The Economics of Delaying Policy Change:

An Application to the 1992 CAP Reform

Klaus Mittenzwei[1], David S. Bullock[2], Klaus Salhofer[3] and Jukka Kola[4]

[1] Norwegian Agricultural Economics Research Institute, Postboks 8024 Dep., NO-0030 Oslo, Norway

[2] University of Illinois, USA

[3] Technical University of Munich, Germany

[4] University of Helsinki, Finland

Corresponding author: Klaus Mittenzwei (klaus.mittenzwei@nilf.no)

Selected paper prepared for presentation at the Agricultural & Applied Economics Association's 2009 AAEA & ACCI Joint Annual Meeting, Milwaukee, WI, July 26-28, 2009

Abstract

Positive political economy is usually concerned with economic explanations of observed policy choices, while the timing of a policy reform has not gained similar attention. This is somewhat surprising since policy makers most often are free to decide both the design and timing of a policy reform. Drawing on insights from recent developments in the finance literature on investment under uncertainty, here we apply the idea of option value to the analysis of government policy making.

Common political-economic explanations of the 1992 CAP reform are that policy-makers felt domestic political pressure to make the CAP more efficient, and also international political pressure and to bring the CAP in line with treaty obligations. Although these arguments are sound, they fail to explain why policy-makers did not enact the reform earlier, especially during times of decreasing world market prices prior to 1992. We address this question using the theory of option value, which is the value of being able to wait in decision-making. Commonly governments are free to decide when to reform policy. Waiting to reform policy can improve government decisions. For while waiting decision-makers may observe market parameter changes as they occur. (For example, they may obtain better information about changes in world prices.) This reduces their uncertainty about the effects of their decisions. Giving up the option to wait incurs a cost which has to be taken into account in policy decisions. We illustrate the option value concept using a political-economy model of the 1992 CAP reform. We show empirically that if decision-makers had not had the option to wait to reform policy, it would have been more efficient to implement the 1992 CAP reform in the mid 1980s.

The Economics of Delaying Policy Change: An Application to the 1992 CAP Reform

Positive political economy is usually concerned with economic explanations of observed policy choices, while the timing of a policy reform has not gained similar attention. This is somewhat surprising since policy makers most often are free to decide both the design and timing of a policy reform. Drawing on insights from developments in the finance literature on investment under uncertainty, here we apply the idea of option value to the analysis of government policy making.

Our main argument is that, under certain conditions, when information is revealed over time there is a value to having the option to wait, and this value should be taken into account in policy analysis. Irreversibility of the policy reform in question, uncertainty about future variables, and the existence of sunk costs are prerequisites for the ability to wait to be valuable. That is, there is no value of waiting to make a decision if a policy reform can be reversed at no cost. Nor is there value in waiting if there is no uncertainty about the future, since option value can exist only if information is to be revealed during the waiting period. A basic result of the application of the theory is that is may be worthwhile for government to postpone reforms to wait for better information.

Our main theoretical contribution the positive political economy literature comes from relaxing the assumption that the policy-making process occurs at a single point in time under perfect information. Instead, we model policy made under imperfect information over time, with better information revealed as time proceeds.

We apply option value theory to study the timing of European Union (EU) agricultural policy-making. Like most agricultural policies in the Western Hemisphere, the EU's Common Agricultural Policy (CAP) involves a high degree of government intervention. But this degree is not constant; since the early 1990s, the EU has reformed the CAP significantly.

We ask why the reforms were passed when they were passed. For long before the 1992 CAP reform a whole range of policy change proposals had been put forth, all touting the potential benefits of making changes much like those changes finally made in 1992. Our explanation of the timing of EU policy change relies on the relative irreversibility of the reforms (i.e., that once a reform was made, it was quite costly to reverse it). This irreversibility was especially noticeable after the 1992 CAP reform, which introduced direct payments as compensation for reduced price supports. Sunk costs of policy making arise in various ways. There are the pure costs of deciding on policies, i.e. the costs of legislators' salaries, the cost of their travel, and of heating the legislature's building, etc. In addition, sunk costs of agricultural policy reform arise because agricultural investments are often quite sector-specific, having only poor alternative uses once they have been made.

CAP Reforms in the 1990s

The origin of the Common Agricultural Policy of the European Union dates back to 1957 when six member states signed the Treaty of Rome establishing the European Economic Community. Ever since, agriculture has been an integral part of the common policies of the EU. The degree of EU intervention through agricultural policies evolved gradually. At the beginning commodity-specific organizations secured policies with market prices and market intervention rules being common across countries. EU market prices were significantly higher than world market prices and led to considerably increased production. By the 1980s, keeping EU prices at their target levels raised budget costs enough to lead decision makers to intervene in agricultural markets with (quasi) production-limiting instruments. Examples were milk quotas (introduced in 1984) and so-called "stabilisers" for cereals markets that automatically cut next-period prices if production in the current period exceeded pre-specified levels. In February 1991, the EU Commission released a report on the development and future of the CAP, initiating a discussion that led ultimately to the adoption of the MacSharry reforms of May 1992.

Trade negotiations within the GATT Uruguay Round led to a second and parallel strand of pressure for CAP reform. These negotiations covered three areas of agricultural policy: market access, domestic support, and export subsidies. The trade talks began in 1986, and in December 1991 a first draft Final Act was released and acknowledged by Arthur Dunkel, Director-General of GATT. Persistent differences between the EU and the US on agricultural policy reform stalled the negotiations, but significant progress was made with the Blair House Accord in November 1992, just six months after the adoption of the 1992 CAP reform. The Uruguay Round Agreement on Agriculture was then finalized in December 1993, establishing the World Trade Organisation (WTO) on January 1, 1995.

Theoretical Discussion

Our theory of policy timing relies heavily on the concepts of option value and negotiation costs. When decisions are made under uncertainty, and when better information arrives over time, then having the ability to wait before making a decision has a value, called the option value (Dixit and Pindyck 1994). For decisions to be made in the political arena, most nations have in place institutions that facilitate the meeting and bargaining of varying interest groups or their representatives. There are obvious costs to such meetings and the bargaining that takes place in them. In one sense, the whole political process of debating issues, lobbying, voters keeping themselves informed, etc., is costly. We maintain that this costliness of meeting and bargaining affects how often Parliaments meet, how often elections are held, and how often major pieces of agricultural policy legislation are passed. It is this cost which keeps governments from finely tuning policies on a day-by-day or even minute-by-minute basis. In the EU and many separate nations, typical major agricultural policy legislation is passed only once every handful of years.

A Simple Supply and Demand Model of the EU's Intervention Price

For purposes of illustration, we present a very simple model of the European Union wheat market. We assume throughout that prices in all other markets are constant, and that in the absence of government intervention in the wheat market the country is a price-taking importer of wheat. Equations (1) and (2), must hold for $\left(q_{dt}^{*}, q_{st}^{*}, p_{dt}^{*}, p_{st}^{*}\right)$ to be a market equilibrium in year t:

(1) $q_{dt}^{*} = D\left(p_{dt}^{*}\right)$,

(2) $q_{st}^{*} = S\left(p_{st}^{*}\right)$,

where the notation is standard: the asterisks denote an equilibrium value of a variable, the t index denotes year or period, the s index stands for "supply," and the d index denotes demand. We illustrate the supply and demand functions in the usual way in figure 1.

We assume that the EU government has one independent policy instrument available to it to intervene in the EU's wheat market in any year t: the intervention price policy instrument, called a_t. This instrument is the EU government's binding pledge to pay price a_t to any EU wheat producer who wants to sell a unit of wheat at that price in year t. Domestic suppliers refuse to sell to domestic consumers for less than the intervention price because they can always obtain the intervention price by forfeiting their crop to the government. Therefore when the intervention price is set above the world price, that intervention price becomes the price that domestic suppliers receive and domestic consumers pay in equilibrium:

(3) $p_{dt}^{*} = a_t$,

(4) $p_{st}^{*} = a_t$.

We let β_t represent the world price of wheat in year t. In order to maintain the intervention price as the domestic supply and demand price, the government must prevent international arbitrage, which it does by placing a per-unit export subsidy (or import tariff if negative), denoted λ_t^*, equal to $a_t - \beta_t$, on any unit of wheat import from or exported to another nation:[1]

(5) $\lambda_t^* = a_t - \beta_t$.

Equations (1) – (5) implicitly define a vector of five equilibrium functions, $\left(q_{dt}^*(a_t,\beta_t), q_{st}^*(a_t,\beta_t), p_{st}^*(a_t,\beta_t), p_{dt}^*(a_t,\beta_t), \lambda_t^*(a_t,\beta_t)\right)$, all dependent on the intervention price a_t and on the world price β_t.

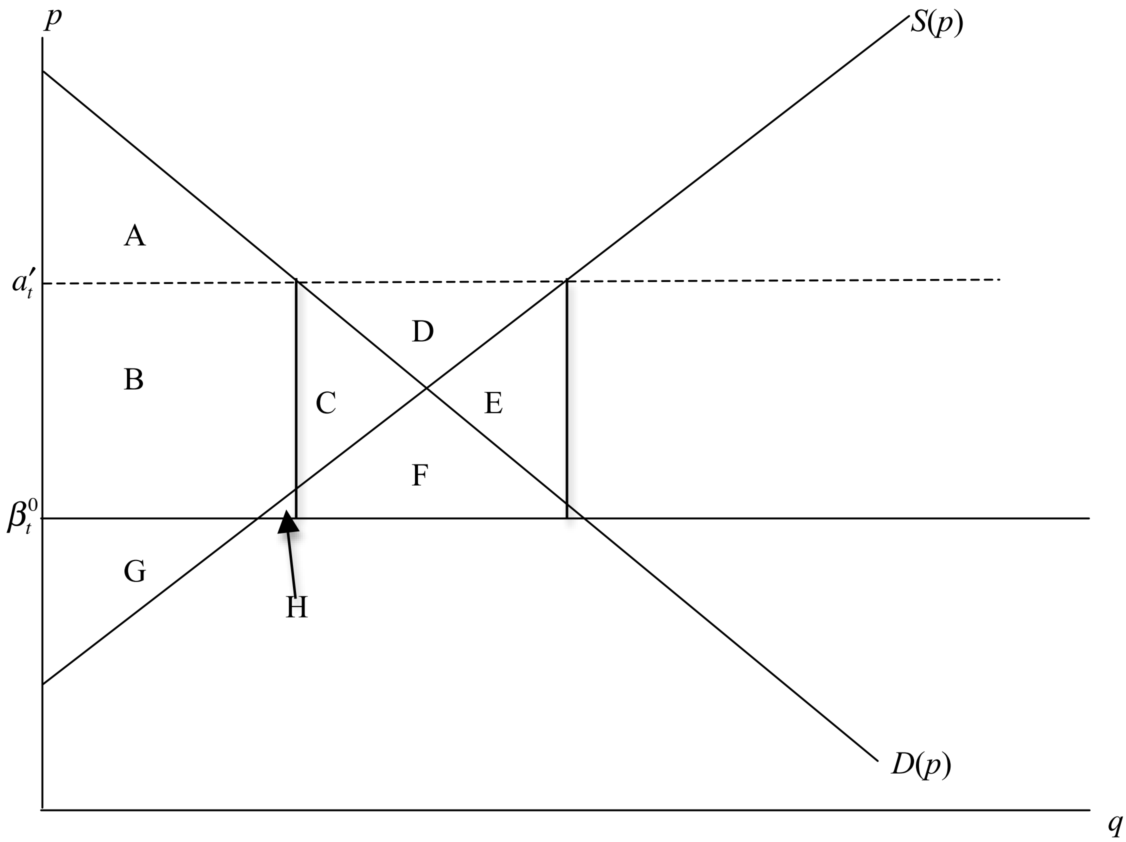

Figure 1. Equilibrium when the intervention price is set above the price and which domestic supply and demand intersect

Meeting and Negotiation Costs

We assume that policy change is costly for government. We imagine that to change a policy, government must hold some type of meeting at which various political interests conduct negotiations. Such a meeting has a fixed cost (the travel time of negotiators, etc.), denoted *f*. We assume that greater changes in policy are more costly to implement than are smaller changes. (Perhaps the debate takes longer, so the opportunity costs of the time spent at the meeting rise.) The negotiation cost function is,

(6) $$c\left(a_t, m_t, a_{t-1}\right) = m_t\left[f + \gamma\left(a_t - a_{t-1}\right)^2\right] + \left(1 - m_t\right)\xi\left(a_t - a_{t-1}\right)^2 .$$

where $m_t = 1$ when a meeting is held and $m_t = 0$ when a meeting is not held. The parameter $\gamma > 0$ determines how costs escalate with the size of the (square of the) policy change. The parameter $\xi > 0$ is assumed to be very large, and has the effect of making it prohibitively costly to change policy if no meeting is held.

Interest Group Welfare

We assume two mutually exclusive interest groups. The group indexed by *c* is made up of EU consumers and taxpayers. The group indexed by *s* is comprised of EU wheat suppliers. We assume that negotiation costs are paid by the interest groups according to their shares of the population, δ_c and δ_s. To measure the supplier group's welfare in year*t*, we use an exogenous level of welfare u_s^0, plus "producer surplus," minus payments to cover the suppliers' share of government's negotiation costs:

$$(7) \qquad u_s\left(a_t, m_t, a_{t-1}\right) = u_s^0 + \int_0^{a_t} S(z)\,dz - \delta_s c\left(a_t, m_t, a_{t-1}\right).$$

There are two periods in our model. Total producer welfare is the discounted sum of the first and second years' producer welfare levels:

$$(8) \qquad U_s(\mathbf{x}) = \sum_{t=1}^{2} \rho^{t-1} u_s\left(a_t, m_t, a_{t-1}\right),$$

where $\mathbf{x} = (a_1, x_1, a_2, m_2)$ is the vector of the government's choice variables, and $\rho \in (0, 1)$ is a discount factor.

We measure consumer-taxpayer welfare as an exogenous level u_1^0 plus consumer surplus, minus the taxes necessary to finance the export subsidy (or, if domestic demand exceeds supply at the intervention price, these are tariff revenues added, not subtracted), minus payments to cover the consumer-taxpayers' share of government's negotiation costs:

(9) $$u_c(a_t,m_t,a_{t-1},\beta_t)=u_c^0+\int_{a_t}^{\infty}D(z)dz-(a_t-\beta_t)\left[S(a_t)-D(a_t)\right]-\delta_c c(a_t,m_t,a_{t-1}).$$

Total consumer-taxpayer welfare is the discounted sum of their first and second-year welfare:

(10) $$U_c(\mathbf{x},\omega)=\sum_{t=1}^{2}\rho^{t-1}u_c(a_t,m_t,a_0,\beta_t),$$

where ω = (β_1, β_2) represents the ordered pair of the world prices.

The parts of the welfare measures $u_c(a_t,m_t,a_{t-1},\beta_t)$ and $u_s(a_t,m_t,a_{t-1})$ not involving negotiation costs are illustrated in figure 1, assuming a particular policy a_t' and a particular world price β_t^0. Without payments for negotiation costs, the welfare level of wheat producers in year t is some number u_s^0 plus the sum of areas B, C, D, and G. The welfare level of consumers-taxpayers is some number u_c^0 plus area A, minus the sum of areas C, D, E, and F.

Government's Ex Post *Payoff Function*

We will employ a very simple model of political economy, in which government's objective function, denoted ψ, is a weighted average of the interest groups' welfare:

(11) $$\begin{aligned}\psi(\mathbf{x},\omega)&\equiv\alpha_c U_s(\mathbf{x})+\alpha_s U_s(\mathbf{x},\omega)=\sum_{t=1}^{2}\rho^{t-1}\left[\alpha_c u_c(a_t,m_t,a_{t-1},\beta_t)+\alpha_s u_s(a_t,m_t,a_{t-1})\right]\\&=\underbrace{\left[\alpha_c u_c(a_1,m_1,a_0,\beta_1)+\alpha_s u_s(a_1,m_1,a_0)\right]}_{\zeta_1(x_1,\beta_1)}+\rho\underbrace{\left[\alpha_c u_c(a_2,m_2,a_1,\beta_2)+\alpha_s u_s(a_2,m_2,a_1)\right]}_{\zeta_2(x_1,x_2,\beta_2)}.\end{aligned}$$

As shown in (11), $\zeta_1(x_1, \beta_1)$ is the utility derived by government in year 1 when it makes decision $x_1 = (a_1, m_1)$, given the world price β_1, and $\zeta_2(x_1, x_2, \beta_2)$ is the utility derived by government in year 2 when it makes decision $x_2 = (a_2, m_2)$, given the world price β_2, and given its past decision $x_1 = (a_1, m_1)$.

Policy Timing

To focus on some essential aspects of information and policy timing, our model political economy operates for two years.[2] We illustrate our policy-timing story in figure 2. At the start of period 1 ("May 1") everyone is assumed to know that level of the previous year's world price. With this information, politicians meet and negotiate in period 1, when they must set period 1's intervention price level. They may also decide to set period 2's intervention price at this time, thus eliminating negotiations in period 2. Or, they may decide to put off setting period 2's intervention price until they meet again in period 2. If they decide to set both years' policy levels in year 1, then they do so only with information about the level that the world price random variable took on in the previous year (on "October 1"). If, however, they delay setting year 2's policy, then when year 2 comes around they have more information, having observed the value that the world price took on in period 1 after their meeting in that period. Having knowledge of the level of the preceding year's world price provides useful information because the world price follows a random walk.

The Random Walk of the World Price

As illustrated in figure 3, we bring uncertainty into the model by assuming that the world price follows a random walk, and is known to have taken on the value β^0 in the year preceding year 1. The world price in year 1 can take on two values: a value β^D lower than β^0, or a value β^U higher than β^0. Relative to year 1's world price, the world price in year 2 can either change by some positive amount ΔH or by some negative amount ΔL. Therefore in period 2 one of four possible world prices occurs: $\beta^D + \Delta L$, $\beta^D + \Delta H$, $\beta^U + \Delta L$, or $\beta^U + \Delta H$. We define a generic *state of nature* as $\omega = (\beta_1, \beta_2)$, an ordered pair of the first and second periods' world prices. There are therefore four possible states of nature in our model: the world price can fall in both years, leading to the state of nature $\omega^{DL} = (\beta^D, \beta^D + \Delta L)$, it can fall then rise, leading to $\omega^{DH} = (\beta^D, \beta^D + \Delta H)$, it can rise then fall, leading to $\omega^{UL} = (\beta^U, \beta^U + \Delta L)$, or it can rise in both years, leading to $\omega^{UH} = (\beta^U, \beta^U + \Delta H)$. The *set of states of nature* is $\Omega = \{\omega^{DL}, \omega^{DH}, \omega^{HL}, \omega^{UH}\}$.[3] We assume that the price goes down in year one with probability π^D, goes up in year 1 with probability $\pi^U = 1 - \pi^D$, becomes lower in year 2 with probability π^L, and becomes higher in year 2 with probability $\pi^H = 1 - \pi^L$. Assuming that price movements (*not* the price levels, which follow a random walk) in each year are independent, then the four states of nature occur with probabilities $\pi^{DL} = \pi^D\pi^L$, $\pi^{DH} = \pi^D\pi^H$, $\pi^{UL} = \pi^U\pi^L$, and $\pi^{UH} = \pi^U\pi^H$. We will find it convenient at times also to use the notation $\pi^{ij} = \pi(\omega^{ij})$ for $i = D, U$ and $j = L, H$.

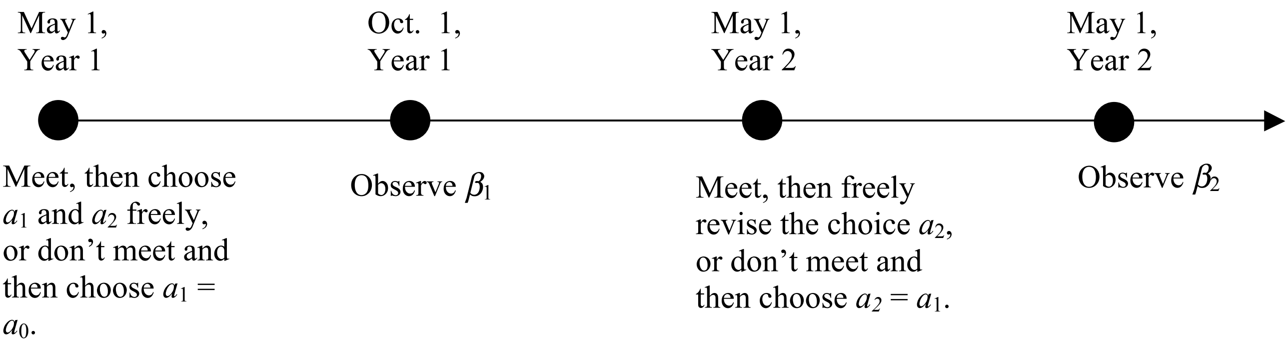

Figure 2. Scenarios of policy timing

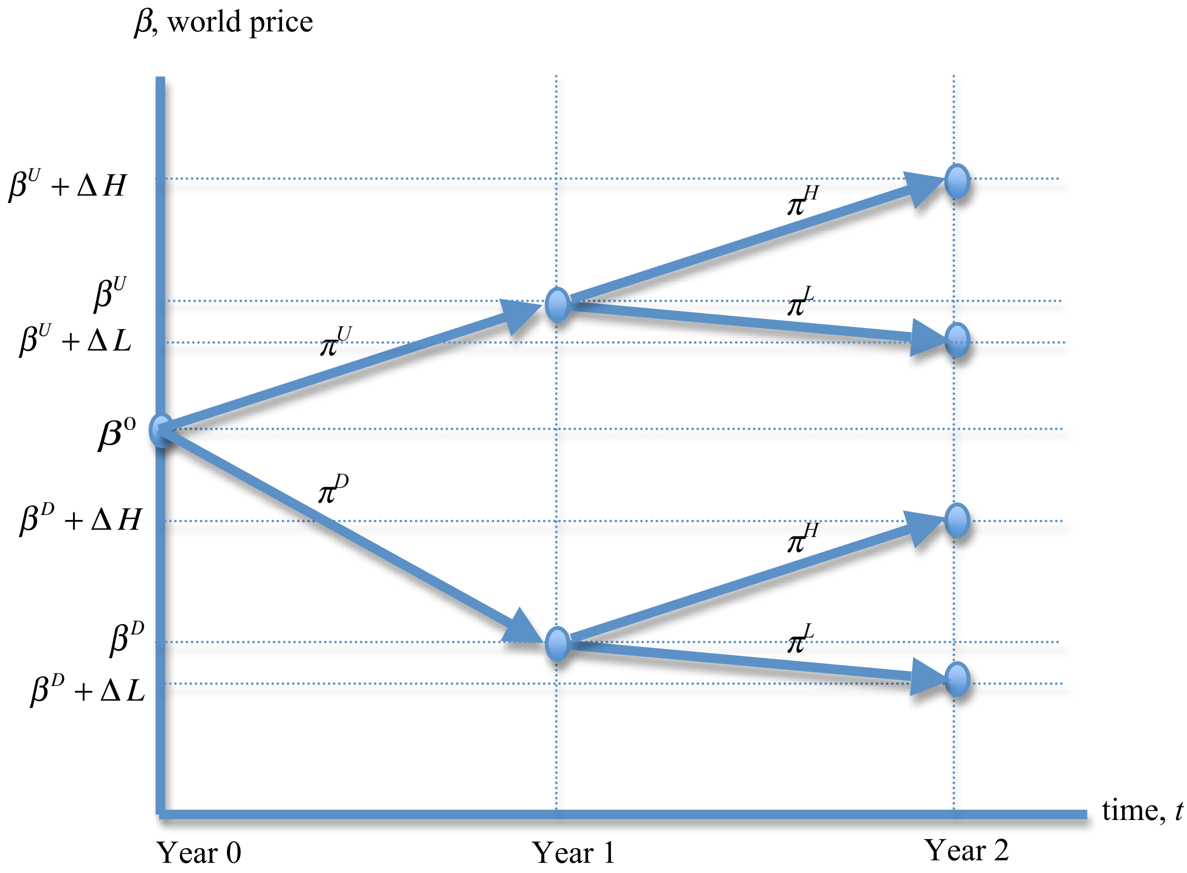

Figure 3. Random walk of world price

Information Structures

The value of information plays a crucial part in our theory of policy timing. In this section we follow Laffont (1990) to define formally what we mean by the "value of information."

Definition of an Information Structure without Noise

We have already defined the set of states of nature as $\Omega = \{\omega^{DL}, \omega^{DH}, \omega^{HL}, \omega^{UH}\}$. We use θ to denote the sigma algebra of Ω, which because Ω has a finite number of elements is the set of subsets of Ω (Laffont 1990, p. 6). The *space of states of nature* is the set containing all the (proper and improper) subsets of Ω excluding the empty set:[4]

$$
(12)\quad (\Omega,\theta) = \left\{ \begin{array}{l}
\overbrace{\{\omega^{DL}\}}^{s_1}, \overbrace{\{\omega^{DH}\}}^{s_2}, \overbrace{\{\omega^{UL}\}}^{s_3}, \overbrace{\{\omega^{UH}\}}^{s_4}, \\
\overbrace{\{\omega^{DL},\omega^{DH}\}}^{s_5}, \overbrace{\{\omega^{DL},\omega^{UL}\}}^{s_6}, \overbrace{\{\omega^{DL},\omega^{UH}\}}^{s_7}, \overbrace{\{\omega^{DH},\omega^{UL}\}}^{s_8}, \overbrace{\{\omega^{DH},\omega^{UH}\}}^{s_9}, \overbrace{\{\omega^{UL},\omega^{UH}\}}^{s_{11}}, \\
\overbrace{\{\omega^{DL},\omega^{DH},\omega^{UL}\}}^{s_{11}}, \overbrace{\{\omega^{DL},\omega^{DH},\omega^{UH}\}}^{s_{12}}, \overbrace{\{\omega^{DL},\omega^{UL},\omega^{UH}\}}^{s_{13}}, \overbrace{\{\omega^{DH},\omega^{DL},\omega^{UH}\}}^{s_{14}}, \\
\overbrace{\{\omega^{DL},\omega^{DH},\omega^{UL},\omega^{UH}\}}^{s_{15}=\Omega}
\end{array} \right\}.
$$

The number of ways that a set with n elements can be partitioned is called the n^{th} Bell number (Wolfram Math World 2009). The fourth Bell number is 15, and this is the number of partitions of the set of states of nature in our example.[5] These partitions are displayed in table 1.

Table 1. Partitions of the set of states of nature, Ω

$P^1=\{\{\omega^{DL},\omega^{DH},\omega^{UL},\omega^{UH}\}\}$	$P^5=\{\{\omega^{UH}\},\{\omega^{DL},\omega^{DH},\omega^{UL}\}\}$	$P^9=\{\{\omega^{DL},\omega^{DH}\},\{\omega^{UL}\},\{\omega^{UH}\}\}$	$P^{13}=\{\{\omega^{DH},\omega^{UH}\},\{\omega^{DL}\},\{\omega^{UL}\}\}$
$P^2=\{\{\omega^{DL}\},\{\omega^{DH},\omega^{UL},\omega^{UH}\}\}$	$P^6=\{\{\omega^{DL},\omega^{DH}\},\{\omega^{UL},\omega^{UH}\}\}$	$P^{10}=\{\{\omega^{DL},\omega^{UL}\},\{\omega^{DH}\},\{\omega^{UH}\}\}$	$P^{14}=\{\{\omega^{UL},\omega^{UH}\},\{\omega^{DL}\},\{\omega^{DH}\}\}$
$P^3=\{\{\omega^{DH}\},\{\omega^{DL},\omega^{UL},\omega^{UH}\}\}$	$P^7=\{\{\omega^{DL},\omega^{UL}\},\{\omega^{DH},\omega^{UH}\}\}$	$P^{11}=\{\{\omega^{DL},\omega^{UH}\},\{\omega^{DH}\},\{\omega^{UL}\}\}$	$P^{15}=\{\{\omega^{DL}\},\{\omega^{DH}\},\{\omega^{UL}\},\{\omega^{UH}\}\}$
$P^4=\{\{\omega^{UL}\},\{\omega^{DL},\omega^{DH},\omega^{UH}\}\}$	$P^8=\{\{\omega^{DL},\omega^{UH}\},\{\omega^{DH},\omega^{UL}\}\}$	$P^{12}=\{\{\omega^{DH},\omega^{UL}\},\{\omega^{DL}\},\{\omega^{UH}\}\}$	

Each of the partitions of Ω is associated with a separate *information structure without noise*. For example, if the government has information structure I^{13}, which is the information structure without noise associated with the partition $P^{13} = \{\{\omega^{DH},\omega^{UH}\},\{\omega^{DL}\},\{\omega^{UL}\}\}$, it is as if there is an "expert" who knows the true state of nature, and makes the following offer to the government: "If you pay me some money, if the true state of nature is ω^{DL}, I will tell you. If it is ω^{UL}, I will tell you. And if it is in the set $\{\omega^{DH}, \omega^{UH}\}$ I will tell you that it is in that set, but I will not tell which element of that set it is."

More formally, let $I^1, \ldots, I^{15}$ denote the information structures without noise in our example. For $j = 1, \ldots, 15$, I^j consists of a space of signals Y^j and a function ϕ^j from the space of states of nature (Ω, θ) to Y^j. The function ϕ^j defines a partition of Ω. For example, consider $P^5 = \{\{\omega^{UH}\},\{\omega^{DL},\omega^{DH},\omega^{UL}\}\}$. Let us define a function ϕ^5:

$$(13)\qquad \phi^5(S) = \begin{cases} y_1^5 \text{ if } S = \{\omega^{UH}\} \\ y_2^5 \text{ if } S = \{\omega^{DL},\omega^{DH},\omega^{UL}\} \\ \text{undefined for all other } S \in (\Omega,\theta) \end{cases}.$$

Then $P^5 = \{S \in (\Omega, \theta)\text{: } \phi^5(S) \text{ is defined}\}$, or equivalently, letting $Y^5 = \{y_1^5, y_2^5\}$ and $O^5(y)$ be the inverse of function ϕ^5, we can write $P^5 = \{O^5(y) : y \in Y^5\}$. The other fourteen functions ϕ^j and spaces Y^j are defined similarly and then used to define the other fourteen partitions as $P^j =$

{$S \in (\Omega, \theta)$: $\phi^j(S)$ is defined} = $\{O^j(y) : y \in Y^j\}$. The fifteen information structures without noise are then $I^j = (Y^j, \phi^j)$, $j = 1, \ldots 15$.[6]

The Value of an Information Structure

We assume that the government maximizes expected utility given the information structure it faces. When facing P^j, the government believes that it will receive signal y with probability,

$$\text{(14)} \quad \Pr\left(y \middle| P^j\right) = \begin{cases} 0 \text{ if } \omega \notin O^j(y) \\ \int\limits_{O^j(y)} \pi(\omega)\, d\omega \text{ otherwise} \end{cases} .$$

Using Bayes's theorem, it believes that if it receives signal y then the probability of the true state being ω is[7]

$$\text{(15)} \quad v(\omega|y) = \begin{cases} 0 \text{ if } \omega \notin O^j(y) \\ \dfrac{\pi(\omega)}{\int\limits_{O^j(y)} \pi(z)\, dz} \text{ otherwise} \end{cases} .$$

The government knows that after receiving a signal y it will maximize expected utility, solving

$$\text{(16)} \quad \underset{\substack{(a_1, m_1) \in X_1 \\ (a_2, m_2) \in X_2}}{Max} \left\{ \int\limits_{\Omega} \psi(\mathbf{x}, \omega) v(\omega|y)\, d\omega \right\},$$

where X_t is the set of feasible decisions (a_t, m_t) in period $t = 1, 2$. Let the solution to this problem be denoted $\mathbf{x}^*(y) = \left(a_1^*(y), m_1^*(y), a_2^*(y), m_2^*(y)\right)$. Then the value (the expected utility) of receiving signal y is $V(y)$:

$$\text{(17)} \quad V(y) = \int\limits_{\Omega} \psi\left(\mathbf{x}^*(y), \omega\right) v(\omega|y)\, d\omega .$$

Equations (14) – (17) imply that the government can make an *ex ante* evaluation of the expected utility from facing partition P^j as,

$$
\begin{aligned}
W\left(P^j;\pi(.),\psi(.)\right) &= \int_{Y^j} V(y)\cdot \Pr\left(y|P^j\right)dy \\
&= \int_{Y^j}\int_{\Omega}\psi\left(\mathbf{x}^*(y),\omega\right)\cdot v\left(\omega|y\right)\cdot \Pr\left(y|P^j\right)d\omega\, dy \\
&= \int_{Y^j}\int_{O^j(y)}\psi\left(\mathbf{x}^*(y),\omega\right)\cdot v\left(\omega|y\right)\cdot \Pr\left(y|P^j\right)d\omega\, dy \qquad (18)\\
&= \int_{Y^j}\int_{O^j(y)}\psi\left(\mathbf{x}^*(y),\omega\right)\cdot\left[\frac{\pi(\omega)}{\int_{O^j(y)}\pi(z)dz}\cdot\int_{O^j(y)}\pi(z)dz\right]d\omega\, dy \\
&= \int_{Y^j}\int_{O^j(y)}\psi\left(\mathbf{x}^*(y),\omega\right)\cdot\pi(\omega)d\omega\, dy.
\end{aligned}
$$

If there are a finite number of states of nature, then equation (18) reduces to

$$(19)\qquad W\left(P^j;\pi(.),\psi(.)\right)=\sum_{y\in Y^j}\sum_{\omega\in O^j(y)}\psi\left(\mathbf{x}^*(y),\omega\right)\pi(\omega),$$

For example, the government's *ex ante* expected utility when facing information structure I^5 is

$$
\begin{aligned}
W\left(P^5;\pi(.),\psi(.)\right) &= \sum_{y\in Y^5}\sum_{\omega\in O^5(y)}\psi\left(\mathbf{x}^*(y),\omega\right)\pi(\omega) \\
&= \psi\left(\mathbf{x}^*\left(y_1^5\right),\omega^{UH}\right)\pi\left(\omega^{UH}\right)+ \qquad (20)\\
&\quad \psi\left(\mathbf{x}^*\left(y_2^5\right),\omega^{DL}\right)\pi\left(\omega^{DL}\right)+\psi\left(\mathbf{x}^*\left(y_2^5\right),\omega^{DH}\right)\pi\left(\omega^{DH}\right)+\psi\left(\mathbf{x}^*\left(y_2^5\right),\omega^{UL}\right)\pi\left(\omega^{UL}\right).
\end{aligned}
$$

The Fineness of Information Structures

We say that an information structure I^m is *finer* than an information structure I^n if the partition P^m associated with I^m is finer than the partition P^n associated with I^n.[8] Laffont (1990, p. 59) proves that given any prior distribution $\pi(.)$ and any utility function $\psi(.)$, that the expected value of facing the finer information structure I^n is at least as great as the expected value of facing I^m:

$$(21)\qquad W\left(P^n;\pi(.),\psi(.)\right)\geq W\left(P^m;\pi(.),\psi(.)\right).$$

Applying the Information Structure Framework to Our Model

To more easily compare the expected utility of the government who must choose $x_1 = (a_1, m_1)$, and $x_2 = (a_2, m_2)$ in period 1 to the government who chooses x_1 and period 1 and x_2 in period 2, consider a third government who also must choose x_1 in period 1 and x_2 in period 2, but has no memory. This government's choices and ex ante expected utility will be the same as the government who must choose both x_1 and x_2 in period 1. This third government would face partition P^1 in the first period, and it would make a binding choice for x_1 and a "provisional" decision for x_2, where these solve,

$$\text{(22)} \qquad \underset{\substack{x_1 \in X_1 \\ x_2 \in X_2}}{Max} \sum_{\omega \in O^1(y)} \left[\zeta_1(x_1, \omega) + \rho \zeta_2(x_1, x_2, \omega)\right] \pi(\omega).$$

Letting the solution to this problem be called $\left(x_1^{**}, \hat{x}_2\right)$, only the decision x_1^{**} would actually "count," since the third government could choose a different value for x_2 in the second period. Once arrived at period 2, since this government has no memory of its previous choices or the world price that was revealed in period 1, again it faces partition P^1 (that is, all it knows is that the true state of nature is in $\{\omega^{DL}, \omega^{DH}, \omega^{UL}, \omega^{UH}\}$). Therefore in the second period it again solves the problem in (22). Call the decisions it makes in the second period $\left(\hat{x}_1, x_2^{**}\right)$, where the choice $\hat{x}_1$ is the choice the government would make if it could actually choose x_1 again, and x_2^{**} is the actual decision that "counts." Note that the government that has to make both decisions in period 1 also faces partition P^1, and also solves (22). Call this government's choices $\left(x_1^*, x_2^*\right)$. Because $\left(x_1^*, x_2^*\right)$, $\left(x_1^{**}, \hat{x}_2\right)$, and $\left(\hat{x}_1, x_2^{**}\right)$ all solve (22), then assuming that the solution to (22) is unique, it must be that $\left(x_1^*, x_2^*\right) = \left(\hat{x}_1, x_2^{**}\right) = \left(x_1^{**}, \hat{x}_2\right)$. Clearly also, $\left(x_1^*, x_2^*\right) = \left(x_1^{**}, x_2^{**}\right)$. The utility expected by the government who must make both decisions in period 1 is

(23) $$W^* = \sum_{\omega \in O^1(y)} \left[\zeta_1\left(x_1^*,\omega\right) + \rho\zeta_2\left(x_1^*,x_2^*,\omega\right) \right] \pi(\omega).$$

We can break this welfare amount up into the amount experienced in period 1 and the absolute value of the amount experienced in period 2:

(24) $$W_1^* = \sum_{\omega \in O^1(y)} \zeta_1\left(x_1^*,\omega\right)\pi(\omega);$$

(25) $$W_2^* = \sum_{\omega \in O^1(y)} \rho\zeta_2\left(x_1^*,x_2^*,\omega\right)\pi(\omega).$$

The utility expected to be derived in period 1 by the government who chooses x_1 in period 1 and x_2 in period 2 but has no memory, and therefore chooses x_1 facing partition P^1 and then chooses x_2 also facing partition P^1 is

(26) $$W_1^{**} = \sum_{\omega \in O^1(y)} \zeta_1\left(x_1^{**},\omega\right)\pi(\omega).$$

The present value of the expected utility derived in the second period by the government without memory is

(27) $$W_2^{**} = \sum_{\omega \in O^1(y)} \rho\zeta_2\left(x_1^{**},x_2^{**},\omega\right)\pi(\omega).$$

Summing, the expected value of the utility of the government without memory is,

(28) $$\begin{aligned} W^{**} = W_1^{**} + W_2^{**} &= \sum_{\omega \in O^1(y)} \zeta_1\left(x_1^{**},\omega\right)\pi(\omega) + \sum_{\omega \in O^1(y)} \rho\zeta_2\left(x_1^{**},x_2^{**},\omega\right)\pi(\omega) \\ &= \sum_{\omega \in O^1(y)} \left[\zeta_1\left(x_1^{**},\omega\right) + \rho\zeta_2\left(x_1^{**},x_2^{**},\omega\right) \right]\pi(\omega). \end{aligned}$$

Comparing (23) and (28), since $\left(x_1^*,x_2^*\right) = \left(x_1^{**},x_2^{**}\right)$, it must be that $W^* = W^{**}$. That is, the expected utility of a government who must make both of its choices in period 1 is equal to the expected utility of a government who must choose x_1 in period 1 and then choose x_2 in period 2 with no memory—that is, of the government who faces P^1 when choosing x_1 and P^1 again when choosing x_2.

In contrast, if the government decides on x_1 in period 1 and then on x_2 in period 2 with full knowledge of the value of β_1 that appeared in the first period, then it bases its decision on x_1 on partition P^1. Call its choice x_1^{***}. Since it made this choice while facing the same partition, P^1, as did the other two governments, its first-year choices will be the same as theirs, so $x_1^{***} = x_1^{**} = x_1^{*}$. Therefore its expected utility derived in the first period will be

$$(29) \quad W_1^{***} = \sum_{\omega \in O^1(y)} \zeta_1\left(x_1^{***}, \omega\right)\pi(\omega).$$

Since $x_1^{***} = x_1^{**} = x_1^{*}$, then (24), (26), and (29) imply that the amount of utility derived in the first period is the same for all three governments: that $W_1^{*} = W_1^{**} = W_1^{***}$.

Now say that before period 1 a government was trying to calculate how much it is worth, *ex ante*, to have the right to decide on x_2 in period 2. (That is, it is trying to calculate how much it would be willing to pay, before the world price in period 1 is revealed, to have the right to decide on x_2 after the world price in period 1 is revealed.) With the right, the *ex ante* value of the government's upcoming utility gained in period 1 is W_1^{***} show in (29), and the *ex ante* value of its gains in the second period is

$$(30) \quad W_2^{***} = \underset{x_2 \in X_2}{Max} \sum_{\omega \in O^6(y)} \left[\zeta_2\left(x_1^{***}, x_2, \omega\right)\right]\pi(\omega).$$

Since $x_1^{***} = x_1^{*}$, then we can write

$$(31) \quad W_2^{***} = \underset{x_2 \in X_2}{Max} \sum_{\omega \in O^6(y)} \left[\zeta_2\left(x_1^{*}, x_2, \omega\right)\right]\pi(\omega).$$

But the government that makes its choices in separate periods expects to obtain to W_2^{**} of equation (27) in period 2. Finally, since $x_1^{*} = x_1^{**}$, we can substitute x_1^{*} for x_1^{**} in equation (27) and conclude,

$$(32) \quad W_2^{**} = \sum_{\omega \in O^6(y)} \rho\zeta_2\left(x_1^{*}, x_2^{**}, \omega\right)\pi(\omega).$$

Comparing (31) and (32), we can conclude,

(33) $W_2^{***} \geq W_2^{**}$.

Finally, since we have already shown that $W_1^{*} = W_1^{**} = W_1^{***}$, we can conclude from (33) that

(34) $W_1^{***} + W_2^{***} \geq W_1^{**} + W_2^{**}$.

Equation (34) mean that the welfare expected by the government when it can wait to choose x_2 until after the value of the first period's random world has been revealed is at least as great as the welfare expected when it must make all its decisions before period 1 begins.[9] The difference in these two welfare levels is the value of having the option to wait until after the world price is revealed to make the x_2 decision is called an *option value*:

(35) $OV = \left(W_1^{***} + W_2^{***}\right) - \left(W_1^{**} + W_2^{**}\right) \geq 0.$

The Trade-off between Obtaining Good Information and Setting Policies as Immediate Circumstances Dictate

The concepts of option value and negotiation costs are key to our theory of policy timing. If changing policies were not costly and information were complete, then it would make sense for governments to change policies very frequently as it views changes in the economic and/or political climate. But real governments face a trade-off. If they meet and change a policy today, then it will be costly to meet again and change that policy some time in the future. But since more information is available over time, it might make sense for a government to wait before holding a meeting to change policy. Two questions arise: How often should a government hold meetings?; and what policy changes should it make at such meetings?

A Simulation Conducted with Our Model of Political Economy

Data and Parameters

The baseline data for our model are shown in table 1.

Table 1. Basiline data and elasticities

Intervention price of wheat, 1991, in year-2000 euros per ton	169.68	Source: FAOSTAT. Food and Agriculture Organization of the United Nations. http://faostat.fao.org.
Production, 1990/1991, million metric tons of wheat and course grains	89.1	Source: www.fas.usda.gov/grain/circular/2000/00-07/hist_tbl.pdf
Dometic total use, 1990/1991, million metric tons	65.1	Source: www.fas.usda.gov/grain/circular/2000/00-07/hist_tbl.pdf
Own-price elasticity of supply of wheat	0.50	Sullivan, et al. (1989)
Own-price elasticity of supply of wheat	-0.27	Sullivan, et al. (1989)

set the parameters of the model at the following levels:

a_0 = 169.68 (year 2000 Euros per ton,), c_0 = 82.677 (million tons); c_1—0.103589 (million tons per euro); b_0 = 44.55 (million tons); b_1 = 0.262553 (million tons per euro); δ_c = 0.90; δ_s = 0.10; ξ = 100,000000 (million Euros per euro of change in the intervention price); u_c^0 = 10,000,000 (million Euros); u_s^0 = 10,000,000; γ= 10; ρ = 0.95, α_c = 0.25; a_s = 0.75, π^D = 0.4, π^U = 0.6, π^L = 0.7, = 0.7, π^H = 0.3, and we let the parameter representing the fixed costs of holding a negotiation, *f*, vary. We let the initial value of the world price be b0 = 100. First-period values are β_1^D = 90 and β_1^U = 106. From the first period to the second period, the world price can change by ΔL = -5 or by ΔH = 13. The supply and demand parameters reflect the SWOPSIM elasticities (Sullivan, et al. 1989) of 0.5 and -0.27. For the purposes of the simulation, other parameter values were chosen largely arbitrarily.

Political Power Weights

We obtain estimates of our model's "political power weights," ac and as by assuming that (x1, x2, m1, m2) = (169.68, 169.68, 1, 1) was the solution to the maximization problem implied by (11) and (23), for year 1 being 1990 and year 2 being 1991. (That is, we are assuming that the actual intervention price set by the EU in 1991 was set in both years, and that negotiations were held in both years, and that the result was to maximize the government's objective function in (11).[10]) Combining (11) and (23), the government's problem of maximizaing its expected utility, $E\psi(a_1, a_2, m_1, m_2)$ can be written as,

(36)

$$\underset{\substack{a_1 \geq 0 \\ a_2 \geq 0 \\ m_1 \in \{0,1\} \\ m_2 \in \{0,1\}}}{Max} \sum_{i \in \{D,U\}} \sum_{j \in \{L,H\}} \pi^{ij} \Big(\alpha_c \left[u_c\left(a_1, m_1, a_0, \beta_1^i\right) + \rho u_c\left(a_2, m_2, a_1, \beta_2^{ij}\right) \right] + \alpha_s \left[u_s\left(a_1, m_1, a_0\right) + \rho u_s\left(a_2, m_2, a_1\right) \right] \Big).$$

Using the parameter values discussed above, we substituted the observed values a_1^{ob} = 169.68, a_2^{ob} = 169.68, m_1^{ob} = 1, and m_1^{ob} = 1 into the first-order conditions of (36) to obtain,

$$
(37)\quad
\begin{aligned}
\frac{\partial E\psi\left(a_1,a_2,m_1,m_2\right)}{\partial a_1} &\equiv \alpha_c \sum_{i\in\{D,U\}}\sum_{j\in\{L,H\}} \pi^{ij}\left[\frac{\partial u_c\left(a_1^{ob},m_1^{ob},a_0,\beta_1^i\right)}{\partial a_1}+\rho\frac{\partial u_c\left(a_2^{ob},m_2^{ob},a_1^{ob},\beta_2^{ij}\right)}{\partial a_1}\right] \\
&\quad + \alpha_s \sum_{i\in\{D,U\}}\sum_{j\in\{L,H\}} \pi^{ij}\left[\frac{\partial u_s\left(a_1^{ob},m_1^{ob},a_0\right)}{\partial a_1}+\rho\frac{u_s\left(a_2^{ob},m_2^{ob},a_1^{ob}\right)}{\partial a_1}\right]\equiv 0 \\
\frac{\partial E\psi\left(a_1,a_2,m_1,m_2\right)}{\partial a_2} &\equiv \alpha_c \sum_{i\in\{D,U\}}\sum_{j\in\{L,H\}} \pi^{ij}\left[\frac{\partial u_c\left(a_1^{ob},m_1^{ob},a_0,\beta_1^i\right)}{\partial a_2}+\rho\frac{\partial u_c\left(a_2^{ob},m_2^{ob},a_1^{ob},\beta_2^{ij}\right)}{\partial a_2}\right] \\
&\quad + \alpha_s \sum_{i\in\{D,U\}}\sum_{j\in\{L,H\}} \pi^{ij}\left[\rho\frac{u_s\left(a_2^{ob},m_2^{ob},a_1^{ob}\right)}{\partial a_2}\right]\equiv 0.
\end{aligned}
$$

The equations in (37), together with $a_c + a_S = 1$, form an over-derermined system of three equations with two unknowns which has no solution. This difficulty is typical, and is usually overcome in PPF studies by assuming a model of political economy in which the number of interest groups is exactly one more than the number of policy instruments (Bullock 1994). For the purposes of the simulation, we ignore this difficulty, and instead solve the first equation in (37) along with $a_c + a_S = 1$ to obtain $a_c = 0.340574$ and $a_s = 0.659426$. Then we solve the second equatio in (37) along with $a_c + a_S = 1$ to obtain $a_c = 0.340169$ and $a_s = 0.659831$. Because theses results are very similar, we simply take their means to obtain $a_c = 0.340371$ and $a_s = 0.659629$ for use in the rest of the simulation.

The Effects of Higher Fixed Costs of Negotiation on the Frequency of Meetings

The effects of higher fixed costs of negotiation on the frequency of meetings and on each period's intervention price are summarized in Table 3, and also in figure 4.

Table 3. Relationship between the fixed costs of negotiation the frequency of negotiations, and the intervention prices set in each period

f fixed costs of negotitation	Meet in first period?	Meet in second period?	a_1, intervention price in first period	a_2, intervention price in second period	Option value of being able to wait before making the policy
$f < 23.3$	Yes	Yes	166.712	165.233	
$23.3 < f < 106.1$	Yes	No	166.625	166.625	
$106.1 < f$	No	No	169.68	169.68	

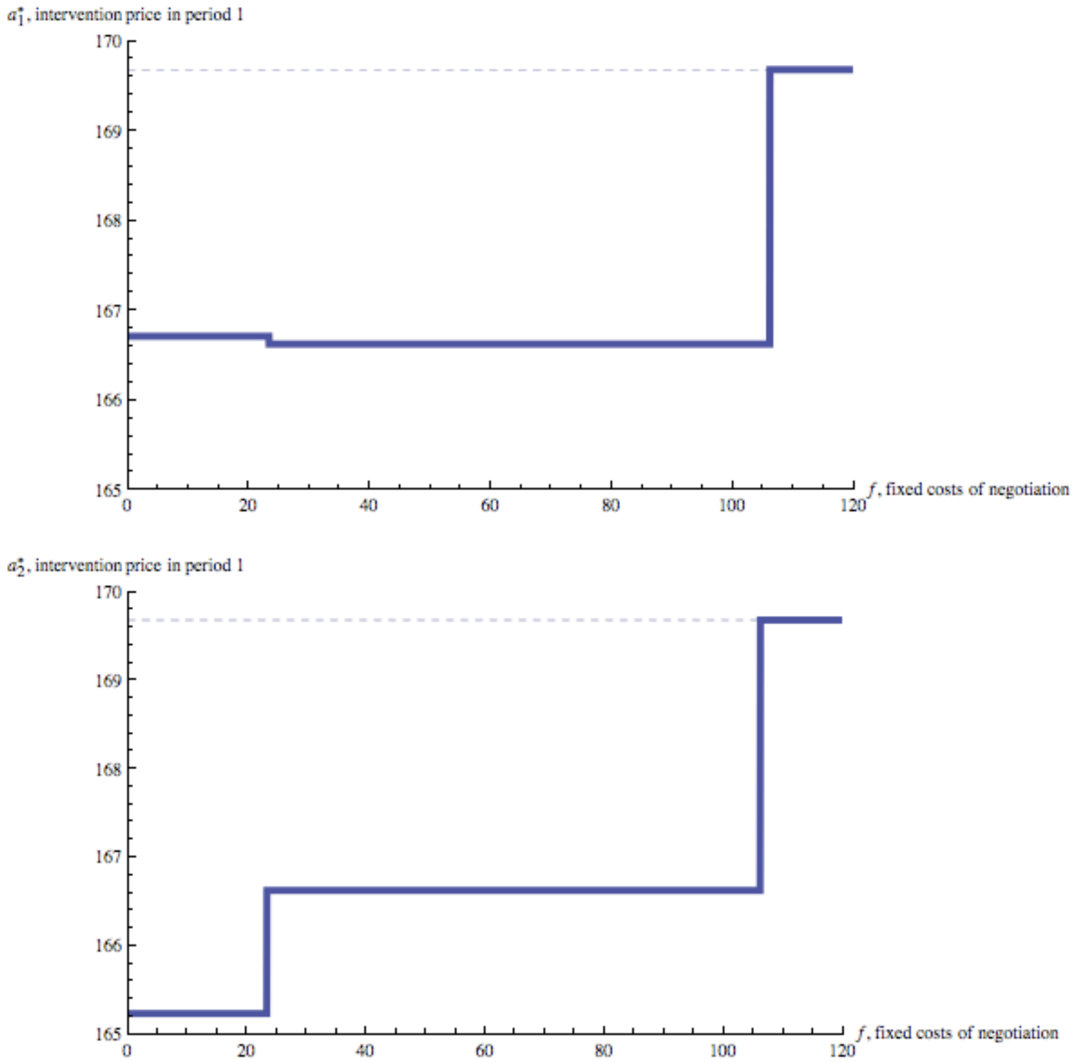

Figure 2. The intervention price in political-economic equilibrium, as a function of the fixed costs of negotiation

Acknowledgements

This research has been financed by a grant from the Research Council of Norway. The authors would like to thank two anonymous referees and the editor for valuable comments on earlier drafts. All remaining errors are the sole responsibility of the authors.

References

Anania, G. 2007. Multilateral Negotiations, Regional Integration Processes and the CAP. What's ahead? Invited paper, 51st Annual Conference of the Australian Agricultural and Resource Economics Society (AARES), Queenstown, New Zealand.

Baffes, J. and Meerman, J. 1997. From Prices to Incomes. Agricultural Subsidization Without Protection? Policy Research Working Paper 1776. The World Bank.

Baffes, J. 2004. Experience with Decoupling Agricultural Support. ???

Buckwell, A., and Tangermann, S. 1999. Agricultural Policy Issues of European Integration: The Future of Direct Payments in the Context of Eastern Enlargement and the WTO. MOCT-MOST 9: 229-254.

Bullock, David S. "In Search of Rational Government: What Political Preference Function Studies Measure and Assume." *American Journal of Agricultural Economics* 76(1994): 347-361.

Cavallo, A., Correani, L., Iagatti, M. and Sorrentino, A. 2007. EU Agricultural Policy Bargaining and Domestic Politics: An Evolutionary Game Model. Paper presented at the 57th Political Studies Association Annual Conference, Bath, United Kingdom.

Daugbjerg, C. 2003. Policy feedback and paradigm shift in EU agricultural policy: the effects of the MacSharry reform on future reform. Journal of European Public Policy 10(3): 421-437.

Daugbjerg, C. 1999. Reforming the CAP: Policy Networks and Broader Institutional Structures. Journal of Common Market Studies 37(3): 407-428.

EU-commission. 1991. *The Development and Future of the CAP. Reflections paper of the Commission. Communication of the Commission to the Council. COM (91) 100 final, 1 February 1991.*

Field, H. and Fulton, M. 1994. Germany and the CAP: A Bargaining Model of EC Agricultural Policy Formation. American Journal of Agricultural Economics 76: 15-25.

Fouilleux, E. 2008. CAP Reforms and Multilateral Trade Negotiations: Another View on Discourse Efficiency. West European Politidcs 27(2): 235-255.

Franchino, F. 2002. Efficiency or credibility? Testing the two logics of delegation to the European Commission. Journal of European Public Policy 9(5): 677-694.

Frandsen, S.E., Bach, C.F., and Stephensen, P. ???. European Integration and the Common Agricultural Policy: A CGE Multi Regional Analysis. Development Economics Research Group working paper no. 5.

Henning, C.H.C.A, and Glauben, T. 2000. Dynamik, Dimensionen und Determinanten der Gemeinsamen Europäischen Agrarpolitik. Department of Agricultural Policy, AP 4, University of Kiel.

Harvey WE 2003.

Herrmann, R., Thompson, S.R., and Gohout, W. 2001. CAP Reforms in the 1990s and Their Price and Welfare Implications: The Case of Wheat. Discussion Paper in Agricultural Economics No. 65. University of Giessen.

Hodge, I. 2000. Agri-environmental Relationships and the Choice of Policy Mechanism. 257-273.

Josling, T. 1998. The WTO, Agenda 2000 and the Next Steps in Agricultural Policy Reform. Paper prepared for a presentation at the Institute for Agricultural Economics, Giessen, Germany.

Kay, A. 2003. Path dependency and the CAP. Journal of European Public Policy 10(3): 405-420.

Kay, A. 2000. Towards a Theory of the Reform of the Common Agricultural Policy. European Integration online Papers (EIoP) Vol. 4 No. 9.

Olper, A. 1998. Political economy determinants of agricultural protection levels in EU member states: An empirical investigation. European Review of Agricultural Economics 25: 463-487.

Mahé, L.P. and Roe, T.L. 1996. The Political Economy of Reforming the 1992 CAP Reform. American Journal of Agricultural Economics 78: 1314-1323.

Meunier, S. 2000. What Single Voice? European Institutions and EU-U.S. Trade Negotiations. International Organization 54(1): 103-135.

Patterson, L.A. 1997. Agricultural policy reform in the European Community: a three-level game analysis. International Organization 51(1): 135-165.

Pokrivcak, J. ???. Institutions and EU Decisions-Making: The ‘Power’ of the European Commission. Slovak Agricultural University.

Pokrivcak, J., Crombez, C., and Swinnen, J.F.M. 2006. The status quo bias and reform of the Common Agricultural Policy: impact of voting rules, the European Commission and external changes. European Review of Agricultural Economics 33(4): 562-590.

Pokrivcak, J., and Swinnen, J.F.M. 2002. Agenda Setting, Influence, and Voting Rules: The Influence of the European Commission and Status Quo Bias in the Common Agricultural Policy of the EU. Paper presented at the 2002 AAEA Annual Meeting, Long Beach, USA.

Rizov, M. 2004. Rural development and welfare implications of CAP reforms. Journal of Policy Modeling 26: 209-222.

Schmidt, S.K. 2001. Die Einflussmöglichkeiten der Europäischen Kommission auf die europäische Politik. Politische Vierteljahresschrift 42(2): 173-192.

Tangermann, S. 2001. Has the Uruguay Round Agreement on Agriculture Worked Well? International Agricultural Trade Research Consortium (IATRC) Working Paper #01-1.

Thompson, S.R., Herrmann, R. and Gohout, W. 2000. Agricultural Market Liberalization and Instability of Domestic Agricultural Markets: The Case of the CAP. American Journal of Agricultural Economics 82: 718-726.

Wolfram Math World, http://mathworld.wolfram.com/BellNumber.html. Accessed January 2009

[11] The export subsidy/import tariff and the intervention price are interdependent policy instruments. The size of each depends on the size of the other. Whenever government imposes and intervention price above the world price, it must simultaneously impose an import tariff to keep from having to support the whole world's production at its taxpayers' expense. (We assume that this tariff is always set high enough to prevent any imports when domestic quantity supplied exceeds domestic quantity demanded.) Similarly, when the intervention price is set high enough to lead to EU excess supply of wheat, the EU uses an export subsidy to keep the domestic price from falling below the intervention price. We treat P_I is an independent policy instrument, and the export

subsidy/import tariff as the dependent instrument, though we could have just as easily reversed this independent/dependent assignment without affecting our model's results. This issue of policy instrument independence becomes important when we discuss income redistribution possibilities later in the article.

[2] We ignore any within-year discount factor.

[3] Henceforth, our notation and treatment of the value of information basically follows Laffont (1990).

[4] Excluding the empty set, a set with *n* elements has $\sum_{k=1}^{n}\binom{n}{k} = 2^n - 1$ proper and improper subsets (Wolfram Math World, http://mathworld.wolfram.com/Subset.html, accessed January 2009).

[5] The number of subsets of a set with four elements and the fourth Bell number happen to be 15. This type of equality does not hold in general for a set with *n* elements. For example, when $n = 5$, there are 31 proper and improper subsets excluding the empty set, but the fifth Bell number is 52.

[6] Since the chooser is assumed to know already from the beginning the set of states of nature, the least informative information structure is associated with partition $P^1 = \{\{\omega^{DL}, \omega^{DH}, \omega^{HL}, \omega^{UH}\}\}$, which tells only that the true state of nature is in the set of states of nature, which the chooser already knows. The most informative set is $P^1 = \{\{\omega^{DL}\}, \{\omega^{DH}\}, \{\omega^{HL}\}, \{\omega^{UH}\}\}$. If the chooser faces P^1, it will be informed of the true state of nature before taking action, no matter what that state turns out to be. *

[7] For example, when facing $P^5 = \{\{\omega^{UH}\},\{\omega^{DL},\omega^{DH},\omega^{UL}\}\}$, the chooser knows that it will receive one of the two signals in $Y^5 = \{y_1^5, y_2^5\}$. it knows that if it receives y_1^5, then the true state will be the sole element of $O^5(y_1^5) = \{\omega^{UH}\}$, and that if it receives y_2^5 then the true state will be one of the three states listed in $O^5(y_2^5) = \{\omega^{DL}, \omega^{DH}, \omega^{UL}\}$. Given that it knows that he's facing partition P^5, from (12) its prior belief is that the probability of hearing signal y_2^5 is $\pi(\omega^{DL}) + \pi(\omega^{DH}) + \pi(\omega^{UL})$. Given that it receives y_2^5, as in (13) it will believe that the true state is ω^{DL} with probability $v(\omega^{DL} | y_2^5) = \pi(\omega^{DL})/[\pi(\omega^{DL}) + \pi(\omega^{DH}) + \pi(\omega^{UL})]$.

[8] That is, letting P^m have some number T^m sets as members: $P^m = \{O_1^m,\ldots,O_{T_m}^m\}$, and letting P^n have T^n sets as members: $P^n = \{O_1^n,\ldots,O_{T_n}^n\}$, then if I^n is finer than I^m, we can take any element O_i^m in P^m, and it will be the union of one or more of the elements of P^n.

[9] This result here proved is a particular example of the general result of Laffont's Theorem 1 (1989, p. 59).

[10] We use this overly-simplified model of political economy simply for the purposes of the simulation, and not to assert that government policy can be accurately analyzed with such methods.