)+\mu\right)\left(1+\left(\xi-1\right)\left(1-\psi\delta\right)\right)} \\ &= \frac{\xi-p-\left(\xi-1\right)\left(1+p\left(1-\psi\delta\right)\right)}{\left(\xi-1\right)+\left(p\left(\xi-1\right)+\mu\right)\left(1+\left(\xi-1\right)\left(1-\psi\delta\right)\right)}. \end{aligned} \tag{F.26}$$

Inserting this value of B back into (F.25) then provides the solution for D:

$$D = \frac{(1-\psi\delta)}{1+(\xi-1)(1-\psi\delta)}\left[1 - \frac{(\xi-1)[\xi-p-(\xi-1)(1+p(1-\psi\delta))]}{(\xi-1)+(p(\xi-1)+\mu)(1+(\xi-1)(1-\psi\delta))}\right]. \tag{F.27}$$

F.2.3. Solution for country-specific effort and debt

Having derived these averages, we can now go back to each government i's optimality conditions and find the response coefficients to the government types. Let us repeat the conditions:

$$\begin{aligned} & (1-p)\,\xi - (\xi-1)\left[1 + B + D - (1-\psi)\,B_\kappa\kappa_i + (1-\psi\delta)\,D_\kappa\kappa_i\right] \\ = \; & -p\,(\xi-1)\left[1 - B + (1-\psi)\,B_\kappa\kappa_i\right] + \mu\left[B - B_{\kappa\frac{1}{n}}\kappa_i\right], \end{aligned} \tag{F.28}$$

and

$$\begin{aligned} & D + D_\kappa\kappa_i - \kappa_i \\ = \; & \xi\,(1-\psi\delta) - (\xi-1)\,(1-\psi\delta)\left[1 + B + D - (1-\psi)\,B_\kappa\kappa_i + (1-\psi\delta)\,D_\kappa\kappa_i\right]. \end{aligned} \tag{F.29}$$

From this system of equations we subtract (F.23)-(F.24), to yield:

$$(\xi-1)\left[(1-\psi)\,B_\kappa\kappa_i - (1-\psi\delta)\,D_\kappa\kappa_i\right] = -p\,(\xi-1)\,B_\kappa\kappa_i\,(1-\psi) - \mu B_{\kappa\frac{1}{n}}\kappa_i, \tag{F.30}$$

and

$$D_\kappa\kappa_i - \kappa_i = (\xi-1)\,(1-\psi\delta)\left[(1-\psi)\,B_\kappa\kappa_i - (1-\psi\delta)\,D_\kappa\kappa_i\right]. \tag{F.31}$$

From (F.30) we then immediately find

$$(1+p)\,B_\kappa\kappa_i\,(1-\psi) = (1-\psi\delta)\,D_\kappa\kappa_i - \tfrac{\mu}{\xi-1}B_{\kappa\frac{1}{n}}\kappa_i,$$

and thus

$$\begin{aligned} B_\kappa\kappa_i &= \frac{1-\psi\delta}{(1-\psi)\,(1+p) + \mu/\left[n\,(\xi-1)\right]}D_\kappa\kappa_i \\ &= \frac{(1-\psi\delta)\,(\xi-1)}{(\xi-1)\,(1-\psi)\,(1+p) + \mu/n}D_\kappa\kappa_i. \end{aligned} \tag{F.32}$$

This is then inserted back into (F.31) to solve for $D_\kappa\kappa_i$:

$$D_\kappa\kappa_i - \kappa_i = (\xi-1)\,(1-\psi\delta)\left[(1-\psi)\,\tfrac{1-\psi\delta}{(1-\psi)(1+p)+\mu/[n(\xi-1)]}D_\kappa\kappa_i - (1-\psi\delta)\,D_\kappa\kappa_i\right]$$

$$\Leftrightarrow D_\kappa \kappa_i - \kappa_i = (\xi - 1)(1 - \psi\delta)^2 \left[\tfrac{1-\psi}{(1-\psi)(1+p)+\mu/[n(\xi-1)]} D_\kappa \kappa_i - D_\kappa \kappa_i\right]$$

$$\Leftrightarrow D_\kappa \kappa_i - \kappa_i = (\xi - 1)(1 - \psi\delta)^2 \left[\tfrac{1-\psi}{(1-\psi)(1+p)+\mu/[n(\xi-1)]} - 1\right] D_\kappa \kappa_i$$

$$\Leftrightarrow D_\kappa \kappa_i \left[1 - (\xi - 1)(1 - \psi\delta)^2 \tfrac{(1-\psi)-(1-\psi)(1+p)-\mu/[n(\xi-1)]}{(1-\psi)(1+p)+\mu/[n(\xi-1)]}\right] = \kappa_i$$

$$\Leftrightarrow D_\kappa \kappa_i \left[1 + (\xi - 1)(1 - \psi\delta)^2 \tfrac{(1-\psi)p+\mu/[n(\xi-1)]}{(1-\psi)(1+p)+\mu/[n(\xi-1)]}\right] = \kappa_i,$$

and therefore

$$\begin{aligned} D_\kappa &= \left[1 + (\xi - 1)(1 - \psi\delta)^2 \tfrac{(1-\psi)p+\mu/[n(\xi-1)]}{(1-\psi)(1+p)+\mu/[n(\xi-1)]}\right]^{-1} \\ &= \tfrac{(1-\psi)(1+p)+\mu/[n(\xi-1)]}{(1-\psi)+\left[1+(\xi-1)(1-\psi\delta)^2\right][(1-\psi)p+\mu/[n(\xi-1)]]} \\ &= \tfrac{(\xi-1)(1-\psi)(1+p)+\mu/n}{(\xi-1)(1-\psi)+\left[1+(\xi-1)(1-\psi\delta)^2\right][(\xi-1)(1-\psi)p+\mu/n]} > 0. \end{aligned} \tag{F.33}$$

Inserted back into (F.32) we then solve for B_κ:

$$B_\kappa = \tfrac{(\xi-1)(1-\psi\delta)}{(\xi-1)(1-\psi)+\left[1+(\xi-1)(1-\psi\delta)^2\right][(\xi-1)(1-\psi)p+\mu/n]} > 0.$$

Finally, using (F.1), (F.2), (F.6) and (F.7), we obtain

$$\begin{aligned} f_{1i} &= 1 + \tilde{\epsilon} + \tilde{e} + \tilde{b}_1 + \left(\tfrac{n}{n-1}\psi - 1\right)\left[B_\epsilon(\epsilon_i - \tilde{\epsilon}) + B_\kappa(\kappa_i - \tilde{\kappa})\right] \\ &\quad + \left(\tfrac{n}{n-1}\psi\delta - 1\right)\left[(D_\epsilon - 1)(\epsilon_i - \tilde{\epsilon}) - D_\kappa(\kappa_i - \tilde{\kappa})\right] \\ &= 1 + \tilde{\epsilon} + \tilde{e} + \tilde{b}_1 \\ &\quad + \left[\left(\tfrac{n}{n-1}\psi - 1\right)B_\epsilon + \left(\tfrac{n}{n-1}\psi\delta - 1\right)(D_\epsilon - 1)\right](\epsilon_i - \tilde{\epsilon}) \\ &\quad + \left[\left(\tfrac{n}{n-1}\psi - 1\right)B_\kappa + \left(1 - \tfrac{n}{n-1}\psi\delta\right)D_\kappa\right](\kappa_i - \tilde{\kappa}) \\ &= 1 + \tilde{\epsilon} + \tilde{e} + \tilde{b}_1 + F_{1\epsilon}(\epsilon_i - \tilde{\epsilon}) + F_{1\kappa}(\kappa_i - \tilde{\kappa}), \end{aligned}$$

and

$$\begin{aligned} f_{2i} &= 1 - \tilde{b}_1 + \left(1 - \tfrac{n}{n-1}\psi\right)\left[B_\epsilon(\epsilon_i - \tilde{\epsilon}) + B_\kappa(\kappa_i - \tilde{\kappa})\right] \\ &= 1 - \tilde{b}_1 + \left(1 - \tfrac{n}{n-1}\psi\right)B_\epsilon(\epsilon_i - \tilde{\epsilon}) + \left(1 - \tfrac{n}{n-1}\psi\right)B_\kappa(\kappa_i - \tilde{\kappa}) \\ &= 1 - \tilde{b}_1 + F_{2\epsilon}(\epsilon_i - \tilde{\epsilon}) + F_{2\kappa}(\kappa_i - \tilde{\kappa}), \end{aligned}$$

where,

$$
\begin{aligned}
F_{1\epsilon} &= \left(\tfrac{n}{n-1}\psi - 1\right) B_\epsilon + \left(\tfrac{n}{n-1}\psi\delta - 1\right)(D_\epsilon - 1) \\
&= \frac{(\xi-1)(1-\delta)\frac{1}{n-1}\psi + \left(1-\frac{n}{n-1}\psi\delta\right)[(\xi-1)(1-\psi)p+\mu/n]}{(\xi-1)(1-\psi)+\left[1+(\xi-1)(1-\psi\delta)^2\right][(\xi-1)(1-\psi)p+\mu/n]} \geq 0,
\end{aligned}
$$

$$
\begin{aligned}
F_{2\epsilon} &= \left(1-\tfrac{n}{n-1}\psi\right) B_\epsilon \\
&= \frac{(\xi-1)(1-\psi)\left(1-\frac{n}{n-1}\psi\right)(1-\psi\delta)}{(\xi-1)(1-\psi)^2+\left[(\xi-1)(1-\psi)^2 p+\alpha^2/(\phi n^2)\right]\left[1+(\xi-1)(1-\psi\delta)^2\right]} \geq 0,
\end{aligned}
$$

$$
\begin{aligned}
F_{1\kappa} &= \left(\tfrac{n}{n-1}\psi - 1\right) B_\kappa + \left(1-\tfrac{n}{n-1}\psi\delta\right) D_\kappa \\
&= \frac{(\xi-1)\left(\frac{n}{n-1}\psi-1\right)(1-\psi\delta)+\left(1-\frac{n}{n-1}\psi\delta\right)[(\xi-1)(1-\psi)(1+p)+\mu/n]}{(\xi-1)(1-\psi)+\left[1+(\xi-1)(1-\psi\delta)^2\right][(\xi-1)(1-\psi)p+\mu/n]} \\
&= \frac{(\xi-1)(1-\delta)\frac{1}{n-1}\psi+\left(1-\frac{n}{n-1}\psi\delta\right)[(\xi-1)(1-\psi)p+\mu/n]}{(\xi-1)(1-\psi)+\left[1+(\xi-1)(1-\psi\delta)^2\right][(\xi-1)(1-\psi)p+\mu/n]} = F_{1\epsilon} \geq 0,
\end{aligned}
$$

and

$$
\begin{aligned}
F_{2\kappa} &= \left(1-\tfrac{n}{n-1}\psi\right) B_\kappa \\
&= \frac{(\xi-1)(1-\psi\delta)\left(1-\frac{n}{n-1}\psi\right)}{(\xi-1)(1-\psi)+\left[1+(\xi-1)(1-\psi\delta)^2\right][(\xi-1)(1-\psi)p+\mu/n]} = F_{2\epsilon} \geq 0.
\end{aligned}
$$

We can see immediately that, if $(\psi,\delta) = \left(\frac{n-1}{n}, 1\right)$, then $F_{1\epsilon} = F_{1\kappa} = F_{2\epsilon} = F_{2\kappa} = 0$.

G. Proof of result (iii)

(a) One can rewrite

$$
B = (1-\psi)\,\frac{1-p[1+(\xi-1)(1-\psi\delta)]}{(1-\psi)(\xi-1)\{1+p[1+(\xi-1)(1-\psi\delta)]\}+(\alpha^2/\phi n)[1+(\xi-1)(1-\psi\delta)]}.
$$

Hence, using (here and in the sequel) the symbol $\propto$ to indicate that the right-hand side has the same sign as the left-hand side,

$$
\begin{aligned}
\frac{\partial B}{\partial \delta} \propto\; & p(\xi-1)\,\psi\,(1-\psi)(\xi-1)\{1+p[1+(\xi-1)(1-\psi\delta)]\} \\
& + p(\xi-1)\,\psi\left(\alpha^2/\phi n\right)[1+(\xi-1)(1-\psi\delta)] \\
& + \left[(1-\psi)(\xi-1)\,p\,(\xi-1)\,\psi + \left(\alpha^2/\phi n\right)(\xi-1)\,\psi\right]\{1-p[1+(\xi-1)(1-\psi\delta)]\}
\end{aligned}
$$

$$
\begin{aligned}
&\propto \quad p\left\{(1-\psi)(\xi-1)\{1+p[1+(\xi-1)(1-\psi\delta)]\}+\left(\alpha^2/\phi n\right)[1+(\xi-1)(1-\psi\delta)]\right\} \\
&\qquad +\left[(1-\psi)(\xi-1)p+\left(\alpha^2/\phi n\right)\right]\{1-p[1+(\xi-1)(1-\psi\delta)]\} \\
&= \quad p(1-\psi)(\xi-1)\{1+p[1+(\xi-1)(1-\psi\delta)]\} \\
&\qquad +\left[(1-\psi)(\xi-1)p+\left(\alpha^2/\phi n\right)\right] \\
&\qquad -(1-\psi)(\xi-1)p^2[1+(\xi-1)(1-\psi\delta)] \\
&= \quad p(1-\psi)(\xi-1)+p^2(1-\psi)(\xi-1)[1+(\xi-1)(1-\psi\delta)] \\
&\qquad +\left[(1-\psi)(\xi-1)p+\left(\alpha^2/\phi n\right)\right]-(1-\psi)(\xi-1)p^2[1+(\xi-1)(1-\psi\delta)] \\
&= \quad p(1-\psi)(\xi-1)+(1-\psi)(\xi-1)p+\left(\alpha^2/\phi n\right) \\
&> \quad 0.
\end{aligned}
$$

Further,

$$\frac{\partial D}{\partial \delta}=-\tfrac{\psi}{[1+(\xi-1)(1-\psi\delta)]^2}[1-(\xi-1)B]+\left[\tfrac{1-\psi\delta}{1+(\xi-1)(1-\psi\delta)}\right]\tfrac{\partial[1-(\xi-1)B]}{\partial\delta}.$$

Because $1-(\xi-1)B>0$ (this is easy to show), the first term on the right-hand side is negative. In addition, from the result that $\frac{\partial B}{\partial \delta}>0$, it follows that the second term on the right-hand side is also negative. Hence, $\frac{\partial D}{\partial \delta}<0$.

(b) One can write B_ϵ as:

$$B_\epsilon=(\xi-1)(1-\psi)\left(\tfrac{y}{\gamma_0+\gamma_1 y^2}\right),$$

where

$$
\begin{aligned}
y &\equiv (1-\psi\delta)>0, \\
\gamma_0 &\equiv (\xi-1)(1-\psi)^2(1+p)+\alpha^2/\phi n^2>0, \\
\gamma_1 &\equiv \left[(\xi-1)(1-\psi)^2 p+\alpha^2/\phi n^2\right](\xi-1)>0.
\end{aligned}
$$

Hence,

$$\tfrac{\partial B_\epsilon}{\partial y}=(\xi-1)(1-\psi)\left[\tfrac{\gamma_0-\gamma_1 y^2}{(\gamma_0+\gamma_1 y^2)^2}\right].$$

Hence, $\frac{\partial B_\epsilon}{\partial \delta}<0$ is equivalent to $\gamma_0>\gamma_1 y^2$, which is equivalent to:

$$(\xi-1)(1-\psi)^2(1+p)+\alpha^2/\phi n^2>\left[(\xi-1)(1-\psi)^2 p+\alpha^2/\phi n^2\right](\xi-1)(1-\psi\delta)^2.$$

Because $\xi<2$, this condition is fulfilled.

Furthermore, we can write:

$$D_\epsilon = \frac{\gamma_1 y^2}{\gamma_0+\gamma_1 y^2},$$

An increase in δ reduces y and, hence, the result follows.

(c) From the expression of D_κ we see immediately that $\partial D_\kappa/\partial\delta > 0$. Because $B_\kappa = B_\epsilon$, it follows immediately that $\frac{\partial B_\kappa}{\partial \delta} < 0$.

H. Proof of Proposition 2

Government i's equilibrium expected utility as a function of the stability pact parameters and conditional on κ_i is given by:

$$V_{Fi}(\psi,\delta) \equiv \mathrm{E}_{|\kappa_i}\left[-(e_i-\kappa_i)^2/2 + u(f_{1i}) + pu(f_{2i}) - \left(\alpha\tilde{b}_1\right)^2/(2\phi)\right],$$

where u is defined by (20) and where f_{1i} and f_{2i} are understood to be evaluated for the equilibrium outcomes. In the sequel of this appendix all expressions are understood to be evaluated at $\theta^* \equiv (\psi,\delta) = (\frac{n-1}{n},1)$. Differentiating $V_{Fi}(\psi,\delta)$ with respect to δ and thus evaluating at θ^* yields:

$$\frac{\partial V_{Fi}(.)}{\partial\delta} = \mathrm{E}_{|\kappa_i}\left[-(e_i-\kappa_i)\frac{\partial e_i}{\partial\delta} + u'(f_{1i})\frac{\partial f_{1i}}{\partial\delta} + pu'(f_{2i})\frac{\partial f_{2i}}{\partial\delta} - \frac{\alpha^2}{\phi}\tilde{b}_1\frac{\partial\tilde{b}_1}{\partial\delta}\right].$$

where, using (16) and (10), respectively,

$$\frac{\partial f_{1i}}{\partial\delta} = \frac{\partial\tilde{e}}{\partial\delta} + \frac{\partial\tilde{b}_1}{\partial\delta} + [(\tilde{\epsilon}-\epsilon_i)+(\tilde{e}-e_i)], \qquad \frac{\partial f_{2i}}{\partial\delta} = -\frac{\partial\tilde{b}_1}{\partial\delta}.$$

Hence,

$$\frac{\partial V_{Fi}(.)}{\partial\delta} = \mathrm{E}_{|\kappa_i}\left[\begin{array}{c} -(e_i-\kappa_i)\frac{\partial e_i}{\partial\delta} + u'(f_{1i})\left[\frac{\partial\tilde{e}}{\partial\delta} + \frac{\partial\tilde{b}_1}{\partial\delta} + [(\tilde{\epsilon}-\epsilon_i)+(\tilde{e}-e_i)]\right] \\ -pu'(f_{2i})\frac{\partial\tilde{b}_1}{\partial\delta} - \frac{\alpha^2}{\phi}\tilde{b}_1\frac{\partial\tilde{b}_1}{\partial\delta} \end{array}\right].$$

Hence, using government i's first-order conditions for b_{1i} and e_i:

$$\frac{\partial V_{Fi}(.)}{\partial\delta} = T_1+T_2+T_3+T_4+T_5+T_6,$$

where

$$\begin{aligned} T_1 &= \mathrm{E}_{|\kappa_i}\left\{-\mathrm{E}_{|\kappa_i,\epsilon_i}\left[u'(f_{1i})\right]\frac{1}{n}\frac{\partial e_i}{\partial\delta}\right\},\ T_2 = \mathrm{E}_{|\kappa_i}\left[u'(f_{1i})\frac{\partial\tilde{e}}{\partial\delta}\right], \\ T_3 &= \mathrm{E}_{|\kappa_i}\left\{u'(f_{1i})\left[(\tilde{\epsilon}-\epsilon_i)+(\tilde{e}-e_i)\right]\right\}, \end{aligned}$$

$$
\begin{aligned}
T_4 &= \mathrm{E}_{|\kappa_i}\left\{\left[u'(f_{1i})-\mathrm{E}_{|\kappa_i,\epsilon_i}u'(f_{1i})\right]\tfrac{\partial\tilde{b}_1}{\partial\delta}\right\}, \\
T_5 &= -p\mathrm{E}_{|\kappa_i}\left\{\left[u'(f_{2i})-\mathrm{E}_{|\kappa_i,\epsilon_i}u'(f_{2i})\right]\tfrac{\partial\tilde{b}_1}{\partial\delta}\right\}, \\
T_6 &= -\tfrac{\alpha^2}{\phi}\mathrm{E}_{|\kappa_i}\left\{\left[\tilde{b}_1-\mathrm{E}_{|\kappa_i,\epsilon_i}\left(\tilde{b}_1\right)\right]\tfrac{\partial\tilde{b}_1}{\partial\delta}\right\}.
\end{aligned}
$$

We can now work out all these terms one by one, starting with T_1. Note that

$$
u'(f_{1i})=1-(\xi-1)\left[\tilde{\epsilon}+D+B-(D_\epsilon+B_\epsilon)\tilde{\epsilon}+(D_\kappa-B_\kappa)\tilde{\kappa}\right],
$$

using that, at θ^*, $F_{1\epsilon}=F_{1\kappa}=0$. Hence,

$$
\mathrm{E}_{|\kappa_i,\epsilon_i}\left[u'(f_{1i})\right]=1-(\xi-1)\left[D+B+(1-D_\epsilon-B_\epsilon)\tfrac{1}{n}\epsilon_i+(D_\kappa-B_\kappa)\tfrac{1}{n}\kappa_i\right].
$$

Hence,

$$
\begin{aligned}
&T_1=\mathrm{E}_{|\kappa_i}\left\{-\mathrm{E}_{|\kappa_i,\epsilon_i}\left[u'(f_{1i})\right]\tfrac{1}{n}\tfrac{\partial e_i}{\partial\delta}\right\} \\
&= -\mathrm{E}_{|\kappa_i}\left\{\begin{array}{c}\left[1-(\xi-1)\left(D+B+(1-D_\epsilon-B_\epsilon)\tfrac{1}{n}\epsilon_i+(D_\kappa-B_\kappa)\tfrac{1}{n}\kappa_i\right)\right] \\ *\tfrac{1}{n}\left[\tfrac{\partial D}{\partial\delta}-\tfrac{\partial D_\epsilon}{\partial\delta}\epsilon_i+\tfrac{\partial D_\kappa}{\partial\delta}\kappa_i\right]\end{array}\right\} \\
&= -\tfrac{1}{n}\left[1-(\xi-1)\left(D+B+(D_\kappa-B_\kappa)\tfrac{1}{n}\kappa_i\right)\right]\left[\tfrac{\partial D}{\partial\delta}+\tfrac{\partial D_\kappa}{\partial\delta}\kappa_i\right] \\
&\quad -\tfrac{1}{n}(\xi-1)(1-D_\epsilon-B_\epsilon)\tfrac{\partial D_\epsilon}{\partial\delta}\tfrac{1}{n}\sigma_\epsilon^2.
\end{aligned}
$$

Next, we work out:

$$
\begin{aligned}
&T_2=\mathrm{E}_{|\kappa_i}\left[u'(f_{1i})\tfrac{\partial\tilde{e}}{\partial\delta}\right] \\
&= \mathrm{E}_{|\kappa_i}\left\{\begin{array}{c}\left[1-(\xi-1)\left(D+B+(1-D_\epsilon-B_\epsilon)\tilde{\epsilon}+(D_\kappa-B_\kappa)\tilde{\kappa}\right)\right] \\ *\left[\tfrac{\partial D}{\partial\delta}-\tfrac{\partial D_\epsilon}{\partial\delta}\tilde{\epsilon}+\tfrac{\partial D_\kappa}{\partial\delta}\tilde{\kappa}\right]\end{array}\right\} \\
&= \left[1-(\xi-1)(D+B)\right]\left[\tfrac{\partial D}{\partial\delta}+\tfrac{1}{n}\tfrac{\partial D_\kappa}{\partial\delta}\kappa_i\right] \\
&\quad -(\xi-1)(D_\kappa-B_\kappa)\tfrac{\partial D_\kappa}{\partial\delta}\tfrac{1}{n}\left[\tfrac{1}{n}\kappa_i^2+\tfrac{n-1}{n}\sigma_\kappa^2\right] \\
&\quad +(\xi-1)(1-D_\epsilon-B_\epsilon)\tfrac{\partial D_\epsilon}{\partial\delta}\tfrac{1}{n}\sigma_\epsilon^2.
\end{aligned}
$$

Then, we work out:

$$
\begin{aligned}
T_3 &= \mathrm{E}_{|\kappa_i}\left\{u'(f_{1i})\left[(\tilde{\epsilon}-\epsilon_i)+(\tilde{e}-e_i)\right]\right\} \\
&= \mathrm{E}_{|\kappa_i}\left\{\begin{array}{c}\left[1-(\xi-1)\left(D+B+(1-D_\epsilon-B_\epsilon)\tilde{\epsilon}+(D_\kappa-B_\kappa)\tilde{\kappa}\right)\right] \\ *\left[(1-D_\epsilon)(\tilde{\epsilon}-\epsilon_i)+D_\kappa(\tilde{\kappa}-\kappa_i)\right]\end{array}\right\} \\
&= -\left[1-(\xi-1)(D+B)\right]D_\kappa\tfrac{n-1}{n}\kappa_i
\end{aligned}
$$

$$-\left(\xi-1\right)\left(D_\kappa-B_\kappa\right)D_\kappa\tfrac{n-1}{n^2}\left(\sigma_\kappa^2-\kappa_i^2\right).$$

Further,

$$\begin{aligned}
T_4 &= \mathrm{E}_{|\kappa_i}\left\{\left[u'(f_{1i})-\mathrm{E}_{|\kappa_i,\epsilon_i}u'(f_{1i})\right]\tfrac{\partial\tilde{b}_1}{\partial\delta}\right\}\\
&= -\left(\xi-1\right)\mathrm{E}_{|\kappa_i}\left\{\left[f_{1i}-\mathrm{E}_{|\kappa_i,\epsilon_i}\left(f_{1i}\right)\right]\tfrac{\partial\tilde{b}_1}{\partial\delta}\right\}\\
&= -\left(\xi-1\right)\mathrm{E}_{|\kappa_i}\left\{\begin{array}{c}\left[\left(1-D_\epsilon-B_\epsilon\right)\left(\tilde{\epsilon}-\tfrac{1}{n}\epsilon_i\right)+\left(D_\kappa-B_\kappa\right)\left(\tilde{\kappa}-\tfrac{1}{n}\kappa_i\right)\right]\\ *\left[\tfrac{\partial B}{\partial\delta}-\tfrac{\partial B_\epsilon}{\partial\delta}\tilde{\epsilon}-\tfrac{\partial B_\kappa}{\partial\delta}\tilde{\kappa}\right]\end{array}\right\}\\
&= \left(\xi-1\right)\left(1-D_\epsilon-B_\epsilon\right)\tfrac{\partial B_\epsilon}{\partial\delta}\tfrac{1}{n}\left(\tfrac{n-1}{n}\right)\sigma_\epsilon^2\\
&\quad+\left(\xi-1\right)\left(D_\kappa-B_\kappa\right)\tfrac{\partial B_\kappa}{\partial\delta}\tfrac{1}{n}\left(\tfrac{n-1}{n}\right)\sigma_\kappa^2.
\end{aligned}$$

Next,

$$\begin{aligned}
T_5 &= -p\mathrm{E}_{|\kappa_i}\left\{\left[u'(f_{2i})-\mathrm{E}_{|\kappa_i,\epsilon_i}u'(f_{2i})\right]\tfrac{\partial\tilde{b}_1}{\partial\delta}\right\}\\
&= p\left(\xi-1\right)\mathrm{E}_{|\kappa_i}\left\{\left[f_{2i}-\mathrm{E}_{|\kappa_i,\epsilon_i}\left(f_{2i}\right)\right]\tfrac{\partial\tilde{b}_1}{\partial\delta}\right\}\\
&= p\left(\xi-1\right)\mathrm{E}_{|\kappa_i}\left\{\begin{array}{c}\left[B_\epsilon\left(\tilde{\epsilon}-\tfrac{1}{n}\epsilon_i\right)+B_\kappa\left(\tilde{\kappa}-\tfrac{1}{n}\kappa_i\right)\right]\\ *\left[\tfrac{\partial B}{\partial\delta}-\tfrac{\partial B_\epsilon}{\partial\delta}\tilde{\epsilon}-\tfrac{\partial B_\kappa}{\partial\delta}\tilde{\kappa}\right]\end{array}\right\}\\
&= -p\left(\xi-1\right)B_\epsilon\tfrac{\partial B_\epsilon}{\partial\delta}\tfrac{1}{n}\left(\tfrac{n-1}{n}\right)\sigma_\epsilon^2-p\left(\xi-1\right)B_\kappa\tfrac{\partial B_\kappa}{\partial\delta}\tfrac{1}{n}\left(\tfrac{n-1}{n}\right)\sigma_\kappa^2.
\end{aligned}$$

Finally,

$$\begin{aligned}
T_6 &= -\tfrac{\alpha^2}{\phi}\mathrm{E}_{|\kappa_i}\left\{\left[\tilde{b}_1-\mathrm{E}_{|\kappa_i,\epsilon_i}\left(\tilde{b}_1\right)\right]\tfrac{\partial\tilde{b}_1}{\partial\delta}\right\}\\
&= \tfrac{\alpha^2}{\phi}\mathrm{E}_{|\kappa_i}\left\{\begin{array}{c}\left[B_\epsilon\left(\tilde{\epsilon}-\tfrac{1}{n}\epsilon_i\right)+B_\kappa\left(\tilde{\kappa}-\tfrac{1}{n}\kappa_i\right)\right]\\ *\left[\tfrac{\partial B}{\partial\delta}-\tfrac{\partial B_\epsilon}{\partial\delta}\tilde{\epsilon}-\tfrac{\partial B_\kappa}{\partial\delta}\tilde{\kappa}\right]\end{array}\right\}\\
&= -\tfrac{\alpha^2}{\phi}B_\epsilon\tfrac{\partial B_\epsilon}{\partial\delta}\tfrac{1}{n}\left(\tfrac{n-1}{n}\right)\sigma_\epsilon^2-\tfrac{\alpha^2}{\phi}B_\kappa\tfrac{\partial B_\kappa}{\partial\delta}\tfrac{1}{n}\left(\tfrac{n-1}{n}\right)\sigma_\kappa^2.
\end{aligned}$$

Using the previous results, we have:

$$\begin{aligned}
\tfrac{\partial V_{Fi}(.)}{\partial\delta} &= -\tfrac{1}{n}\left[1-\left(\xi-1\right)\left(D+B+\left(D_\kappa-B_\kappa\right)\tfrac{1}{n}\kappa_i\right)\right]\left[\tfrac{\partial D}{\partial\delta}+\tfrac{\partial D_\kappa}{\partial\delta}\kappa_i\right]\\
&\quad-\tfrac{1}{n}\left(\xi-1\right)\left(1-D_\epsilon-B_\epsilon\right)\tfrac{\partial D_\epsilon}{\partial\delta}\tfrac{1}{n}\sigma_\epsilon^2\\
&\quad+\left[1-\left(\xi-1\right)\left(D+B\right)\right]\left[\tfrac{\partial D}{\partial\delta}+\tfrac{1}{n}\tfrac{\partial D_\kappa}{\partial\delta}\kappa_i\right]\\
&\quad-\left(\xi-1\right)\left(D_\kappa-B_\kappa\right)\tfrac{\partial D_\kappa}{\partial\delta}\tfrac{1}{n}\left[\tfrac{1}{n}\kappa_i^2+\tfrac{n-1}{n}\sigma_\kappa^2\right]\\
&\quad+\left(\xi-1\right)\left(1-D_\epsilon-B_\epsilon\right)\tfrac{\partial D_\epsilon}{\partial\delta}\tfrac{1}{n}\sigma_\epsilon^2\\
&\quad-\left[1-\left(\xi-1\right)\left(D+B\right)\right]D_\kappa\tfrac{n-1}{n}\kappa_i
\end{aligned}$$

$$
\begin{aligned}
&-(\xi-1)(D_\kappa-B_\kappa)D_\kappa\tfrac{n-1}{n^2}\left(\sigma_\kappa^2-\kappa_i^2\right)\\
&+(\xi-1)(1-D_\epsilon-B_\epsilon)\tfrac{\partial B_\epsilon}{\partial\delta}\tfrac{1}{n}\left(\tfrac{n-1}{n}\right)\sigma_\epsilon^2\\
&+(\xi-1)(D_\kappa-B_\kappa)\tfrac{\partial B_\kappa}{\partial\delta}\tfrac{1}{n}\left(\tfrac{n-1}{n}\right)\sigma_\kappa^2\\
&-p(\xi-1)B_\epsilon\tfrac{\partial B_\epsilon}{\partial\delta}\tfrac{1}{n}\left(\tfrac{n-1}{n}\right)\sigma_\epsilon^2-p(\xi-1)B_\kappa\tfrac{\partial B_\kappa}{\partial\delta}\tfrac{1}{n}\left(\tfrac{n-1}{n}\right)\sigma_\kappa^2\\
&-\tfrac{\alpha^2}{\phi}B_\epsilon\tfrac{\partial B_\epsilon}{\partial\delta}\tfrac{1}{n}\left(\tfrac{n-1}{n}\right)\sigma_\epsilon^2-\tfrac{\alpha^2}{\phi}B_\kappa\tfrac{\partial B_\kappa}{\partial\delta}\tfrac{1}{n}\left(\tfrac{n-1}{n}\right)\sigma_\kappa^2.
\end{aligned}
$$

Hence,

$$
\begin{aligned}
\tfrac{\partial V_{Fi}(.)}{\partial\delta}\quad=\quad&-\tfrac{1}{n}\left[1-(\xi-1)\left(D+B+(D_\kappa-B_\kappa)\tfrac{1}{n}\kappa_i\right)\right]\left[\tfrac{\partial D}{\partial\delta}+\tfrac{\partial D_\kappa}{\partial\delta}\kappa_i\right]\\
&+\left[1-(\xi-1)(D+B)\right]\left[\tfrac{\partial D}{\partial\delta}+\tfrac{1}{n}\tfrac{\partial D_\kappa}{\partial\delta}\kappa_i-D_\kappa\tfrac{n-1}{n}\kappa_i\right]\\
&-(\xi-1)(D_\kappa-B_\kappa)\left[\tfrac{\partial D_\kappa}{\partial\delta}\tfrac{1}{n}\left[\tfrac{1}{n}\kappa_i^2+\tfrac{n-1}{n}\sigma_\kappa^2\right]+D_\kappa\tfrac{n-1}{n^2}\left(\sigma_\kappa^2-\kappa_i^2\right)-\tfrac{\partial B_\kappa}{\partial\delta}\tfrac{1}{n}\left(\tfrac{n-1}{n}\right)\sigma_\kappa^2\right]\\
&+\left[(\xi-1)\left(1-D_\epsilon-(1+p)B_\epsilon\right)-\tfrac{\alpha^2}{\phi}B_\epsilon\right]\tfrac{\partial B_\epsilon}{\partial\delta}\tfrac{1}{n}\left(\tfrac{n-1}{n}\right)\sigma_\epsilon^2\\
&+(\xi-1)(1-D_\epsilon-B_\epsilon)\tfrac{\partial D_\epsilon}{\partial\delta}\tfrac{1}{n}\left(\tfrac{n-1}{n}\right)\sigma_\epsilon^2\\
&-\left[\tfrac{\alpha^2}{\phi}+p(\xi-1)\right]B_\kappa\tfrac{\partial B_\kappa}{\partial\delta}\tfrac{1}{n}\left(\tfrac{n-1}{n}\right)\sigma_\kappa^2.
\end{aligned}
$$

Hence,

$$
\begin{aligned}
\tfrac{\partial V_{Fi}(.)}{\partial\delta}\quad=\quad&\tfrac{n-1}{n}\left[1-(\xi-1)(D+B)\right]\left[\tfrac{\partial D}{\partial\delta}-D_\kappa\kappa_i\right]-\left[\tfrac{\alpha^2}{\phi}+p(\xi-1)\right]B_\kappa\tfrac{\partial B_\kappa}{\partial\delta}\tfrac{1}{n}\left(\tfrac{n-1}{n}\right)\sigma_\kappa^2\\
&-(\xi-1)(D_\kappa-B_\kappa)\left[\left(D_\kappa+\tfrac{\partial D_\kappa}{\partial\delta}-\tfrac{\partial B_\kappa}{\partial\delta}\right)\left(\tfrac{n-1}{n^2}\right)\sigma_\kappa^2-\left(D_\kappa(n-1)\kappa_i+\tfrac{\partial D}{\partial\delta}\right)\tfrac{1}{n^2}\kappa_i\right]\\
&+\left[(\xi-1)\left(1-D_\epsilon-(1+p)B_\epsilon\right)-\tfrac{\alpha^2}{\phi}B_\epsilon\right]\tfrac{\partial B_\epsilon}{\partial\delta}\tfrac{1}{n}\left(\tfrac{n-1}{n}\right)\sigma_\epsilon^2\\
&+(\xi-1)(1-D_\epsilon-B_\epsilon)\tfrac{\partial D_\epsilon}{\partial\delta}\tfrac{1}{n}\left(\tfrac{n-1}{n}\right)\sigma_\epsilon^2. \qquad\qquad \text{(H.1)}
\end{aligned}
$$

Observe that

$$
\begin{aligned}
1-D_\epsilon-(1+p)B_\epsilon\quad&=\quad-(1+p)B_\epsilon+\tfrac{(\xi-1)(1+p)+\alpha^2/\phi}{\xi-1}B_\epsilon\\
&=\quad\tfrac{\alpha^2/\phi}{\xi-1}B_\epsilon>0,
\end{aligned}
$$

Hence,

$$
(\xi-1)\left(1-D_\epsilon-(1+p)B_\epsilon\right)-\tfrac{\alpha^2}{\phi}B_\epsilon=0,
$$

and, hence, the third line of (H.1) becomes zero. Further, observe that

$$
\tfrac{n-1}{n}\left[1-(\xi-1)(D+B)\right]\left[\tfrac{\partial D}{\partial\delta}-D_\kappa\kappa_i\right]<0,
$$

if $\kappa_i\geq 0$, and that α disappears from expression (H.1) if $\sigma_\kappa^2=0$ (hence, given that all κ's are drawn from a mean-zero distribution, $\kappa_i = 0$ for all i). Hence, we have the following results: in the absence of uncertainty about the government types, $\frac{\partial V_{Fi}(.)}{\partial \delta} < 0$. Further, if $n \to \infty$, then, for all governments i with $\kappa_i \geq 0$, $\frac{\partial V_{Fi}(.)}{\partial \delta} < 0$ (by continuity of all the functions involved, this also holds for n sufficiently large).

I. Proof of Proposition 3

For given $0 < \psi \leq \frac{n-1}{n}$, we evaluate $\partial V_{Fi}(\psi, \delta)/\partial \delta$ at $\delta = 0$, where

$$V_{Fi}(\psi, \delta) \equiv \mathrm{E}_{|\kappa_i}\left[-(e_i - \kappa_i)^2/2 + u(f_{1i}) + pu(f_{2i}) - \left(\alpha \tilde{b}_1\right)^2/(2\phi)\right],$$

is government i 's equilibrium expected utility as a function of the stability pact parameters (f_{1i} and f_{2i} are understood to be evaluated for the equilibrium outcomes), conditional on κ_i, and where u is defined by (20). In the sequel of this appendix, all expressions are understood to be evaluated at $\delta = 0$. Differentiating $V_{Fi}(\psi, \delta)$ with respect to δ and, thus, evaluating at $\delta = 0$ yields:

$$\frac{\partial V_{Fi}(.)}{\partial \delta} = \mathrm{E}_{|\kappa_i}\left[-(e_i - \kappa_i)\frac{\partial e_i}{\partial \delta} + u'(f_{1i})\frac{\partial f_{1i}}{\partial \delta} + pu'(f_{2i})\frac{\partial f_{2i}}{\partial \delta} - \frac{\alpha^2}{\phi}\tilde{b}_1\frac{\partial \tilde{b}_1}{\partial \delta}\right], \tag{I.1}$$

where, using (16) and (10), respectively,

$$\begin{aligned}
\frac{\partial f_{1i}}{\partial \delta} &= \frac{n}{n-1}\psi\frac{\partial \tilde{b}_1}{\partial \delta} + \left(1 - \frac{n}{n-1}\psi\right)\frac{\partial b_{1i}}{\partial \delta} + \frac{\partial e_i}{\partial \delta} + \frac{n}{n-1}\psi\left[(\tilde{\epsilon} - \epsilon_i) + (\tilde{e} - e_i)\right], \\
\frac{\partial f_{2i}}{\partial \delta} &= -\frac{n}{n-1}\psi\frac{\partial \tilde{b}_1}{\partial \delta} - \left(1 - \frac{n}{n-1}\psi\right)\frac{\partial b_{1i}}{\partial \delta}.
\end{aligned}$$

Substitute these expressions into (I.1), which can then be written as:

$$\frac{\partial V_{Fi}(.)}{\partial \delta} = T_1 + T_2 + T_3 + T_4, \tag{I.2}$$

where

$$\begin{aligned}
T_1 &= \mathrm{E}_{|\kappa_i}\left\{\left[-(e_i - \kappa_i) + u'(f_{1i})\right]\frac{\partial e_i}{\partial \delta}\right\}, \\
T_2 &= \mathrm{E}_{|\kappa_i}\left\{\left[u'(f_{1i}) - pu'(f_{2i})\right]\left[\frac{n}{n-1}\psi\frac{\partial \tilde{b}_1}{\partial \delta} + \left(1 - \frac{n}{n-1}\psi\right)\frac{\partial b_{1i}}{\partial \delta}\right]\right\}, \\
T_3 &= -\mathrm{E}_{|\kappa_i}\left[\frac{\alpha^2}{\phi}\tilde{b}_1\frac{\partial \tilde{b}_1}{\partial \delta}\right], \\
T_4 &= \mathrm{E}_{|\kappa_i}\left\{u'(f_{1i})\left[(\tilde{\epsilon} - \epsilon_i) + (\tilde{e} - e_i)\right]\right\}\frac{n}{n-1}\psi.
\end{aligned}$$

We work out these terms one-by-one.

Regarding T_1, we have by use of (17),

$$\begin{aligned} T_1 &= \mathrm{E}_{|\kappa_i}\left\{\left[-\left(e_i-\kappa_i\right)+u'(f_{1i})\right]\frac{\partial e_i}{\partial\delta}\right\} \\ &= \mathrm{E}_{|\kappa_i}\left\{\left[u'(f_{1i})-\mathrm{E}_{|\kappa_i,\epsilon_i}u'(f_{1i})\right]\frac{\partial e_i}{\partial\delta}\right\} \\ &= -\left(\xi-1\right)\mathrm{E}_{|\kappa_i}\left\{\left[f_{1i}-\mathrm{E}_{|\kappa_i,\epsilon_i}\left(f_{1i}\right)\right]\frac{\partial e_i}{\partial\delta}\right\}. \end{aligned}$$

Because

$$f_{1i}=1+\tilde{\epsilon}+\tilde{e}+\tilde{b}_1+F_{1\epsilon}\left(\epsilon_i-\tilde{\epsilon}\right)+F_{1\kappa}\left(\kappa_i-\tilde{\kappa}\right),$$

hence,

$$\begin{aligned} f_{1i}-\mathrm{E}_{|\kappa_i,\epsilon_i}\left(f_{1i}\right) &= \left(\tilde{\epsilon}-\tfrac{1}{n}\epsilon_i\right)+\left(\tilde{e}-\mathrm{E}_{|\kappa_i,\epsilon_i}\tilde{e}\right)+\left(\tilde{b}_1-\mathrm{E}_{|\kappa_i,\epsilon_i}\tilde{b}_1\right) \\ &\quad +F_{1\epsilon}\left(\tfrac{1}{n}\epsilon_i-\tilde{\epsilon}\right)+F_{1\kappa}\left(\tfrac{1}{n}\kappa_i-\tilde{\kappa}\right) \\ &= \left(\tilde{\epsilon}-\tfrac{1}{n}\epsilon_i\right)+D_\epsilon\left(\tfrac{1}{n}\epsilon_i-\tilde{\epsilon}\right)-D_\kappa\left(\tfrac{1}{n}\kappa_i-\tilde{\kappa}\right) \\ &\quad +B_\epsilon\left(\tfrac{1}{n}\epsilon_i-\tilde{\epsilon}\right)+B_\kappa\left(\tfrac{1}{n}\kappa_i-\tilde{\kappa}\right)+F_{1\epsilon}\left(\tfrac{1}{n}\epsilon_i-\tilde{\epsilon}\right)+F_{1\kappa}\left(\tfrac{1}{n}\kappa_i-\tilde{\kappa}\right) \\ &= \left(-1+D_\epsilon+B_\epsilon+F_{1\epsilon}\right)\left(\tfrac{1}{n}\epsilon_i-\tilde{\epsilon}\right) \qquad \text{(I.3)} \\ &\quad +\left(-D_\kappa+B_\kappa+F_{1\kappa}\right)\left(\tfrac{1}{n}\kappa_i-\tilde{\kappa}\right). \end{aligned}$$

Further, note that,

$$\frac{\partial e_i}{\partial\delta}=\frac{\partial D}{\partial\delta}-\frac{\partial D_\epsilon}{\partial\delta}\epsilon_i+\frac{\partial D_\kappa}{\partial\delta}\kappa_i.$$

Hence,

$$\begin{aligned} T_1 &= -\left(\xi-1\right)\left(-D_\kappa+B_\kappa+F_{1\kappa}\right)\mathrm{E}_{|\kappa_i}\left(\tfrac{1}{n}\kappa_i-\tilde{\kappa}\right)\left(\frac{\partial D}{\partial\delta}+\frac{\partial D_\kappa}{\partial\delta}\kappa_i\right) \\ &= 0. \end{aligned}$$

Regarding T_2, we have by use of (18):

$$\begin{aligned} T_2 &= \mathrm{E}_{|\kappa_i}\left\{\left[u'(f_{1i})-pu'(f_{2i})\right]\left[\frac{n}{n-1}\psi\frac{\partial\tilde{b}_1}{\partial\delta}+\left(1-\frac{n}{n-1}\psi\right)\frac{\partial b_{1i}}{\partial\delta}\right]\right\} \\ &= \mathrm{E}_{|\kappa_i}\left\{\left[u'(f_{1i})-\mathrm{E}_{|\kappa_i,\epsilon_i}u'(f_{1i})\right]\left[\frac{n}{n-1}\psi\frac{\partial\tilde{b}_1}{\partial\delta}+\left(1-\frac{n}{n-1}\psi\right)\frac{\partial b_{1i}}{\partial\delta}\right]\right\} \\ &\quad -p\mathrm{E}_{|\kappa_i}\left\{\left[u'(f_{2i})-\mathrm{E}_{|\kappa_i,\epsilon_i}u'(f_{2i})\right]\left[\frac{n}{n-1}\psi\frac{\partial\tilde{b}_1}{\partial\delta}+\left(1-\frac{n}{n-1}\psi\right)\frac{\partial b_{1i}}{\partial\delta}\right]\right\} \\ &\quad +\mathrm{E}_{|\kappa_i}\left\{\mathrm{E}_{|\kappa_i,\epsilon_i}\left[\frac{\alpha^2}{\phi n(1-\psi)}\tilde{b}_1\right]\left[\frac{n}{n-1}\psi\frac{\partial\tilde{b}_1}{\partial\delta}+\left(1-\frac{n}{n-1}\psi\right)\frac{\partial b_{1i}}{\partial\delta}\right]\right\} \\ &= -\left(\xi-1\right)\mathrm{E}_{|\kappa_i}\left\{\left[f_{1i}-\mathrm{E}_{|\kappa_i,\epsilon_i}\left(f_{1i}\right)\right]\left[\frac{n}{n-1}\psi\frac{\partial\tilde{b}_1}{\partial\delta}+\left(1-\frac{n}{n-1}\psi\right)\frac{\partial b_{1i}}{\partial\delta}\right]\right\} \\ &\quad +p\left(\xi-1\right)\mathrm{E}_{|\kappa_i}\left\{\left[f_{2i}-\mathrm{E}_{|\kappa_i,\epsilon_i}\left(f_{2i}\right)\right]\left[\frac{n}{n-1}\psi\frac{\partial\tilde{b}_1}{\partial\delta}+\left(1-\frac{n}{n-1}\psi\right)\frac{\partial b_{1i}}{\partial\delta}\right]\right\} \end{aligned}$$

$$+\mathrm{E}_{|\kappa_i}\left\{\mathrm{E}_{|\kappa_i,\epsilon_i}\left[\frac{\alpha^2}{\phi n(1-\psi)}\tilde{b}_1\right]\left[\frac{n}{n-1}\psi\frac{\partial\tilde{b}_1}{\partial\delta}+\left(1-\frac{n}{n-1}\psi\right)\frac{\partial b_{1i}}{\partial\delta}\right]\right\}.$$

We will now compute each of these three components of T_2. But before that, we need to work out:

$$\begin{aligned}\frac{\partial b_{1i}}{\partial\delta} &= \frac{\partial B}{\partial\delta}-\frac{\partial B_\epsilon}{\partial\delta}\epsilon_i-\frac{\partial B_\kappa}{\partial\delta}\kappa_i,\\ \frac{\partial\tilde{b}_1}{\partial\delta} &= \frac{\partial B}{\partial\delta}-\frac{\partial B_\epsilon}{\partial\delta}\tilde{\epsilon}-\frac{\partial B_\kappa}{\partial\delta}\tilde{\kappa}.\end{aligned}$$

Hence,

$$\begin{aligned}&\frac{n}{n-1}\psi\frac{\partial\tilde{b}_1}{\partial\delta}+\left(1-\frac{n}{n-1}\psi\right)\frac{\partial b_{1i}}{\partial\delta}\\ =\ &\frac{\partial B}{\partial\delta}-\frac{\partial B_\epsilon}{\partial\delta}\left[\frac{n}{n-1}\psi\tilde{\epsilon}+\left(1-\frac{n}{n-1}\psi\right)\epsilon_i\right]-\frac{\partial B_\kappa}{\partial\delta}\left[\frac{n}{n-1}\psi\tilde{\kappa}+\left(1-\frac{n}{n-1}\psi\right)\kappa_i\right]\end{aligned}$$

Further,

$$\begin{aligned}f_{2i} &= 1-\tilde{b}_1+F_{2\epsilon}\left(\epsilon_i-\tilde{\epsilon}\right)+F_{2\kappa}\left(\kappa_i-\tilde{\kappa}\right)\\ &= 1-B+B_\epsilon\tilde{\epsilon}+B_\kappa\tilde{\kappa}+F_{2\epsilon}\left(\epsilon_i-\tilde{\epsilon}\right)+F_{2\kappa}\left(\kappa_i-\tilde{\kappa}\right).\end{aligned}$$

Hence,

$$\begin{aligned}f_{2i}-\mathrm{E}_{|\kappa_i,\epsilon_i}\left(f_{2i}\right) &= B_\epsilon\left(\tilde{\epsilon}-\tfrac{1}{n}\epsilon_i\right)+B_\kappa\left(\tilde{\kappa}-\tfrac{1}{n}\kappa_i\right)\\ &\quad +F_{2\epsilon}\left(\tfrac{1}{n}\epsilon_i-\tilde{\epsilon}\right)+F_{2\kappa}\left(\tfrac{1}{n}\kappa_i-\tilde{\kappa}\right)\\ &= \left(-B_\epsilon+F_{2\epsilon}\right)\left(\tfrac{1}{n}\epsilon_i-\tilde{\epsilon}\right)+\left(-B_\kappa+F_{2\kappa}\right)\left(\tfrac{1}{n}\kappa_i-\tilde{\kappa}\right).\end{aligned}$$

We can now work out the components of T_2, starting with

$$\begin{aligned}&-\left(\xi-1\right)\mathrm{E}_{|\kappa_i}\left\{\left[f_{1i}-\mathrm{E}_{|\kappa_i,\epsilon_i}\left(f_{1i}\right)\right]\left[\frac{n}{n-1}\psi\frac{\partial\tilde{b}_1}{\partial\delta}+\left(1-\frac{n}{n-1}\psi\right)\frac{\partial b_{1i}}{\partial\delta}\right]\right\}\\ =\ &-\left(\xi-1\right)\mathrm{E}_{|\kappa_i}\left\{\begin{array}{c}\left[\begin{array}{c}\left(-1+D_\epsilon+B_\epsilon+F_{1\epsilon}\right)\left(\frac{1}{n}\epsilon_i-\tilde{\epsilon}\right)\\ +\left(-D_\kappa+B_\kappa+F_{1\kappa}\right)\left(\frac{1}{n}\kappa_i-\tilde{\kappa}\right)\end{array}\right]\\ *\left[\begin{array}{c}\frac{\partial B}{\partial\delta}-\frac{\partial B_\epsilon}{\partial\delta}\left[\frac{n}{n-1}\psi\tilde{\epsilon}+\left(1-\frac{n}{n-1}\psi\right)\epsilon_i\right]\\ -\frac{\partial B_\kappa}{\partial\delta}\left[\frac{n}{n-1}\psi\tilde{\kappa}+\left(1-\frac{n}{n-1}\psi\right)\kappa_i\right]\end{array}\right]\end{array}\right\}\\ =\ &\left(\xi-1\right)\mathrm{E}_{|\kappa_i}\left[\left(-1+D_\epsilon+B_\epsilon+F_{1\epsilon}\right)\left(\tfrac{1}{n}\epsilon_i-\tilde{\epsilon}\right)\frac{\partial B_\epsilon}{\partial\delta}\frac{n}{n-1}\psi\tilde{\epsilon}\right]\\ &+\left(\xi-1\right)\mathrm{E}_{|\kappa_i}\left[\left(-D_\kappa+B_\kappa+F_{1\kappa}\right)\left(\tfrac{1}{n}\kappa_i-\tilde{\kappa}\right)\frac{\partial B_\kappa}{\partial\delta}\frac{n}{n-1}\psi\tilde{\kappa}\right]\\ =\ &-\tfrac{1}{n}\left(\xi-1\right)\left(-1+D_\epsilon+B_\epsilon+F_{1\epsilon}\right)\frac{\partial B_\epsilon}{\partial\delta}\psi\sigma_\epsilon^2\\ &-\tfrac{1}{n}\left(\xi-1\right)\left(-D_\kappa+B_\kappa+F_{1\kappa}\right)\frac{\partial B_\kappa}{\partial\delta}\psi\sigma_\kappa^2,\end{aligned}$$

where we have used that κ_i is observable to government i. The first term after the final equality sign is positive, because

$$\begin{aligned} D_\epsilon + B_\epsilon + F_{1\epsilon} &= D_\epsilon + B_\epsilon - \left(1 - \tfrac{n}{n-1}\psi\right) B_\epsilon + \left(1 - \tfrac{n}{n-1}\psi\delta\right)(1 - D_\epsilon) \\ &= 1 + \tfrac{n}{n-1}\psi B_\epsilon > 1, \end{aligned}$$

while the second term is also positive, because

$$\begin{aligned} B_\kappa + F_{1\kappa} &= B_\kappa + \left(\tfrac{n}{n-1}\psi - 1\right) B_\kappa + \left(1 - \tfrac{n}{n-1}\psi\delta\right) D_\kappa \\ &= \tfrac{n}{n-1}\psi B_\kappa + \left(1 - \tfrac{n}{n-1}\psi\delta\right) D_\kappa \\ &> D_\kappa. \end{aligned}$$

Next, we work out the second component of T_2:

$$\begin{aligned} & p\,(\xi - 1)\,\mathrm{E}_{|\kappa_i}\left\{\left[f_{2i} - \mathrm{E}_{|\kappa_i,\epsilon_i}(f_{2i})\right]\left[\tfrac{n}{n-1}\psi\tfrac{\partial\tilde{b}_1}{\partial\delta} + \left(1 - \tfrac{n}{n-1}\psi\right)\tfrac{\partial b_{1i}}{\partial\delta}\right]\right\} \\ = \;& p\,(\xi - 1)\,\mathrm{E}_{|\kappa_i}\left\{\begin{array}{c} \left[(-B_\epsilon + F_{2\epsilon})\left(\frac{1}{n}\epsilon_i - \tilde{\epsilon}\right) + (-B_\kappa + F_{2\kappa})\left(\frac{1}{n}\kappa_i - \tilde{\kappa}\right)\right] \\ * \left[\begin{array}{c} \frac{\partial B}{\partial\delta} - \frac{\partial B_\epsilon}{\partial\delta}\left[\frac{n}{n-1}\psi\tilde{\epsilon} + \left(1 - \frac{n}{n-1}\psi\right)\epsilon_i\right] \\ -\frac{\partial B_\kappa}{\partial\delta}\left[\frac{n}{n-1}\psi\tilde{\kappa} + \left(1 - \frac{n}{n-1}\psi\right)\kappa_i\right] \end{array}\right] \end{array}\right\} \\ = \;& p\,(\xi - 1)(-B_\epsilon + F_{2\epsilon})\tfrac{n}{n-1}\psi\left(-\tfrac{\partial B_\epsilon}{\partial\delta}\right)\mathrm{E}_{|\kappa_i}\left[\left(\tfrac{1}{n}\epsilon_i - \tilde{\epsilon}\right)\tilde{\epsilon}\right] \\ & + p\,(\xi - 1)(-B_\kappa + F_{2\kappa})\tfrac{n}{n-1}\psi\left(-\tfrac{\partial B_\kappa}{\partial\delta}\right)\mathrm{E}_{|\kappa_i}\left[\left(\tfrac{1}{n}\kappa_i - \tilde{\kappa}\right)\tilde{\kappa}\right] \\ = \;& \tfrac{1}{n}p\,(\xi - 1)(-B_\epsilon + F_{2\epsilon})\,\psi\left(\tfrac{\partial B_\epsilon}{\partial\delta}\right)\sigma_\epsilon^2 + \tfrac{1}{n}p\,(\xi - 1)(-B_\kappa + F_{2\kappa})\,\psi\left(\tfrac{\partial B_\kappa}{\partial\delta}\right)\sigma_\kappa^2. \end{aligned}$$

Because $\partial B_\epsilon/\partial\delta < 0$ and $F_{2\epsilon} - B_\epsilon = -\frac{n}{n-1}\psi B_\epsilon < 0$, the first term in the last line is positive. The second term is also positive, because $F_{2\kappa} - B_\kappa = -\frac{n}{n-1}\psi B_\kappa < 0$.

For the final component of T_2 we have that

$$\begin{aligned} & \mathrm{E}_{|\kappa_i}\left\{\mathrm{E}_{|\kappa_i,\epsilon_i}\left[\tfrac{\alpha^2}{\phi n(1-\psi)}\tilde{b}_1\right]\left[\tfrac{n}{n-1}\psi\tfrac{\partial\tilde{b}_1}{\partial\delta} + \left(1 - \tfrac{n}{n-1}\psi\right)\tfrac{\partial b_{1i}}{\partial\delta}\right]\right\} \\ = \;& \mathrm{E}_{|\kappa_i}\left\{\begin{array}{c} \left[\frac{\alpha^2}{\phi n(1-\psi)}\left(B - \frac{1}{n}B_\epsilon\epsilon_i - \frac{1}{n}B_\kappa\kappa_i\right)\right] \\ * \left[\begin{array}{c} \frac{\partial B}{\partial\delta} - \frac{\partial B_\epsilon}{\partial\delta}\left[\frac{n}{n-1}\psi\tilde{\epsilon} + \left(1 - \frac{n}{n-1}\psi\right)\epsilon_i\right] \\ -\frac{\partial B_\kappa}{\partial\delta}\left[\frac{n}{n-1}\psi\tilde{\kappa} + \left(1 - \frac{n}{n-1}\psi\right)\kappa_i\right] \end{array}\right] \end{array}\right\} \\ = \;& \tfrac{\alpha^2}{\phi n(1-\psi)}\left(B - \tfrac{1}{n}B_\kappa\kappa_i\right) + \tfrac{\alpha^2}{\phi n(1-\psi)}B_\epsilon\tfrac{\partial B_\epsilon}{\partial\delta}\tfrac{1}{n-1}\psi\tfrac{1}{n}\sigma_\epsilon^2 \\ & + \tfrac{\alpha^2}{\phi n(1-\psi)}B_\epsilon\tfrac{\partial B_\epsilon}{\partial\delta}\left(1 - \tfrac{n}{n-1}\psi\right)\tfrac{1}{n}\sigma_\epsilon^2 + \tfrac{\alpha^2}{\phi n(1-\psi)}B_\kappa\tfrac{\partial B_\kappa}{\partial\delta}\tfrac{1}{n-1}\psi\tfrac{1}{n}\kappa_i^2 \\ & + \tfrac{\alpha^2}{\phi n(1-\psi)}B_\kappa\tfrac{\partial B_\kappa}{\partial\delta}\left(1 - \tfrac{n}{n-1}\psi\right)\tfrac{1}{n}\kappa_i^2 \\ = \;& \tfrac{\alpha^2}{\phi n(1-\psi)}\left(B - \tfrac{1}{n}B_\kappa\kappa_i\right) + \tfrac{\alpha^2}{\phi n(1-\psi)}B_\epsilon\tfrac{\partial B_\epsilon}{\partial\delta}(1 - \psi)\tfrac{1}{n}\sigma_\epsilon^2 \end{aligned}$$

$$+\frac{\alpha^2}{\phi n(1-\psi)} B_\kappa \frac{\partial B_\kappa}{\partial \delta}(1-\psi)\frac{1}{n}\kappa_i^2.$$

Because none of the terms B, B_κ, B_ϵ, $\frac{\partial B_\epsilon}{\partial \delta}$ and $\frac{\partial B_\kappa}{\partial \delta}$ go to minus or plus infinity as $\alpha \to 0$, this expression can be brought arbitrarily close to zero, by making α small enough.

We now work out

$$\begin{aligned}
T_3 &= \mathrm{E}_{|\kappa_i}\left[\frac{\alpha^2}{\phi}\tilde{b}_1 \frac{\partial \tilde{b}_1}{\partial \delta}\right] \\
&= \mathrm{E}_{|\kappa_i}\left[\frac{\alpha^2}{\phi}\left(B - B_\epsilon \tilde{\epsilon} - B_\kappa \tilde{\kappa}\right)\left(\frac{\partial B}{\partial \delta} - \frac{\partial B_\epsilon}{\partial \delta}\tilde{\epsilon} - \frac{\partial B_\kappa}{\partial \delta}\tilde{\kappa}\right)\right] \\
&= \frac{\alpha^2}{\phi}\left(B - \frac{1}{n}B_\kappa \kappa_i\right)\frac{\partial B}{\partial \delta} + \frac{\alpha^2}{\phi}B_\epsilon \frac{\partial B_\epsilon}{\partial \delta}\frac{1}{n}\sigma_\epsilon^2 \\
&\quad -\frac{\alpha^2}{\phi n}\frac{\partial B_\kappa}{\partial \delta}\left[B\kappa_i - B_\kappa\left(\frac{1}{n}\kappa_i^2 + \frac{n-1}{n}\sigma_\kappa^2\right)\right].
\end{aligned}$$

Because none of the terms B, B_κ, B_ϵ, $\frac{\partial B}{\partial \delta}$, $\frac{\partial B_\epsilon}{\partial \delta}$ and $\frac{\partial B_\kappa}{\partial \delta}$ go to minus or plus infinity as $\alpha \to 0$, this expression can be brought arbitrarily close to zero, by making α small enough.

We finally need to work out T_4:

$$\begin{aligned}
T_4 &= \mathrm{E}_{|\kappa_i}\left\{\begin{array}{c} \left[1 + (1-\xi)\left(\tilde{\epsilon} + \tilde{e} + \tilde{b}_1 + F_{1\epsilon}(\epsilon_i - \tilde{\epsilon}) + F_{1\kappa}(\kappa_i - \tilde{\kappa})\right)\right] \\ *\left[(1-D_\epsilon)(\tilde{\epsilon} - \epsilon_i) + D_\kappa(\tilde{\kappa} - \kappa_i)\right]\frac{n}{n-1}\psi \end{array}\right\} \\
&= -\psi D_\kappa \kappa_i + (1-\xi)\,\mathrm{E}_{|\kappa_i}\left\{\begin{array}{c} \left[\begin{array}{c} B + D + (1 - D_\epsilon - B_\epsilon)\tilde{\epsilon} + (D_\kappa - B_\kappa)\tilde{\kappa} \\ +F_{1\epsilon}(\epsilon_i - \tilde{\epsilon}) + F_{1\kappa}(\kappa_i - \tilde{\kappa}) \end{array}\right] \\ *\left[(1-D_\epsilon)(\tilde{\epsilon} - \epsilon_i) + D_\kappa(\tilde{\kappa} - \kappa_i)\right]\frac{n}{n-1}\psi \end{array}\right\} \\
&= -\psi D_\kappa \kappa_i + \psi(\xi - 1)(B + D)D_\kappa \kappa_i \\
&\quad + (1-\xi)\frac{n}{n-1}\psi\,\mathrm{E}_{|\kappa_i}\left\{\begin{array}{c} \left[\begin{array}{c} (1 - D_\epsilon - B_\epsilon)\tilde{\epsilon} + (D_\kappa - B_\kappa)\tilde{\kappa} \\ +F_{1\epsilon}(\epsilon_i - \tilde{\epsilon}) + F_{1\kappa}(\kappa_i - \tilde{\kappa}) \end{array}\right] \\ *\left[(1-D_\epsilon)(\tilde{\epsilon} - \epsilon_i) + D_\kappa(\tilde{\kappa} - \kappa_i)\right] \end{array}\right\} \\
&= -\psi\left[1 - (\xi - 1)(B + D)\right]D_\kappa \kappa_i \\
&\quad + (\xi - 1)\frac{n}{n-1}\psi F_{1\epsilon}(1 - D_\epsilon)\,\mathrm{E}_{|\kappa_i}\left[(\tilde{\epsilon} - \epsilon_i)^2\right] \\
&\quad + (1-\xi)\psi(D_\kappa - B_\kappa)D_\kappa \frac{1}{n}\left(\sigma_\kappa^2 - \kappa_i^2\right) \\
&\quad + (\xi - 1)\psi D_\kappa F_{1\kappa}\left[\frac{1}{n}\left(\sigma_\kappa^2 - \kappa_i^2\right) + \kappa_i^2\right] \\
&= -\psi\left[1 - (\xi - 1)(B + D)\right]D_\kappa \kappa_i \\
&\quad + (\xi - 1)\psi F_{1\epsilon}(1 - D_\epsilon)\sigma_\epsilon^2 \\
&\quad - (\xi - 1)\psi(D_\kappa - B_\kappa)D_\kappa \frac{1}{n}\left(\sigma_\kappa^2 - \kappa_i^2\right) \\
&\quad + (\xi - 1)\psi D_\kappa F_{1\kappa}\left[\frac{1}{n}\left(\sigma_\kappa^2 - \kappa_i^2\right) + \kappa_i^2\right].
\end{aligned}$$

This can be worked out further to give:

$$
\begin{aligned}
& -\psi D_\kappa \left\{ \begin{array}{c} [1-(\xi-1)(B+D)]\,\kappa_i - (\xi-1)\,F_{1\kappa}\kappa_i^2 \\ +(1-\xi)\,(B_\kappa + F_{1\kappa} - D_\kappa)\,\frac{1}{n}\,(\sigma_\kappa^2 - \kappa_i^2) \end{array} \right\} \\
& +(\xi-1)\,\psi F_{1\epsilon}\,(1-D_\epsilon)\,\sigma_\epsilon^2 \\
= \; & \psi D_\kappa \left\{ \begin{array}{c} [-1+(\xi-1)(B+D+F_{1\kappa}\kappa_i)]\,\kappa_i \\ +(\xi-1)\,\frac{1}{n-1}\psi B_\kappa\,(\sigma_\kappa^2 - \kappa_i^2) \end{array} \right\} \\
& +(\xi-1)\,\psi F_{1\epsilon}\,(1-D_\epsilon)\,\sigma_\epsilon^2.
\end{aligned}
$$

Note that the final line of the last expression is positive. Suppose that $\alpha \to 0$ (and use that $\delta = 0$). Then,

$$
\begin{aligned}
& -1+(\xi-1)\,(B+D+F_{1\kappa}) \\
= \; & -1+(\xi-1)\,\tfrac{1}{\xi}\,(1+B)+(\xi-1)\,F_{1\kappa} \\
= \; & -\tfrac{1}{\xi}\,[1+(1-\xi)\,B]+(\xi-1)\,F_{1\kappa} \\
= \; & -\frac{2p}{1+\xi p}+\frac{\frac{1}{n-1}\psi+(1-\psi)\,p}{(1-\psi)\,(1+\xi p)} \\
= \; & \frac{\frac{1}{n-1}\psi-(1-\psi)\,p}{(1-\psi)\,(1+\xi p)} < 0, \text{ if } \psi < \tfrac{p}{p+1/(n-1)}.
\end{aligned}
$$

Hence, if $\kappa_i \leq 1$ (which seems reasonable given the initial size of the resources) $-1 + (\xi-1)\,(B+D+F_{1\kappa}\kappa_i) \leq -1+(\xi-1)\,(B+D+F_{1\kappa}) < 0$. Further, if $\kappa_i = 0$, then $T_4 = \psi D_\kappa\,(\xi-1)\,\frac{1}{n-1}\psi B_\kappa \sigma_\kappa^2 + (\xi-1)\,\psi F_{1\epsilon}\,(1-D_\epsilon)\,\sigma_\epsilon^2$. The first (and second) term of this expression is positive.

Adding T_1, T_2, T_3 and T_4, we conclude the following: if α is sufficiently small and $\kappa_i = 0$, then $\frac{\partial V_{Fi}(.)}{\partial \delta} > 0$. If α and σ_ϵ^2 are sufficiently small and n is sufficiently large, then if $\kappa_i > 0$, $\frac{\partial V_{Fi}(.)}{\partial \delta} < 0$ (n sufficiently large ensures that all terms involving σ_κ^2 or κ_i^2 become sufficiently small).

J. Variation (I): General functions

Now, v_i and u are of the more general format, where $v_i'' > 0$ and $v_i'(e_i) = 0$ for some $e_i = \kappa_i \lesseqgtr 0$ and u fulfills the assumptions made in Section 2. We assume that $\tilde{e}$ and $\tilde{b}_1$ converge to constants (i.e., become non-stochastic) as $n \to \infty$. This is a weak assumption, because all possible shock combinations are independent. Further, we assume that all expectations taken in the sequel exist. We impose the restriction that $v_i = v$, if $\kappa_i = \kappa$, $\forall i$. In this case, we limit ourselves to equilibria in which the governments' strategies as functions of shocks are symmetric.

J.1. Moral hazard results

The relevant first-order conditions are given by (17) and (18). Let $n \to \infty$. Hence, under the assumptions made above, the terms within the $\mathrm{E}_{|\kappa_i,\epsilon_i}[.]$ operator only depend on ϵ_i and κ_i, so that the first-order conditions become:

$$v_i'(e_i) = u'(f_{1i})(1-\psi\delta), \quad \forall i, \tag{J.1}$$

$$u'(f_{1i}) = pu'(f_{2i}), \quad \forall i. \tag{J.2}$$

The effects of shocks on the policy outcomes will generally be nonlinear. Therefore, we investigate only the impact of a change in δ on effort when *all* shock realizations are zero (i.e., $\epsilon_j = 0$ and $\kappa_j = 0$, $\forall j$). Focussing on symmetric equilibria, the first-order conditions of government i can then be written as:

$$\begin{aligned} v'(e_i) &= u'(1+e_i+b_{1i})(1-\psi\delta), \quad \forall i, \\ u'(1+e_i+b_{1i}) &= pu'(1-b_{1i}), \quad \forall i. \end{aligned}$$

To explore the impact of a change in δ, differentiate both equations with respect to δ:

$$v''(e_i)\tfrac{\partial e_i}{\partial \delta} = u''(f_{1i})\left(\tfrac{\partial e_i}{\partial \delta} + \tfrac{\partial b_{1i}}{\partial \delta}\right)(1-\psi\delta) - \psi u'(f_{1i}), \tag{J.3}$$

$$u''(f_{1i})\left(\tfrac{\partial e_i}{\partial \delta} + \tfrac{\partial b_{1i}}{\partial \delta}\right) = -pu''(f_{2i})\tfrac{\partial b_{1i}}{\partial \delta}. \tag{J.4}$$

Rewriting (J.4), we have:

$$\tfrac{\partial b_{1i}}{\partial \delta} = -\tfrac{u''(f_{1i})}{u''(f_{1i})+pu''(f_{2i})}\tfrac{\partial e_i}{\partial \delta}.$$

Substitute this into (J.3), to give:

$$v''(e_i)\tfrac{\partial e_i}{\partial \delta} = u''(f_{1i})\left[\tfrac{pu''(f_{2i})}{u''(f_{1i})+pu''(f_{2i})}\right](1-\psi\delta)\,\tfrac{\partial e_i}{\partial \delta} - \psi u'(f_{1i}).$$

Hence,

$$\left[v''(e_i) - \tfrac{pu''(f_{1i})u''(f_{2i})(1-\psi\delta)}{u''(f_{1i})+pu''(f_{2i})}\right]\tfrac{\partial e_i}{\partial \delta} = -\psi u'(f_{1i}).$$

Hence, $\frac{\partial e_i}{\partial \delta} < 0$ and, hence, $\frac{\partial b_{1i}}{\partial \delta} > 0$, thereby confirming *Result (iii)(a)* for effort.

J.2. Proof that full insurance is suboptimal

Government i's expected equilibrium utility as a function of the stability pact parameters is given by:

$$V_{Fi}(\psi,\delta) \equiv \mathrm{E}_{|\kappa_i}\left[-v_i(e_i) + u(f_{1i}) + pu(f_{2i}) - \left(\alpha\tilde{b}_1\right)^2 / (2\phi)\right],$$

where $V_{Fi}(\psi,\delta)$ is the expected equilibrium utility as a function of the stability pact parameters and f_{1i}, f_{2i} and $\tilde{b}_1$ are the equilibrium outcomes. In the sequel of this proof all expressions are understood to be evaluated at $\theta^* \equiv (\psi,\delta) = (\frac{n-1}{n},1)$. Differentiating $V_{Fi}(\psi,\delta)$ with respect to δ and thus evaluating at θ^* yields:

$$\frac{\partial V_{Fi}(.)}{\partial\delta} = \mathrm{E}_{|\kappa_i}\left[-v_i'(e_i)\frac{\partial e_i}{\partial\delta} + u'(f_{1i})\frac{\partial f_{1i}}{\partial\delta} + pu'(f_{2i})\frac{\partial f_{2i}}{\partial\delta} - \frac{\alpha^2}{\phi}\tilde{b}_1\frac{\partial\tilde{b}_1}{\partial\delta}\right].$$

where, using (16) and (10), respectively,

$$\frac{\partial f_{1i}}{\partial\delta} = \frac{\partial\tilde{e}}{\partial\delta} + \frac{\partial\tilde{b}_1}{\partial\delta} + \left[(\tilde{\epsilon}-\epsilon_i) + (\tilde{e}-e_i)\right], \qquad \frac{\partial f_{2i}}{\partial\delta} = -\frac{\partial\tilde{b}_1}{\partial\delta}.$$

Hence,

$$\frac{\partial V_{Fi}(.)}{\partial\delta} = \mathrm{E}_{|\kappa_i}\left[\begin{array}{c} -v_i'(e_i)\frac{\partial e_i}{\partial\delta} + u'(f_{1i})\left[\frac{\partial\tilde{e}}{\partial\delta} + \frac{\partial\tilde{b}_1}{\partial\delta} + \left[(\tilde{\epsilon}-\epsilon_i) + (\tilde{e}-e_i)\right]\right] \\ -pu'(f_{2i})\frac{\partial\tilde{b}_1}{\partial\delta} - \frac{\alpha^2}{\phi}\tilde{b}_1\frac{\partial\tilde{b}_1}{\partial\delta} \end{array}\right].$$

Hence, using government i's first-order conditions for b_{1i} and e_i:

$$\frac{\partial V_{Fi}(.)}{\partial\delta} = T_1 + T_2 + T_3 + T_4 + T_5 + T_6,$$

where

$$\begin{aligned}
T_1 &= \mathrm{E}_{|\kappa_i}\left\{-\mathrm{E}_{|\kappa_i,\epsilon_i}\left[u'(f_{1i})\right]\frac{1}{n}\frac{\partial e_i}{\partial\delta}\right\}, \\
T_2 &= \mathrm{E}_{|\kappa_i}\left\{u'(f_{1i})\left[\frac{\partial\tilde{e}}{\partial\delta} + (\tilde{\epsilon}-\epsilon_i) + (\tilde{e}-e_i)\right]\right\}, \\
T_3 &= \mathrm{E}_{|\kappa_i}\left\{\left[u'(f_{1i}) - \mathrm{E}_{|\kappa_i,\epsilon_i}u'(f_{1i})\right]\frac{\partial\tilde{b}_1}{\partial\delta}\right\}, \\
T_4 &= -p\mathrm{E}_{|\kappa_i}\left\{\left[u'(f_{2i}) - \mathrm{E}_{|\kappa_i,\epsilon_i}u'(f_{2i})\right]\frac{\partial\tilde{b}_1}{\partial\delta}\right\}, \\
T_5 &= -\frac{\alpha^2}{\phi}\mathrm{E}_{|\kappa_i}\left\{\left[\tilde{b}_1 - \mathrm{E}_{|\kappa_i,\epsilon_i}\left(\tilde{b}_1\right)\right]\frac{\partial\tilde{b}_1}{\partial\delta}\right\}.
\end{aligned}$$

Let $n \to \infty$. Hence, $T_1 \to 0$. Further, $\tilde{\epsilon} \to 0$, almost surely. Hence, in the limit, $f_{1i} = 1 + \tilde{e} + \tilde{b}_1$ and $f_{2i} = 1 - \tilde{b}_1$ are constant and, hence, $u'(f_{1i}) \to \mathrm{E}_{|\kappa_i,\epsilon_i}u'(f_{1i})$ and

$u'(f_{2i}) \to \mathrm{E}_{|\kappa_i,\epsilon_i} u'(f_{2i})$, almost surely. Hence, $T_3 \to 0$, $T_4 \to 0$ and $T_5 \to 0$. Hence, we have that:

$$\begin{aligned}
\tfrac{\partial V_{Fi}(.)}{\partial \delta} &\to \mathrm{E}_{|\kappa_i} \left\{ u'(f_{1i}) \left[\tfrac{\partial \tilde{e}}{\partial \delta} + (\tilde{e} - e_i) - \epsilon_i \right] \right\} \\
&= \mathrm{E}_{|\kappa_i} \left\{ u'(1 + \tilde{e} + \tilde{b}_1) \left[\tfrac{\partial \tilde{e}}{\partial \delta} + (\tilde{e} - e_i) - \epsilon_i \right] \right\} \\
&= u'(1 + \tilde{e} + \tilde{b}_1) \mathrm{E}_{|\kappa_i} \left[\tfrac{\partial \tilde{e}}{\partial \delta} + (\tilde{e} - e_i) - \epsilon_i \right] \\
&= u'(1 + \tilde{e} + \tilde{b}_1) \mathrm{E}_{|\kappa_i} \left[\tfrac{\partial \tilde{e}}{\partial \delta} + (\tilde{e} - e_i) \right] \\
&= u'(1 + \tilde{e} + \tilde{b}_1) \left[\tfrac{\partial \tilde{e}}{\partial \delta} + \left(\tilde{e} - \mathrm{E}_{|\kappa_i} e_i \right) \right],
\end{aligned}$$

again using that $\tilde{e}$ and $\tilde{b}_1$ are constant in the limit. From (J.1) evaluated at θ^* with $n \to \infty$, we have that $e_i = \kappa_i$, $\forall i$. Hence, $\tilde{e} = \tilde{\kappa} \to 0$.

We still need to determine $\frac{\partial \tilde{e}}{\partial \delta}$. The first-order condition for e_i when $n \to \infty$ can be written as:

$$v_i'(e_i) = u'(f_{1i})(1 - \psi\delta).$$

Differentiate this equation with respect to δ to give

$$v_i''(e_i) \tfrac{\partial e_i}{\partial \delta} = u''(f_{1i}) \left(\tfrac{\partial \tilde{e}}{\partial \delta} + \tfrac{\partial \tilde{b}_1}{\partial \delta} + [\tilde{e} - (e_i + \epsilon_i)] \right) (1 - \psi\delta) - \psi u'(f_{1i}).$$

Evaluate this at θ^* and, again, use that $n \to \infty$:

$$v_i''(e_i) \tfrac{\partial e_i}{\partial \delta} = -u'(1 + \tilde{e} + \tilde{b}_1).$$

Hence, $\frac{\partial e_i}{\partial \delta} < 0$ and, hence, $\frac{\partial \tilde{e}}{\partial \delta} < 0$.

Suppose that $\sigma_\kappa^2 = 0$, so that $\kappa_j = 0$ for all j. Hence, $\tilde{e} - \mathrm{E}_{|\kappa_i} e_i = 0$. Hence, $\frac{\partial V_{Fi}(.)}{\partial \delta} < 0$. This completes the proof of the analogue to Proposition 2*(a)*, if $n \to \infty$. Now, let $\sigma_\kappa^2 > 0$. If the $\kappa_i \geq 0$, then $\tilde{e} - \mathrm{E}_{|\kappa_i} e_i < 0$. Hence, $\frac{\partial V_{Fi}(.)}{\partial \delta} < 0$. This completes the proof of the analogue to Proposition 2*(b)*.

J.3. Is some contingency welfare improving?

For given $0 < \psi \leq \frac{n-1}{n}$, we evaluate $\partial V_{Fi}(\psi, \delta)/\partial \delta|_{\delta=0}$, where

$$V_{Fi}(\psi, \delta) \equiv \mathrm{E}_{|\kappa_i} \left[-v_i(e_i) + u(f_{1i}) + pu(f_{2i}) - \left(\alpha \tilde{b}_1 \right)^2 / (2\phi) \right],$$

is government i 's equilibrium expected utility as a function of the stability pact parameters, conditional on κ_i. In sequel of this proof, all expressions are understood to be evaluated at $\delta = 0$. Differentiating this expression with respect to δ and thus evaluating at $\delta = 0$ yields:

$$\frac{\partial V_{Fi}(.)}{\partial \delta} = \mathrm{E}_{|\kappa_i} \left[-v_i'(e_i) \frac{\partial e_i}{\partial \delta} + u'(f_{1i}) \frac{\partial f_{1i}}{\partial \delta} + pu'(f_{2i}) \frac{\partial f_{2i}}{\partial \delta} - \frac{\alpha^2}{\phi} \tilde{b}_1 \frac{\partial \tilde{b}_1}{\partial \delta} \right], \tag{J.5}$$

where, using (16) and (10), respectively,

$$\begin{aligned} \frac{\partial f_{1i}}{\partial \delta} &= \frac{n}{n-1} \psi \frac{\partial \tilde{b}_1}{\partial \delta} + \left(1 - \frac{n}{n-1} \psi\right) \frac{\partial b_{1i}}{\partial \delta} + \frac{\partial e_i}{\partial \delta} + \frac{n}{n-1} \psi \left[(\tilde{\epsilon} - \epsilon_i) + (\tilde{e} - e_i) \right], \\ \frac{\partial f_{2i}}{\partial \delta} &= -\frac{n}{n-1} \psi \frac{\partial \tilde{b}_1}{\partial \delta} - \left(1 - \frac{n}{n-1} \psi\right) \frac{\partial b_{1i}}{\partial \delta}. \end{aligned}$$

Substitute these expressions into (J.5), which can then be written as:

$$\frac{\partial V_{Fi}(.)}{\partial \delta} = \mathrm{E}_{|\kappa_i} \left\{ \begin{array}{c} \left[u'(f_{1i}) - v_i'(e_i) \right] \frac{\partial e_i}{\partial \delta} + u'(f_{1i}) \left[(\tilde{\epsilon} - \epsilon_i) + (\tilde{e} - e_i) \right] \frac{n}{n-1} \psi \\ + \left[u'(f_{1i}) - pu'(f_{2i}) \right] \left[\frac{n}{n-1} \psi \frac{\partial \tilde{b}_1}{\partial \delta} + \left(1 - \frac{n}{n-1} \psi\right) \frac{\partial b_{1i}}{\partial \delta} \right] \\ - \frac{\alpha^2}{\phi} \tilde{b}_1 \frac{\partial \tilde{b}_1}{\partial \delta} \end{array} \right\},$$

which, using the first-order conditions for e_i and b_{1i}, can be written as:

$$\frac{\partial V_{Fi}(.)}{\partial \delta} = \mathrm{E}_{|\kappa_i} \left\{ \begin{array}{c} \left[u'(f_{1i}) - \mathrm{E}_{|\kappa_i, \epsilon_i} u'(f_{1i}) \right] \frac{\partial e_i}{\partial \delta} + u'(f_{1i}) \left[(\tilde{\epsilon} - \epsilon_i) + (\tilde{e} - e_i) \right] \frac{n}{n-1} \psi \\ + \left[u'(f_{1i}) - \mathrm{E}_{|\kappa_i, \epsilon_i} u'(f_{1i}) \right] \left[\frac{n}{n-1} \psi \frac{\partial \tilde{b}_1}{\partial \delta} + \left(1 - \frac{n}{n-1} \psi\right) \frac{\partial b_{1i}}{\partial \delta} \right] \\ -p \left[u'(f_{2i}) - \mathrm{E}_{|\kappa_i, \epsilon_i} u'(f_{2i}) \right] \left[\frac{n}{n-1} \psi \frac{\partial \tilde{b}_1}{\partial \delta} + \left(1 - \frac{n}{n-1} \psi\right) \frac{\partial b_{1i}}{\partial \delta} \right] \\ - \frac{\alpha^2}{\phi} \tilde{b}_1 \frac{\partial \tilde{b}_1}{\partial \delta} + \frac{\alpha^2}{\phi n (1-\psi)} \mathrm{E}_{|\kappa_i, \epsilon_i} \left(\tilde{b}_1 \right) \left[\frac{n}{n-1} \psi \frac{\partial \tilde{b}_1}{\partial \delta} + \left(1 - \frac{n}{n-1} \psi\right) \frac{\partial b_{1i}}{\partial \delta} \right] \end{array} \right\}.$$

Now, letting $\alpha \to 0$, we have:

$$\frac{\partial V_{Fi}(.)}{\partial \delta} \to \mathrm{E}_{|\kappa_i} \left\{ \begin{array}{c} \left[u'(f_{1i}) - \mathrm{E}_{|\kappa_i, \epsilon_i} u'(f_{1i}) \right] \frac{\partial e_i}{\partial \delta} + u'(f_{1i}) \left[(\tilde{\epsilon} - \epsilon_i) + (\tilde{e} - e_i) \right] \frac{n}{n-1} \psi \\ + \left[u'(f_{1i}) - \mathrm{E}_{|\kappa_i, \epsilon_i} u'(f_{1i}) \right] \left[\frac{n}{n-1} \psi \frac{\partial \tilde{b}_1}{\partial \delta} + \left(1 - \frac{n}{n-1} \psi\right) \frac{\partial b_{1i}}{\partial \delta} \right] \\ -p \left[u'(f_{2i}) - \mathrm{E}_{|\kappa_i, \epsilon_i} u'(f_{2i}) \right] \left[\frac{n}{n-1} \psi \frac{\partial \tilde{b}_1}{\partial \delta} + \left(1 - \frac{n}{n-1} \psi\right) \frac{\partial b_{1i}}{\partial \delta} \right] \end{array} \right\}.$$

Let $n \to \infty$. Hence, $\tilde{\epsilon} \to 0$, while $\tilde{e}$ and $\tilde{b}_1$ are constant in the limit. Hence, by the first order conditions, in the limit, all uncertainty in f_{1i} and f_{2i} arises from ϵ_i and κ_i. Hence, $u'(f_{1i}) \to \mathrm{E}_{|\kappa_i, \epsilon_i} u'(f_{1i})$ and $u'(f_{2i}) \to \mathrm{E}_{|\kappa_i, \epsilon_i} u'(f_{2i})$, almost surely. Hence, if $n \to \infty$,

$$\begin{aligned} \frac{\partial V_{Fi}(.)}{\partial \delta} &\to \mathrm{E}_{|\kappa_i} \left\{ u'(f_{1i}) \left[\tilde{e} \right] \psi - u'(f_{1i}) \left(\epsilon_i + e_i \right) \psi \right\} \\ &= \mathrm{E}_{|\kappa_i} \left[u'(f_{1i}) \left(\tilde{e} \right) \right] \psi - \mathrm{E}_{|\kappa_i} \left[u'(f_{1i}) \left(\epsilon_i + e_i \right) \right] \psi \\ &= \mathrm{E}_{|\kappa_i} \left[u'(f_{1i}) \right] \mathrm{E}_{|\kappa_i} \left[\tilde{e} \right] \psi - \mathrm{E}_{|\kappa_i} \left[u'(f_{1i}) \left(\epsilon_i + e_i \right) \right] \psi \\ &= \mathrm{E}_{|\kappa_i} \left[u'(f_{1i}) \right] \left[\tilde{e} - \mathrm{E}_{|\kappa_i} \left(e_i \right) \right] \psi - \mathrm{Cov}_{|\kappa_i} \left[u'(f_{1i}) \left(\epsilon_i + e_i \right) \right] \psi. \end{aligned}$$

Here, we have used the assumption that, as $n \to \infty$, $\tilde{e}$ becomes constant. We now consider two cases:

Case 1: Suppose that the government of country i expects to exert the same amount of effort as the average in the union, i.e., $\mathrm{E}_{|\kappa_i}(e_i) = \tilde{e}$. Then, $\frac{\partial V_{Fi}(.)}{\partial \delta} > 0$ if the correlation between $u'(f_{1i})$ and $(\epsilon_i + e_i)$ is negative. This completes the proof of the analogue of Proposition 3*(a)*.

The question is under what circumstances this negative correlation is likely to be the case. To explore this issue, write out government i's first-order conditions evaluated at $\delta = 0$, realizing that ϵ_i is observed by government i and using that average variables become non-stochastic when $n \to \infty$:

$$\begin{aligned} v_i'(e_i) &= u'\left[1 + \epsilon_i + e_i + b_{1i} - \psi\left(b_{1i} - \tilde{b}_1\right)\right], \\ pu'\left[1 - b_{1i} + \psi\left(b_{1i} - \tilde{b}_1\right)\right] &= u'\left[1 + \epsilon_i + e_i + b_{1i} - \psi\left(b_{1i} - \tilde{b}_1\right)\right]. \end{aligned}$$

Differentiating these two equations with respect to ϵ_i, we have:

$$v_i''(e_i)\frac{\partial e_i}{\partial \epsilon_i} = u''(f_{1i})\left[1 + \frac{\partial e_i}{\partial \epsilon_i} + (1-\psi)\frac{\partial b_{1i}}{\partial \epsilon_i}\right], \tag{J.6}$$

$$pu''(f_{2i})(\psi - 1)\frac{\partial b_{1i}}{\partial \epsilon_i} = u''(f_{1i})\left[1 + \frac{\partial e_i}{\partial \epsilon_i} + (1-\psi)\frac{\partial b_{1i}}{\partial \epsilon_i}\right]. \tag{J.7}$$

Combining these two equations we find that

$$(1-\psi)\frac{\partial b_{1i}}{\partial \epsilon_i} = -\frac{v_i''(e_i)}{pu''(f_{2i})}\frac{\partial e_i}{\partial \epsilon_i}.$$

Use this expression to substitute away $\frac{\partial b_{1i}}{\partial \epsilon_i}$ from either (J.6) or (J.7) and rewrite the resulting expression to give:

$$\frac{\partial e_i}{\partial \epsilon_i} = \frac{pu''(f_{1i})u''(f_{2i})}{pu''(f_{2i})v_i''(e_i) + u''(f_{1i})v_i''(e_i) - pu''(f_{1i})u''(f_{2i})} < 0.$$

Hence, $\frac{\partial b_{1i}}{\partial \epsilon_i} < 0$. Further,

$$\frac{\partial(\epsilon_i + e_i)}{\partial \epsilon_i} = 1 + \frac{\partial e_i}{\partial \epsilon_i} = \frac{pu''(f_{2i})v_i''(e_i) + u''(f_{1i})v_i''(e_i)}{pu''(f_{2i})v_i''(e_i) + u''(f_{1i})v_i''(e_i) - pu''(f_{1i})u''(f_{2i})} > 0.$$

Further,

$$\frac{\partial f_{1i}}{\partial \epsilon_i} = 1 + \frac{\partial e_i}{\partial \epsilon_i} + (1-\psi)\frac{\partial b_{1i}}{\partial \epsilon_i} = \frac{pu''(f_{2i})v_i''(e_i)}{pu''(f_{2i})v_i''(e_i) + u''(f_{1i})v_i''(e_i) - pu''(f_{1i})u''(f_{2i})} > 0.$$

In other words $\epsilon_i + e_i$ and f_{1i} move up and down together in response to the shock ϵ_i, which makes it likely that $\epsilon_i + e_i$ and $u'(f_{1i})$ are negatively correlated.

Case 2: Now, suppose that $\sigma_\epsilon^2 \to 0$. Hence,

$$\tfrac{\partial V_{Fi}(.)}{\partial \delta} \to \mathrm{E}_{|\kappa_i}\left[u'(f_{1i})\right]\left[\tilde{e} - \mathrm{E}_{|\kappa_i}(e_i)\right]\psi,$$

where we have used that $u'(f_{1i}) \to \mathrm{E}_{|\kappa_i}\left[u'(f_{1i})\right]$.[18] Hence, if $\mathrm{E}_{|\kappa_i}(e_i) > \tilde{e}$, the government type of country i is worse off. This completes the proof of the analogue of Proposition 3*(b)*.

K. Variation II: Re-election probability depends on effort

Government i now optimizes over b_{1i} and e_i the following function:

$$V_{Fi}(\psi, \delta) \equiv \mathrm{E}_{|\epsilon_i}\left[u(f_{1i}) + p(e_i)\,u(f_{2i}) - \pi^2/(2\phi)\right],$$

subject to (16), (10) and (7), with the expectation $\mathrm{E}_{|\epsilon_i}$ taken over all ϵ_j, $j \neq i$. The re-election probability depends on the degree of effort. It is not immediately clear whether p should depend in a positive or negative way on e_i. On the one hand, more structural reform may result in more support from the part of society that benefits from it. On the other hand, more reform may reduce the constituency of the party in power and, thereby, lead to less political support. If $p' > 0$, more reform is always better for the government and no equilibrium exists. Therefore, and in accordance with the main text, we assume that $p' < 0$, which captures that reform has political costs in terms of reducing the re-election probability. To keep matters tractable, we assume that there is no difference in government types.

In the sequel we consider only interior equilibria, implicitly assuming that the resulting choices of effort imply that $0 < p < 1$. Furthermore, we assume that $\tilde{e}$ and $\tilde{b}_1$ converge to constants (i.e., become non-stochastic) as $n \to \infty$. This is a weak assumption, because all possible shock combinations are independent. We also assume that all expectations taken in the sequel exist. Finally, we limit ourselves to equilibria in which the governments' strategies as functions of shocks are symmetric.

The government's necessary first-order conditions with respect to b_{1i} and e_i are given

[18] Because the aggregate variables $\tilde{e}$ and $\tilde{b}_1$ become constant when $n \to \infty$, the policy outcomes for country i only depend on ϵ_i and κ_i, as the first-order conditions for country i show. Hence, if $\sigma_\epsilon^2 \to 0$, $u'(f_{1i})$, given κ_i, becomes constant.

by, respectively:

$$
\begin{aligned}
\mathrm{E}_{|\epsilon_i}\left[u'(f_{1i})\right](1-\psi) &= p(e_i)\,\mathrm{E}_{|\epsilon_i}\left[u'(f_{2i})\right](1-\psi)+\mathrm{E}_{|\epsilon_i}\left[\alpha^2\tilde{b}_1/(\phi n)\right], \quad \forall i, \\
\mathrm{E}_{|\epsilon_i}\left[u'(f_{1i})\right](1-\psi\delta) &= -p'(e_i)\,\mathrm{E}_{|\epsilon_i}\left[u(f_{2i})\right], \quad \forall i.
\end{aligned}
$$

The second-order conditions are, respectively,

$$
\mathrm{E}_{|\epsilon_i}\left[u''(f_{1i})\right](1-\psi)^2+p(e_i)\,\mathrm{E}_{|\epsilon_i}\left[u''(f_{2i})\right](1-\psi)^2-\mathrm{E}_{|\epsilon_i}\left[\alpha^2/\left(\phi n^2\right)\right]<0, \quad \forall i, \tag{K.1}
$$

$$
\begin{aligned}
& \left\{\mathrm{E}_{|\epsilon_i}\left[u''(f_{1i})\right](1-\psi)^2+p(e_i)\,\mathrm{E}_{|\epsilon_i}\left[u''(f_{2i})\right](1-\psi)^2-\mathrm{E}_{|\epsilon_i}\left[\alpha^2/\left(\phi n^2\right)\right]\right\} \\
& *\left\{\mathrm{E}_{|\epsilon_i}\left[u''(f_{1i})\right](1-\psi\delta)^2+p''(e_i)\,\mathrm{E}_{|\epsilon_i}\left[u(f_{2i})\right]\right\} \\
& -\left\{\mathrm{E}_{|\epsilon_i}\left[u''(f_{1i})\right](1-\psi)(1-\psi\delta)-p'(e_i)\,\mathrm{E}_{|\epsilon_i}\left[u'(f_{2i})\right](1-\psi)\right\}^2 \\
> {} & 0, \quad \forall i,
\end{aligned} \tag{K.2}
$$

where the last one implies that

$$
\mathrm{E}_{|\epsilon_i}\left[u''(f_{1i})\right](1-\psi\delta)^2+p''(e_i)\,\mathrm{E}_{|\epsilon_i}\left[u(f_{2i})\right]<0,
$$

must hold.

K.1. Moral hazard results

It is difficult to analyze the model in its most general format. Therefore, we let $n\to\infty$. Because $\tilde{\epsilon}\to 0$, almost surely, and $\tilde{e}$ and $\tilde{b}_1$ converge to constants, the only remaining source of uncertainty in f_{1i} and f_{2i} is ϵ_i. Hence, the first-order conditions can be written as:

$$
u'(f_{1i}) = p(e_i)\,u'(f_{2i}), \quad \forall i, \tag{K.3}
$$

$$
u'(f_{1i})(1-\psi\delta) = -p'(e_i)\,u(f_{2i}), \quad \forall i. \tag{K.4}
$$

The second-order conditions then become:

$$
u''(f_{1i})+p(e_i)\,u''(f_{2i})<0, \tag{K.5}
$$

$$
\left[u''(f_{1i})(1-\psi)^2+p(e_i)\,u''(f_{2i})(1-\psi)^2\right] \tag{K.6}
$$

$$
\begin{aligned}
&* \left[u''(f_{1i})\,(1-\psi\delta)^2 + p''\,(e_i)\,u(f_{2i})\right] \\
&- \left[u''(f_{1i})\,(1-\psi)\,(1-\psi\delta) - p'\,(e_i)\,u'(f_{2i})\,(1-\psi)\right]^2 \\
> \;& 0.
\end{aligned}
$$

The last inequality can be simplified to

$$
\begin{aligned}
&\left[u''(f_{1i}) + p\,(e_i)\,u''(f_{2i})\right]\left[u''(f_{1i})\,(1-\psi\delta)^2 + p''\,(e_i)\,u(f_{2i})\right] \\
&- \left[u''(f_{1i})\,(1-\psi\delta) - p'\,(e_i)\,u'(f_{2i})\right]^2 \\
> \;& 0 \Leftrightarrow
\end{aligned}
$$

$$
\begin{aligned}
&\left[u''(f_{1i})\right]^2(1-\psi\delta)^2 + p\,(e_i)\,u''(f_{1i})u''(f_{2i})\,(1-\psi\delta)^2 \\
&+p''\,(e_i)\,u''(f_{1i})u(f_{2i}) + p\,(e_i)\,p''\,(e_i)\,u''(f_{2i})u(f_{2i}) \\
&- \left[u''(f_{1i})\right]^2(1-\psi\delta)^2 - \left[p'\,(e_i)\right]^2\left[u'(f_{2i})\right]^2 + 2p'\,(e_i)\,u''(f_{1i})u'(f_{2i})\,(1-\psi\delta) \\
> \;& 0,
\end{aligned}
$$

and thus

$$
\begin{aligned}
&p\,(e_i)\,u''(f_{1i})u''(f_{2i})\,(1-\psi\delta)^2 + p''\,(e_i)\,u''(f_{1i})u(f_{2i}) + p\,(e_i)\,p''\,(e_i)\,u''(f_{2i})u(f_{2i}) \\
&- \left[p'\,(e_i)\right]^2\left[u'(f_{2i})\right]^2 + 2p'\,(e_i)\,u''(f_{1i})u'(f_{2i})\,(1-\psi\delta) \\
> \;& 0. \qquad \text{(K.7)}
\end{aligned}
$$

The effects of shocks on the policy outcomes will generally be nonlinear. Therefore, we investigate only the impact of a change in δ on effort when *all* shock realizations are zero (i.e., $\epsilon_j = 0$, $\forall j$). Focussing on symmetric equilibria, the first-order conditions of government i can then be written as:

$$
\begin{aligned}
u'(1+e_i+b_{1i}) &= p\,(e_i)\,u'(1-b_{1i}), \\
u'(1+e_i+b_{1i})\,(1-\psi\delta) &= -p'\,(e_i)\,u(1-b_{1i}).
\end{aligned}
$$

To explore the impact of a change in δ, differentiate both equations with respect to δ:

$$
u''(f_{1i})\left(\tfrac{\partial e_i}{\partial\delta} + \tfrac{\partial b_{1i}}{\partial\delta}\right) = p'\,(e_i)\,\tfrac{\partial e_i}{\partial\delta}u'(f_{2i}) - p\,(e_i)\,u''(f_{2i})\tfrac{\partial b_{1i}}{\partial\delta}, \qquad \text{(K.8)}
$$

$$
u''(f_{1i})\left(\tfrac{\partial e_i}{\partial\delta} + \tfrac{\partial b_{1i}}{\partial\delta}\right)(1-\psi\delta) - \psi u'(f_{1i}) = -p''\,(e_i)\,\tfrac{\partial e_i}{\partial\delta}u(f_{2i}) + p'\,(e_i)\,u'(f_{2i})\tfrac{\partial b_{1i}}{\partial\delta}. \qquad \text{(K.9)}
$$

Rewriting (K.8), we have:

$$\frac{\partial b_{1i}}{\partial \delta} = \left[\frac{p'(e_i)\, u'(f_{2i}) - u''(f_{1i})}{p(e_i)\, u''(f_{2i}) + u''(f_{1i})}\right] \frac{\partial e_i}{\partial \delta}. \tag{K.10}$$

Substitute this into (K.9) and rewrite to give:

$$\begin{aligned} & u''(f_{1i})\,(1-\psi\delta)\left[\frac{p(e_i)\, u''(f_{2i}) + p'(e_i)\, u'(f_{2i})}{p(e_i)\, u''(f_{2i}) + u''(f_{1i})}\right]\frac{\partial e_i}{\partial \delta} \\ = \; & \psi u'(f_{1i}) - p''(e_i)\,\frac{\partial e_i}{\partial \delta} u(f_{2i}) + \left[\frac{[p'(e_i)]^2\,[u'(f_{2i})]^2 - p'(e_i)\, u'(f_{2i}) u''(f_{1i})}{p(e_i)\, u''(f_{2i}) + u''(f_{1i})}\right]\frac{\partial e_i}{\partial \delta}. \end{aligned}$$

Hence,

$$\begin{aligned} & \left[\frac{p(e_i)\, u''(f_{1i}) u''(f_{2i})\,(1-\psi\delta) + p'(e_i)\, u''(f_{1i}) u'(f_{2i})\,(1-\psi\delta)}{p(e_i)\, u''(f_{2i}) + u''(f_{1i})}\right. \\ & + \frac{p(e_i)\, p''(e_i)\, u''(f_{2i}) u(f_{2i}) + p''(e_i)\, u''(f_{1i}) u(f_{2i})}{p(e_i)\, u''(f_{2i}) + u''(f_{1i})} \\ & \left. - \frac{[p'(e_i)]^2\,[u'(f_{2i})]^2 - p'(e_i)\, u''(f_{1i}) u'(f_{2i})}{p(e_i)\, u''(f_{2i}) + u''(f_{1i})}\right]\frac{\partial e_i}{\partial \delta} \\ = \; & \psi u'(f_{1i}). \end{aligned}$$

Hence,

$$\begin{aligned} & \left[\frac{p(e_i)\, u''(f_{1i}) u''(f_{2i})\,(1-\psi\delta) + p'(e_i)\, u''(f_{1i}) u'(f_{2i})\,(2-\psi\delta)}{p(e_i)\, u''(f_{2i}) + u''(f_{1i})}\right. \\ & \left. + \frac{p(e_i)\, p''(e_i)\, u''(f_{2i}) u(f_{2i}) + p''(e_i)\, u''(f_{1i}) u(f_{2i}) - [p'(e_i)]^2\,[u'(f_{2i})]^2}{p(e_i)\, u''(f_{2i}) + u''(f_{1i})}\right]\frac{\partial e_i}{\partial \delta} \\ = \; & \psi u'(f_{1i}). \end{aligned} \tag{K.11}$$

Since

$$\begin{aligned} & p(e_i)\, u''(f_{1i}) u''(f_{2i})\,(1-\psi\delta) + p'(e_i)\, u''(f_{1i}) u'(f_{2i})\,(2-\psi\delta) \\ & + p(e_i)\, p''(e_i)\, u''(f_{2i}) u(f_{2i}) + p''(e_i)\, u''(f_{1i}) u(f_{2i}) - [p'(e_i)]^2\,[u'(f_{2i})]^2 \\ \geq \; & p(e_i)\, u''(f_{1i}) u''(f_{2i})\,(1-\psi\delta)^2 + p''(e_i)\, u''(f_{1i}) u(f_{2i}) + p(e_i)\, p''(e_i)\, u''(f_{2i}) u(f_{2i}) \\ & - [p'(e_i)]^2\,[u'(f_{2i})]^2 + 2p'(e_i)\, u''(f_{1i}) u'(f_{2i})\,(1-\psi\delta) \\ > \; & 0, \end{aligned}$$

[where the first inequality follows from the facts that $(1-\psi\delta) \geq (1-\psi\delta)^2$ and $(2-\psi\delta) \geq 2(1-\psi\delta)$, and the second inequality follows from the second-order condition (K.7)], and since $p(e_i)\,u''(f_{2i}) + u''(f_{1i}) < 0$ [by (K.5)], it follows from (K.11) that $\partial e_i/\partial\delta < 0$. This confirms *Result (iii)(a)* for effort in this variation of the model.

Note that raising δ will have ambiguous implications for debt; cf. (K.10). I.e., if $p'(e_i)\,u'(f_{2i}) - u''(f_{1i}) > 0$, then $\partial b_{1i}/\partial\delta > 0$, whereas if $p'(e_i)\,u'(f_{2i}) - u''(f_{1i}) < 0$, then $\partial b_{1i}/\partial\delta < 0$. This is not surprising: all things equal, as effort goes down with δ, for *fixed* re-election probability one would have debt go up because resources in the first period shrink. However, in the case in which the decline in effort raises the election probability (i.e., $p'(e_i) < 0$), period 2 consumption gets more weight, and period 1 debt may fall so as to free up more resources for period 2. This case is indeed the relevant one when $p'(e_i) < 0$ is relatively large in absolute value, i.e., when $p'(e_i)\,u'(f_{2i}) - u''(f_{1i}) < 0$. On the other hand, when $p'(e_i)$ is small in absolute value, the response of debt is mainly driven by the loss of resources in period 1; hence, debt increases with δ.

K.2. Is some contingency welfare improving?

We investigate now whether indexing the reference deficit level to the observed economic situation $(\epsilon_i + e_i)$ is beneficial for government i. Hence, we evaluate $\partial V_{Fi}(\psi,\delta)/\partial\delta|_{\delta=0}$, where

$$V_{Fi}(\psi,\delta) \equiv \mathrm{E}\left[u(f_{1i}) + p(e_i)\,u(f_{2i}) - \left(\alpha\tilde{b}_1\right)^2/(2\phi)\right],$$

where $V_{Fi}(\psi,\delta)$ is the expected equilibrium utility as a function of the stability pact parameters and f_{1i} and f_{2i} are the equilibrium outcomes. In the sequel of this proof all expressions are understood to be evaluated at $\delta = 0$. Taking the derivative with respect to δ, and thus evaluating at $\delta = 0$, we obtain:

$$\frac{\partial V_{Fi}(.)}{\partial\delta} = \mathrm{E}\left[u'(f_{1i})\frac{\partial f_{1i}}{\partial\delta} + p(e_i)\,u'(f_{2i})\frac{\partial f_{2i}}{\partial\delta} + p'(e_i)\frac{\partial e_i}{\partial\delta}u(f_{2i}) - \frac{\alpha^2}{\phi}\tilde{b}_1\frac{\partial\tilde{b}_1}{\partial\delta}\right].$$

Substitute into this equation:

$$\frac{\partial f_{1i}}{\partial\delta} = \frac{n}{n-1}\psi\frac{\partial\tilde{b}_1}{\partial\delta} + \left(1 - \frac{n}{n-1}\psi\right)\frac{\partial b_{1i}}{\partial\delta} + \frac{\partial e_i}{\partial\delta} + \frac{n}{n-1}\psi\left[(\tilde{\epsilon} - \epsilon_i) + (\tilde{e} - e_i)\right],$$

$$\frac{\partial f_{2i}}{\partial\delta} = -\frac{n}{n-1}\psi\frac{\partial\tilde{b}_1}{\partial\delta} - \left(1 - \frac{n}{n-1}\psi\right)\frac{\partial b_{1i}}{\partial\delta},$$

which gives

$$\frac{\partial V_{Fi}(.)}{\partial\delta} = \mathrm{E}\left\{\begin{array}{c} \left[u'(f_{1i}) + p'(e_i)\,u(f_{2i})\right]\frac{\partial e_i}{\partial\delta} \\ +\left[u'(f_{1i}) - p(e_i)\,u'(f_{2i})\right]\left[\frac{n}{n-1}\psi\frac{\partial\tilde{b}_1}{\partial\delta} + \left(1 - \frac{n}{n-1}\psi\right)\frac{\partial b_{1i}}{\partial\delta}\right] \\ +u'(f_{1i})\frac{n}{n-1}\psi\left[(\tilde{\epsilon} - \epsilon_i) + (\tilde{e} - e_i)\right] - \frac{\alpha^2}{\phi}\tilde{b}_1\frac{\partial\tilde{b}_1}{\partial\delta} \end{array}\right\}.$$

Let $n \to \infty$. We can then use (K.3) and (K.4). In addition, letting $\alpha \to 0$, we obtain:

$$\begin{aligned}
\frac{\partial V_{Fi}(.)}{\partial \delta} &\to \mathrm{E}\left\{u'(f_{1i})\left[\tilde{e}\right]\psi - u'(f_{1i})\left(\epsilon_i + e_i\right)\psi\right\} \\
&= \mathrm{E}\left[u'(f_{1i})\left(\tilde{e}\right)\right]\psi - \mathrm{E}\left[u'(f_{1i})\left(\epsilon_i + e_i\right)\right]\psi \\
&= \mathrm{E}\left[u'(f_{1i})\right]\mathrm{E}\left[\tilde{e}\right]\psi - \mathrm{E}\left[u'(f_{1i})\left(\epsilon_i + e_i\right)\right]\psi \\
&= \mathrm{E}\left[u'(f_{1i})\right]\left[\tilde{e} - \mathrm{E}\left(e_i\right)\right]\psi - \mathrm{Cov}\left[u'(f_{1i})\left(\epsilon_i + e_i\right)\right]\psi \\
&= -\mathrm{Cov}\left[u'(f_{1i})\left(\epsilon_i + e_i\right)\right]\psi.
\end{aligned}$$

Here, the next-to-final equality has used the assumption that, as $n \to \infty$, $\tilde{e}$ becomes constant while the final line has used the result that, as $n \to \infty$, $\tilde{e} \to \mathrm{E}(e_i)$, because shocks are i.i.d. and the response to shocks is symmetric across governments. Hence, $\left.\frac{\partial V_{Fi}(.)}{\partial \delta}\right|_{\delta=0} > 0$ if the correlation between $(\epsilon_i + e_i)$ and $u'(f_{1i})$ is negative. This completes the proof of the analogue of Proposition 3*(a)*.

The question is under what circumstances this correlation is likely to be negative. To explore this issue, write out government i's first-order conditions evaluated at $\delta = 0$, realizing that ϵ_i is observed by government i and that aggregate variables are constant in the limit when $n \to \infty$:

$$\begin{aligned}
u'\left[1 + \epsilon_i + e_i + b_{1i} - \psi\left(b_{1i} - \tilde{b}_1\right)\right] &= p\left(e_i\right)u'\left[1 - b_{1i} + \psi\left(b_{1i} - \tilde{b}_1\right)\right], \\
u'\left[1 + \epsilon_i + e_i + b_{1i} - \psi\left(b_{1i} - \tilde{b}_1\right)\right] &= -p'\left(e_i\right)u\left[1 - b_{1i} + \psi\left(b_{1i} - \tilde{b}_1\right)\right].
\end{aligned}$$

Differentiate both equations with respect to ϵ_i, realizing that ϵ_i does not affect $\tilde{b}_1$, to give:

$$u''(f_{1i})\left[1 + \frac{\partial e_i}{\partial \epsilon_i} + (1-\psi)\frac{\partial b_{1i}}{\partial \epsilon_i}\right] = p'\left(e_i\right)\frac{\partial e_i}{\partial \epsilon_i}u'(f_{2i}) + p\left(e_i\right)u''(f_{2i})\left(\psi - 1\right)\frac{\partial b_{1i}}{\partial \epsilon_i}, \quad \text{(K.12)}$$

$$u''(f_{1i})\left[1 + \frac{\partial e_i}{\partial \epsilon_i} + (1-\psi)\frac{\partial b_{1i}}{\partial \epsilon_i}\right] = -p''\left(e_i\right)\frac{\partial e_i}{\partial \epsilon_i}u(f_{2i}) - p'\left(e_i\right)u'(f_{2i})\left(\psi - 1\right)\frac{\partial b_{1i}}{\partial \epsilon_i}. \quad \text{(K.13)}$$

Hence, combining these last two expressions:

$$\left[p'\left(e_i\right)u'(f_{2i}) + p\left(e_i\right)u''(f_{2i})\right](1-\psi)\frac{\partial b_{1i}}{\partial \epsilon_i} = \left[p'\left(e_i\right)u'(f_{2i}) + p''\left(e_i\right)u(f_{2i})\right]\frac{\partial e_i}{\partial \epsilon_i}.$$

Hence,

$$\frac{\partial b_{1i}}{\partial \epsilon_i} = \left[\frac{p'(e_i)u'(f_{2i}) + p''(e_i)u(f_{2i})}{p'(e_i)u'(f_{2i}) + p(e_i)u''(f_{2i})}\right]\frac{1}{1-\psi}\frac{\partial e_i}{\partial \epsilon_i}.$$

Plug this expression back into (K.13):

$$\begin{aligned} & u''(f_{1i})\left\{1+\left[\frac{p(e_i)u''(f_{2i})+2p'(e_i)u'(f_{2i})+p''(e_i)u(f_{2i})}{p'(e_i)u'(f_{2i})+p(e_i)u''(f_{2i})}\right]\frac{\partial e_i}{\partial\epsilon_i}\right\} \\ = & \left[\frac{[p'(e_i)u'(f_{2i})]^2+p'(e_i)p''(e_i)u(f_{2i})u'(f_{2i})-p'(e_i)p''(e_i)u(f_{2i})u'(f_{2i})-p(e_i)p''(e_i)u(f_{2i})u''(f_{2i})}{p'(e_i)u'(f_{2i})+p(e_i)u''(f_{2i})}\right]\frac{\partial e_i}{\partial\epsilon_i}. \end{aligned}$$

Hence,

$$\begin{aligned} & u''(f_{1i})+\left[\frac{p(e_i)u''(f_{1i})u''(f_{2i})+2p'(e_i)u''(f_{1i})u'(f_{2i})+p''(e_i)u''(f_{1i})u(f_{2i})}{p'(e_i)u'(f_{2i})+p(e_i)u''(f_{2i})}\right]\frac{\partial e_i}{\partial\epsilon_i} \\ = & \left[\frac{[p'(e_i)u'(f_{2i})]^2-p(e_i)p''(e_i)u(f_{2i})u''(f_{2i})}{p'(e_i)u'(f_{2i})+p(e_i)u''(f_{2i})}\right]\frac{\partial e_i}{\partial\epsilon_i}. \end{aligned}$$

Hence,

$$\begin{aligned} & \left[\frac{p(e_i)u''(f_{1i})u''(f_{2i})+2p'(e_i)u''(f_{1i})u'(f_{2i})+p''(e_i)u''(f_{1i})u(f_{2i})+p(e_i)p''(e_i)u(f_{2i})u''(f_{2i})-[p'(e_i)u'(f_{2i})]^2}{p'(e_i)u'(f_{2i})+p(e_i)u''(f_{2i})}\right]\frac{\partial e_i}{\partial\epsilon_i} \\ = & -u''(f_{1i}). \end{aligned}$$

Hence,

$$\frac{\partial e_i}{\partial\epsilon_i}=\frac{-p'(e_i)u''(f_{1i})u'(f_{2i})-p(e_i)u''(f_{1i})u''(f_{2i})}{p(e_i)u''(f_{1i})u''(f_{2i})+2p'(e_i)u''(f_{1i})u'(f_{2i})+p''(e_i)u''(f_{1i})u(f_{2i})+p(e_i)p''(e_i)u(f_{2i})u''(f_{2i})-[p'(e_i)u'(f_{2i})]^2}.$$

Observe that the numerator of the right-hand side of this expression is negative, while the denominator equals the left-hand side of (K.7) for $\delta=0$. Hence, $\frac{\partial e_i}{\partial\epsilon_i}<0$.

Further,

$$\begin{aligned} \frac{\partial(\epsilon_i+e_i)}{\partial\epsilon_i} &= 1+\frac{\partial e_i}{\partial\epsilon_i} \\ &= \frac{p'(e_i)u''(f_{1i})u'(f_{2i})+p''(e_i)u''(f_{1i})u(f_{2i})+p(e_i)p''(e_i)u(f_{2i})u''(f_{2i})-[p'(e_i)u'(f_{2i})]^2}{p(e_i)u''(f_{1i})u''(f_{2i})+2p'(e_i)u''(f_{1i})u'(f_{2i})+p''(e_i)u''(f_{1i})u(f_{2i})+p(e_i)p''(e_i)u(f_{2i})u''(f_{2i})-[p'(e_i)u'(f_{2i})]^2}, \end{aligned}$$

while,

$$\begin{aligned} & \frac{\partial f_{1i}}{\partial\epsilon_i}=1+\frac{\partial e_i}{\partial\epsilon_i}+(1-\psi)\frac{\partial b_{1i}}{\partial\epsilon_i} \\ = & \frac{p(e_i)p''(e_i)u(f_{2i})u''(f_{2i})-[p'(e_i)u'(f_{2i})]^2}{p(e_i)u''(f_{1i})u''(f_{2i})+2p'(e_i)u''(f_{1i})u'(f_{2i})+p''(e_i)u''(f_{1i})u(f_{2i})+p(e_i)p''(e_i)u(f_{2i})u''(f_{2i})-[p'(e_i)u'(f_{2i})]^2}. \end{aligned}$$

The denominator is positive by the second-order condition. Hence, $\frac{\partial f_{1i}}{\partial\epsilon_i}>0$ iff

$$p(e_i)\,p''(e_i)\,u(f_{2i})u''(f_{2i})-[p'(e_i)\,u'(f_{2i})]^2>0.$$

This requires that $p''<0$ and that $[p'(e_i)\,u'(f_{2i})]^2$ is not too large. Observe that, if $p''<0$, then $\frac{\partial b_{1i}}{\partial\epsilon_i}<0$. Hence, if $\frac{\partial f_{1i}}{\partial\epsilon_i}>0$, then $1+\frac{\partial e_i}{\partial\epsilon_i}>0$, so that (ϵ_i+e_i) and $u'(f_{1i})$ are likely to be negatively correlated.

Let us give some more intuition for the requirement that $p'' < 0$. Consider, for the sake of the argument, the effect of a shock on debt, *holding* e_i *constant*. Hence, we set $\frac{\partial e_i}{\partial \epsilon_i} = 0$ in (K.12), to obtain

$$\frac{\partial b_{1i}}{\partial \epsilon_i} = \frac{-u''(f_{1i})}{(1-\psi)\left[u''(f_{1i}) + p(e_i)\,u''(f_{2i})\right]} < 0.$$

Hence, a negative shock induces additional borrowing, as one would expect. Now, consider the effect of a shock on effort, *holding* b_{1i} *constant*. Hence, we set $\frac{\partial b_{1i}}{\partial \epsilon_i} = 0$ in (K.13), to obtain

$$\frac{\partial e_i}{\partial \epsilon_i} = -\frac{u''(f_{1i})}{u''(f_{1i}) + p''(e_i)\,u(f_{2i})} < 0,$$

where the unambiguous sign follows from the second-order condition (K.6). Hence, a negative shock raises effort. Note that the response may be larger or smaller than one-for-one, depending on the sign of $p''(e_i)$. When $p''(e_i) = 0$, then the marginal loss of effort as measured by the reduced re-election probability is unaffected by the response of e_i to the shock, and effort can safely neutralize the shock completely, i.e., $\partial e_i / \partial \epsilon_i = -1$. When $p''(e_i) < 0$, the response will be *less* than one-for-one, as the marginal loss of effort *increases* ($p'(e_i)$ becomes more negative); hence, in the optimum, the marginal gain (in the form of higher first-period resources) must increase as well, which can only be possible if the shock is not fully compensated by the increase in effort. Hence, first-period public consumption *decreases*. Finally, for $p''(e_i) > 0$, the opposite holds.

What is the effect on public debt? Suppose that $p''(e_i) = 0$. Hence, the change in effort neutralizes the effect of a negative shock completely. This means that choice of public debt can only be driven by the effect of the change in effort. The reduction in the re-election probability as a result of the increase in effort renders the second period less important for the first-period government and induces it to issue more debt. Hence, first period consumption increases when a negative shock occurs. If $p''(e_i) > 0$, the increase in effort overcompensates the effect of a negative shock. Debt may go up or down, depending on whether the effect of the increase in first period resources or the fall in the re-election probability is strongest. The overall effect, though, is an increase in first-period public consumption. Hence, for first-period consumption to fall in response to a negative shock, we need that $p''(e_i) < 0$.

Other cases are also possible. For example, $p''(e_i) > 0$ and $p'(e_i)\,u'(f_{2i}) < u''(f_{1i})$. Then, $1 + \frac{\partial e_i}{\partial \epsilon_i} < 0$ and $1 + \frac{\partial e_i}{\partial \epsilon_i} + (1-\psi)\frac{\partial b_{1i}}{\partial \epsilon_i} < 0$, so that $\epsilon_i + e_i$ and f_{1i} are positively correlated and, hence, $\epsilon_i + e_i$ and $u'(f_{1i})$ are likely to be negatively correlated, so that

$\left.\frac{\partial V_{Fi}(.)}{\partial \delta}\right|_{\delta=0} > 0$. Another example is when $p''(e_i) = 0$ and $p'(e_i)\, u'(f_{2i}) > u''(f_{1i})$. Hence, $1 + \frac{\partial e_i}{\partial \epsilon_i} > 0$ and $1 + \frac{\partial e_i}{\partial \epsilon_i} + (1-\psi)\frac{\partial b_{1i}}{\partial \epsilon_i} < 0$, so that $\epsilon_i + e_i$ and f_{1i} are negatively correlated, hence $\epsilon_i + e_i$ and $u'(f_{1i})$ are likely to be positively correlated, so that $\left.\frac{\partial V_{Fi}(.)}{\partial \delta}\right|_{\delta=0} < 0$.