Making secession costly but efficient: the political economy of exit clauses

Martijn Huysmans[1]

Christophe Crombez[2]

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Abstract

This article presents a political economy analysis of exit clauses in currency unions and (con)federations. In such unions, participants' benefits depend on their characteristics and on the state of the world. If a participant's benefits become negative, it may wish to exit. Using a dynamic stochastic model, we show that state-contingent exit penalties can enable exit at the socially efficient exit state. Even if exit penalties cannot be made state-contingent, they may still enhance social welfare by preventing secession wars. This finding runs counter to the dominant point of view in the literature that exit clauses should be avoided in federations.

Keywords: Exit, Withdrawal, Exit Clauses, Secession, Real Options

[1] Doctoral Candidate, LICOS Research Center, Faculty of Economics and Business, KU Leuven. Email: martijn.huysmans@kuleuven.be.

[2] Professor of Political Economy, Faculty of Economics and Business, KU Leuven, and Consulting Professor, Freeman Spogli Institute for International Studies, Stanford University.

Introduction

In this article we develop a political economy model of exit clauses in political unions, by which we mean currency unions such as the Euro and (con)federations such as the United States or the European Union (EU). An exit clause specifies the conditions of unilateral exit or withdrawal from an agreement. Examples of exit clause conditions are the payment of a penalty, waiting out a notice period, or obtaining consent from (a certain fraction of) the remaining parties. Exit clauses are a common feature of contracts among individuals and firms. Rental agreements and employment contracts typically specify notice periods and sometimes fines for early contract termination. Another example are pre-nuptial or pre-marital contracts, which may specify monetary compensation in the event of a divorce (Rainer, 2007).

Exit clauses are not common in currency unions and (con)federations, although they do exist. To the best of our knowledge, the only current examples are the secession clauses in the constitutions of Ethiopia (Habtu, 2005) and Saint Kitts and Nevis (Weinstock, 2001), and the withdrawal clause in the Treaty on European Union (Athanassiou, 2009).[3] Liechtenstein, a non-federal country, also has a constitutional secession clause for its municipalities (Sorens, 2016).

An historical example of an exit clause in a political union is the 1885 liquidation clause in the Latin Monetary Union (Cohen, 1993). The Latin Monetary Union was a currency union created in 1865 between Belgium, France, Italy and Switzerland. This liquidation clause is particularly interesting because it specified an exit penalty: the clause required states wishing to exit from the monetary union to buy back all their silver held at the remaining members' banks (silver had lost a lot of value relative to gold). Perhaps thanks to this costly exit clause, the Latin Monetary Union persisted until Switzerland's withdrawal in 1926, and was dissolved in 1927 (Cohen, 1993). Another example is Article 72 in the constitution of the Soviet Union (Sunstein, 1991: 645-647), which did not specify any mechanisms or conditions: "Each Union

[3] The conditions in the Federal Republic Ethiopia include a two-thirds majority in the Parliament of the seceding entity, and a simple majority in a regional referendum to be organized by the federal state within three years. The Federation of Saint Kitts and Nevis allows for secession in case a two-thirds majority is reached in an independence referendum in the seceding entity. Article 50 of the Treaty on European Union specifies that any Member State may withdraw from the Union by notifying the Council, and is guaranteed the right to leave unilaterally within two years.

Republic shall retain the right freely to secede from the USSR". More recently, two historical examples are the 2005 Comprehensive Peace Agreement in Sudan[4], and Article 60 of the 2003 Constitutional Charter of Serbia and Montenegro.[5]

For the purpose of studying exit clauses, political unions are different from common contracts in two important ways. First, for common contracts such as the lease of an apartment or an employment contract, legislators have typically defined default exit rules that are applicable even if there are none in the contract, or have limited the scope for freely specifying exit conditions. Such default exit rules are not applicable to political unions, although the Vienna Convention on the Law of Treaties (VCLT) does provide some ground rules about withdrawal from international agreements.[6] Second, common contracts are enforceable before national courts and political unions are not. Depending on the reputational costs, secession wars may occur to obtain illegal secession (Helfer, 2005). Conversely, attempts at legal secession on the basis of an exit clause may be met with anti-secession wars, as happened in the break-up of the Soviet Union.[7]

Table 1 gives an empirical illustration of the relationship between exit, exit-related violence and exit clauses. The left column collects currency unions or (con)federations without exit clauses, while the right

[4] The 2005 Comprehensive Peace Agreement ended the Second Sudanese Civil War which ran from 1983 to 2005 between the Sudanese government and the Sudan People's Liberation Army located in the South of the country. The peace treaty stipulated that the South would have autonomy for 6 years, and that oil revenues would be split equally during this period. The period of autonomy would be followed by an independence referendum in 2011. In the referendum, 98.8% voted in favor of independence, and South Sudan declared its independence.

[5] In 1946, the Socialist Federal Republic of Yugoslavia consisted of six republics: Bosnia and Herzegovina, Croatia, Macedonia, Montenegro, Serbia (including the autonomous regions of Kosovo and Vojvodina), and Slovenia. Over the period 1991-1992, Slovenia, Croatia, Macedonia and Bosnia Herzegovina declared their independence. This left only Serbia and Montenegro in the federation. In 2003, they adopted the Constitutional Charter of Serbia and Montenegro, which specified in Article 60 a three year waiting period before either could declare independence. A referendum was required, but the necessary threshold for independence was not specified. In 2006, Montenegro called a referendum. They initially proposed a simple majority pro-independence threshold. However, under pressure from the EU they accepted a 55% threshold. The outcome of the referendum on 21 May 2006 was 55.5% in favor of independence, which Montenegro then declared.

[6] Article 56 of the VCLT specifies that unilateral withdrawal from a treaty is only allowed if the treaty explicitly specifies a withdrawal right, or if a withdrawal right was implied by the parties or the nature of the treaty. If withdrawal is allowed, the default notice period is twelve months. See Koremenos (2016: 144) for an empirical investigation of states' actual practice regarding notice periods, which diverges from the default twelve months in more than half of her sample. If there is no explicit nor implicit withdrawal right, article 62 of the VCLT provides for the possibility of withdrawal under "fundamental change of circumstances", although legal scholars are divided about the validity and applicability of this so-called *rebus sic stantibus* clause in practice (Helfer 2005: 1643-1644).

[7] In the case of the American Civil War, some Southerners claimed there was an implicit secession right and that hence the North was conducting an illegal anti-secession war (Buchanan, 1997: 36).

column lists examples with exit clauses. The first two rows gives some notable examples of violence associated with exit, while the third row gives examples of peaceful exits, and the fourth row of unions from which exit has so far not occurred.

	No exit clause	**Exit clause**
Violence without exit	ETA Basque terrorism (1961-2011) Second Sudanese Civil War (1983-2005) US Civil War (1861-1865)	-
Violent exit	Yugoslavia-Bosnia Herzegovina (1992) Pakistan-Bangladesh (1971) Netherlands-Belgium (1830)	Dissolution of Soviet Union (1990-1991)
Peaceful exit	Czech Republic & Slovakia (1993) Scandinavian Monetary Union (1931) Sweden-Norway (1905)	Sudan-South Sudan (2011) Serbia-Montenegro (2006) Latin Monetary Union-Switzerland (1926)
No exit so far	Spain-Catalonia United Kingdom-Scotland Eurozone-Greece Canada-Québec	European Union (EU) Ethiopia Saint Kitts & Nevis

Table 1. Historical cases of exit, exit-related violence and exit clauses

Examples of exit-related violence occurred during the terrorist period of the Basque independence movement ETA in Spain, the Second Sudanese Civil War, the US Civil War, the independence of Bosnia Herzegovina from Yugoslavia, the independence of Bangladesh (formerly East-Pakistan) from Pakistan, the independence of Belgium from the Netherlands, and the dissolution of the Soviet Union.

Formal exit clauses can enable peaceful exit, as in the independence of South Sudan from Sudan and Montenegro from Serbia-Montenegro, and the exit of Switzerland from the Latin Monetary Union. However, a pre-agreed exit clause is not a requirement for peaceful exit: the split of Czechoslovakia, the dissolution of the Scandinavian Monetary Union (Cohen, 1993), and the independence of Norway from

Sweden occurred peacefully. While having no exit clause is not a guarantee against exit, having an exit clause of course also does not imply that exit is bound to occur, as the examples of Ethiopia and Saint Kitts & Nevis show. Britain has voted to leave the EU on 23 June 2016, but has so far not triggered Article 50, which would be required to actually start the process of exit. No doubt the largest category in the universe of political unions are those which have no exit clause and from which no exit has occurred. Well-known examples are Spain, the United Kingdom, the Eurozone, and Canada.

If anything emerges from Table 1, it is that there is no immediately obvious empirical relationship between exit clauses, exit, and violence. This is where believe lies the value of the model developed below: it will identify theoretically the expected relationships between these elements. Our main finding will be that appropriately costly exit clauses may ex-ante enable efficient exit. Negotiating exit ex-post may be difficult, hence the numerous historical attempts at violent exit. This leads to a new puzzle, since exit clauses are actually rare in currency unions and (con)federations. After solving the model, we identify four reasons why this may be the case.

Efficient breach and the constitutionalist position against exit clauses

If contracts lack exit clauses, economically inefficient contracts may be upheld. In some states of the world the aggregate benefit from the contract may be negative while one or more participants still benefit. Such "vested interests" may be opposed to renegotiation (Aghion & Bolton, 2003). This may be true even if ex ante, before the state of the world is known, all parties would prefer allowing socially efficient reforms (exit being an extreme type of reform).

The idea that not respecting a contract may be socially desirable is known as "efficient breach" (Goetz & Scott, 1977). In theory, if exit is efficient those better off outside the contract could offer an acceptable side-payment for exit and make everyone better off – an application of Coase (1960). In this light, Drèze, De Grauwe, & Edwards (1993) discuss a practical rule suggested by Drèze to ex-post reapportion national debt at the time of secession. However, as pointed out by De Grauwe, ex-post renegotiation may be very difficult politically. Hence there may be a role for ex-ante negotiated exit clauses to enable efficient breach.

Exit from a (con)federation specifically is usually called secession. Depending on how a secession takes place, it can be peaceful and swift, or painful and costly (Young, 1994). Having constitutional exit provisions can expedite the process once it has become inevitable, increasing order and predictability. Carefully constructed exit clauses may even accomplish this goal without necessarily increasing the likelihood of secession (Weinstock, 2001). By contrast, without exit provisions, exit boils down to a fundamental contract renegotiation, implying that unanimity or the use of threats, coercion or violence are needed to change the status quo. If unanimity cannot be reached, embarking on a destructive secession war (figuratively or literally) may be the only remaining alternative for the entity wishing to secede.

In spite of the potential benefits of secession clauses, the dominant position in the constitutionalist literature is that they should be avoided. This position was pioneered by Sunstein (1991, 2001), who sees constitutions as pre-commitment strategies in the presence of multiple equilibria. He argues that if there are multiple equilibria in the federation game, equilibria with secession must be Pareto inefficient. Having a constitution that precludes secession then functions as a pre-commitment device to a Pareto superior equilibrium. Chen & Ordeshook (1994) take the same starting point as Sunstein, but develop a formal three-player game-theoretical model which is taken up further in Filippov, Ordeshook, & Shvetsova (2004). Their conclusion is that there should be a constitutional ban on exit, in order to coordinate on non-secession equilibria, which are assumed to be Pareto superior.

The strength of the conclusions drawn by Chen & Ordeshook (1994) is limited because of three strong assumptions. First, they assume that maintaining the federation is always socially efficient (efficient breach does not exist by assumption). Second, they assume that without an exit clause, exit cannot occur. Of course in reality a party wishing to exit may embark on a destructive secession war (figuratively or literally). Such unregulated exit may be particularly chaotic and costly. Third, they assume that exit clauses are necessarily unconditional, i.e. free in use. In fact, exit will necessarily cause one-off transaction costs, and exit clauses may stipulate costly conditions such as the payment of an exit penalty or the organization of a referendum.

Bordignon & Brusco (2001) analyze optimal secession rules in a two-player game with two periods and a discrete stochastic state. Their model, like ours, covers both (con)federations and currency unions. In

period one, members may receive some benefit that depends on the expected stability in period two. This feature of the model captures the fact that the benefits of currency unions (e.g. price stability, increased foreign investment) depend on their perceived stability. In period two, members of the federation decide between accepting a federal allocation or starting a secession war. Bordignon & Brusco find that secession clauses may be inefficient if the benefits from the federation depend significantly on its perceived stability. While their model allows for stochastic shocks and hence the possibility of efficient breach, it still has some important limitations. The discretized set-up with only two periods and four states of the world does not allow for dynamics such as enduring short-term losses. In addition, they introduce a new restrictive assumption compared to Chen & Ordeshook (1994), namely that countries are ex-ante identical.

Using a formal model of costly exit clauses, we show that the position of Sunstein (1991) and Chen & Ordeshook (1994) against exit clauses is untenable. By modeling the dynamic aspect of exit decisions in continuous time, we introduce considerations of optimal exit timing absent in Bordignon & Brusco (2001). In addition, our model allows for participants to the agreement to be different ex-ante, so that the distributional consequences of exit clauses can be studied. We also show that appropriately costly exit clauses do not increase the likelihood of exit given the implicit option of exit through a secession war.

The model

The following continuous time model describes a political union between two entities indexed by $i \in \{A, B\}$. For each entity i, the net benefits of such a union will depend on its nature (i.e. a currency union or a federation), and on the entity's characteristics. For instance, in the case of a federal country, the net benefits will be roughly composed of economies of scale in the provision of public goods, the internalization of externalities, fiscal transfers, and welfare losses from centralized decision-making in the presence of heterogeneity between the federated entities (Alesina & Spolaore, 2003; Desmet, Breton, Ortuño-Ortin, & Weber, 2011). Each of these components will be determined by the substantive terms of the agreement, such as the rules for computing fiscal transfers, and the characteristics of the entities, such as their average

income. We denote the net benefits at the time of the agreement by an entity's type, θ_i. A high type indicates high benefits from the union.

However, over time the benefits may change because of changes in the state of the world. For instance, an entity may become richer. While this may be good for the entity per se, it may also decrease its benefits from the federation, because it will have to pay higher fiscal transfers. This seems to be case, for instance, in Catalonia, Scotland and Flanders. In our model, we capture such changes in benefits by an entity's state x_i. A high state means that an entity is currently enjoying the union more, and vice versa. We assume that the link between the state of the world and benefit flows is fully exogenous. Substantively, this assumption means that the terms of the agreement cannot be renegotiated: the rules for computing fiscal transfers cannot be changed. While this is a limitation, we leave for future work a model where the link between the state of the world and benefits is endogenous.

To summarize, the net benefit flow from the agreement at time t for both entities depends on the stochastic state of the world $x(t) = \big(x_A(t), x_B(t)\big)$ and on the entities' types θ_i. Concretely, entity i's benefit flow $\pi_i(t)$ at time t is given by:

$$\pi_i(t) = x_i(t) + \theta_i \qquad (1)$$

The state of the world captures the changes in benefits over time, which are uncertain. For simplicity, assume that entity i's state $x_i(t)$ evolves according to a Brownian motion[8] without drift and with variance σ_i^2. A Brownian motion is simply a particular type of random process over time. Over any given time period dt, it can go up or down, as the increments dx_i have a normal distribution characterized by variance σ_i^2. A higher variance σ_i^2 means that entity i's benefits are expected to fluctuate more. Formally, a Brownian motion is characterized by

$$dx_i = \sigma_i \epsilon_{it} \sqrt{dt} \qquad (2)$$

[8] See Mörters & Peres (2010) for the theory of Brownian motions.

where ϵ_{it} has a standard normal distribution and is serially uncorrelated so that for all $t > 0$

$$E[\epsilon_{it}] = 0, \qquad Var(\epsilon_{it}) = E\left[\epsilon_{it}^2\right] = 1, \qquad E\left[\epsilon_{it_1}\epsilon_{it_2}\right] = 0, t_1 \neq t_2 \tag{3}$$

This implies that $E[dx_i] = 0$ and $E[(dx_i)^2] = \sigma_i^2 dt$: benefits are expected to remain the same, but have a variance of σ_i^2 per unit of time.

Assume furthermore that the increments ϵ_{At} and ϵ_{Bt} of the Brownian motions $x_A(t)$ and $x_B(t)$ are jointly normally distributed for all t, with correlation ρ so that

$$E[\epsilon_{At}\epsilon_{Bt}] = \rho, \; E[dx_A dx_B] = \rho\sigma_A\sigma_B dt \tag{4}$$

A positive correlation means that both entities' benefits tend to move together. A negative correlation means that changes in the state of the world tend to have an opposite effect on both entities. This would be the case, for instance, for fiscal transfers. If one entity grows richer, it will benefit less from the union while the other will benefit more, since transfers will increase.

Without loss of generality, suppose that the agreement starts at $t = 0$ and set $x_i(0) = 0$. Since we have assumed no drift in the states x_i, their ex ante expected value is 0 for any future date T; mathematically, $E[x_i(T)] = 0, \forall T > 0$. Similarly, the expected value at time t for a later time T is simply the value at the time of the expectation: $E_t[x_i(T)] = x_i(t)$. The variance of a Brownian motion increases linearly over time. At time t the probability density for time T at state x_i is

$$P_t(x_i(T) = x_i) = \phi\big(x_i; x_i(t), \sigma_i^2(T-t)\big) = \phi\left(\frac{x_i - x_i(t)}{\sigma_i\sqrt{T-t}}\right) \tag{5}$$

where $\phi(x; \mu, \sigma^2)$ is the probability density function (pdf) of the normal distribution with mean μ and variance σ^2, and $\phi(x)$ is the pdf of the standard normal distribution. The expected change in x_i is zero, large changes are less likely than small changes, but the expected magnitude of changes increases over time.

Assume that the entities have a common discount rate r, so that the expected discounted benefit from the agreement for entity i until time T is $E\left[\int_0^T \pi_i(t)e^{-rt}dt\right]$. The ex-ante expected value for entity i from a perpetual agreement is

$$E\left[\int_0^{+\infty} \pi_i(t)e^{-rt}dt\right] = \lim_{T\to+\infty}\left(\frac{\theta_i}{r} - \frac{\theta_i}{r}e^{-rT}\right) = \frac{\theta_i}{r} \quad (6)$$

Hence, entity i will only voluntarily enter the agreement if its type $\theta_i > 0$. However, even if the agreement is ex ante positive, in some states of the world $x(t)$ it may turn out bad for one or both entities, so that they may wish to exit from the agreement.

In the model, we will consider three types of ex-ante specified exit conditions: penalties, one-off costs and notice periods. An exit penalty consist of the payment of a penalty c_i by the party exiting i to the remaining party j. One-off cost k_i comprise all costs associated with exit from the agreement other than the penalty, whether stated explicitly or required implicitly. For instance, in the case of a federation the one-off costs comprise the legal costs of writing a new constitution, negotiating international treaties, and the logistical costs of organizing a referendum (if required). For a monetary union, the one-off costs comprise the cost of market uncertainty and the costs of printing new money. A notice period specifies the minimal amount of time N between an entity's announcement that it wishes to exit, and the effective exit. We analyze exit penalties and one-off exit costs in the main text. In the Appendix, we show that notice periods do not affect decisions of exit timing, although they do affect the entities' expected benefits from the agreement.

Optimal exit in a decision theoretical setting

As a first step we solve a decision-theoretical version of the model, in which only one entity can exit. If both entities can exit game-theoretical considerations come into play, as we discuss in the next section. The main technique in this section is dynamic stochastic programming, similar to Dixit (1989) and Dixit & Pindyck (1994). In what follows, we assume for simplicity that exit is definitive and that there is no possibility of re-entering later. However, even if re-entry is free the qualitative conclusions from our model would still hold, but the solution process would be more complicated as the optimal exit decisions and optimal entry decisions would be mutually interdependent.

In the decision-theoretical version of the model we assume that only one entity can exit from the agreement, and only consider that entity. Hence for now we drop the index i to lighten notation. When

thinking about exit in a continuous time set-up, an entity compares the expected value of maintaining the agreement to the value of exiting right now. Assuming rational behavior, the expected value of maintaining the agreement should reflect optimal exit behavior in the future. This is captured by the notion of continuation value: the continuation value $V(x)$ is the expected discounted benefit from maintaining the agreement when the current state is x, assuming optimal exit behavior in the future (Dixit & Pindyck, 1994).

At any point in time, in order for an entity to be willing to maintain the agreement for dt longer, the expected change in the continuation value combined with the benefit flow (1) over dt should add up to the normal return $rV(x)dt$:

$$E[dV] + (x + \theta)dt = rV(x)dt \tag{7}$$

Determining the continuation value is just like pricing a stock with expected appreciation $E[dV]$ and dividend flow $x + \theta$. By Ito's lemma[9], $dV = \frac{\partial V}{\partial t}dt + \frac{\partial V}{\partial x}dx + \frac{1}{2}\frac{\partial^2 V}{\partial x^2}(dx)^2$. The benefit flow does not depend on calendar time directly: $\frac{\partial V}{\partial t} = 0$. Together with (2), $E[dx] = 0$ and $E[(dx_i)^2] = \sigma_i^2 dt$, this implies

$$dV = V'(x)dx + \frac{1}{2}V''(x)\sigma^2\epsilon_t^2 dt \Rightarrow E[dV] = \frac{1}{2}V''(x)\sigma^2 dt \tag{8}$$

By substituting (8) in (7), we find

$$\frac{1}{2}\sigma^2 V''(x) - rV(x) = -x - \theta \tag{9}$$

This is a second order differential equation in x: we solve it by first identifying the solution $V_h(x)$ of the homogeneous equation $\frac{1}{2}\sigma^2 V''(x) - rV(x) = 0$. Next we identify a particular solution $V_p(x)$ which satisfies the equation $\frac{1}{2}\sigma^2 V''(x) - rV(x) = -x - \theta$. The general solution is given by the particular solution plus any linear combination of solutions to the homogeneous equation. For the homogeneous part, try a solution of the form $V(x) = e^{\lambda x}$. This yields

[9] See Øksendal (1991) for the theory of stochastic differential equations.

$$V_h(x) = Ae^{\alpha x} + Be^{\beta x}, \qquad \alpha = \sqrt{\frac{2r}{\sigma^2}}, \beta = -\sqrt{\frac{2r}{\sigma^2}} \tag{10}$$

with constants A and B to be identified. Note that $\alpha > 0$ and $\beta = -\alpha < 0$. For a particular solution, try $V(x) = ax + b$. This yields the solution $V_p(x) = \frac{x+\theta}{r}$. Note that this is the expected perpetuity value from the agreement starting from state x. Combining the particular solution with the homogeneous part, the general solution is

$$V(x) = V_p(x) + V_h(x) = \frac{x+\theta}{r} + Ae^{\alpha x} + Be^{\beta x} \tag{11}$$

Since $V_p(x)$ represents the value from maintaining the agreement perpetually, $V_h(x)$ represents the option value of exit, which should be positive. As the state improves, the value of the exit option should converge to 0: the better the state, the higher your benefit flow and the less valuable the exit option. This implies that $A = 0$ since $\alpha > 0$. We now have an expression for the continuation value $V(x)$ up to the constant B. This constant will be determined by a boundary condition corresponding to optimal exit.

Optimal exit with an exit penalty c

The continuation value is the value of maintaining the agreement for now, assuming optimal behavior for the future. Hence the constant B will depend on the optimal exit state x^e. Two conditions are needed for optimal exit in a continuous time stochastic model (Dixit & Pindyck, 1994). The first is *Value Matching (VM)*: exit should occur when $V(x)$ drops to the value of the outside option. In our model, the outside option consists of paying the one-off costs and the penalty c, which corresponds to a value of $-k - c$. The second condition is *Smooth Pasting (SP)*: optimal stopping requires that $V'(x)$ be equal to the derivative of the value of being outside of the agreement – which is 0 in our case, since the exit value does not depend on the state. Grouping the two conditions we obtain a system with two equations and two unknowns (x^e, B):

$$V(x^e) = -k - c \Leftrightarrow \frac{x^e + \theta}{r} + Be^{\beta x^e} = -k - c \qquad \textbf{\textit{VM}} \tag{12}$$

$$V'(x^e) = 0 \Leftrightarrow \frac{1}{r} + \beta B e^{\beta x^e} = 0 \qquad \textbf{\textit{SP}}\ (13)$$

The solutions for (x^e, B) are

$$x^e = -\theta - r(k+c) + \frac{1}{\beta}, \qquad B = -\frac{e^{-\beta x^e}}{r\beta} \qquad (14)$$

The optimal exit state has three components. The first one, $-\theta$, is the most intuitive. When x reaches $-\theta$, the benefit flow drops to zero: $\pi(t|x(t) = -\theta) = -\theta + \theta = 0$. The higher an entity's type θ, the more negative the optimal exit state, i.e. the longer it is optimal to stay in the agreement: $\frac{\partial x^e}{\partial \theta} < 0$. The second term, $-r(k+c)$, reflects the deterring effect of exit costs since $\frac{\partial x^e}{\partial k} = \frac{\partial x^e}{\partial c} < 0$. The benefit flow needs to drop to $-r(k+c)$ to make exit worth considering, since the corresponding expected perpetuity value at that state would be equal to the exit costs $-(k+c)$.

The third term in (14), $\frac{1}{\beta}$, is the least intuitive but can be interpreted as the optimal forbearance level. It reflects sophisticated rational behavior: given that re-entry is precluded, one should be willing to sustain some losses in the hope that the state improves again.[10] Intuitively, it seems clear that the higher the variance of the benefits, the higher the possibility that a bad state would improve substantially again, and the more reluctant one should be to exit. This intuition is confirmed: since $\frac{1}{\beta} = -\sqrt{\frac{\sigma^2}{2r}}$, it is easy to show that $\frac{\partial x^e}{\partial \sigma} < 0$.

Given (11) and (14), the continuation value at state x is

$$V(x) = \frac{x+\theta}{r} - \frac{e^{\beta(x-x^e)}}{r\beta} \qquad (15)$$

The continuation value consists of the perpetuity value plus the option value of optimal exit. As the state deteriorates to the optimal exit state, the continuation value converges to the cost of exit: $\lim_{x \to x^e} V(x) = -(k+c)$. The higher the cost of exit, the lower the value of the exit option and hence the continuation value: $\frac{\partial V}{\partial k} = \frac{\partial V}{\partial c} < 0$. The entity with exit option prefers an exit penalty of $c_i = 0$. The difference in

[10] In fact, even if re-entry is free one should be willing to sustain some losses before exiting (Dixit, 1989).

continuation value for different values of $k + c$ is illustrated in Figure 1. This figure also illustrates the value matching and smooth-pasting conditions: at x^e, the continuation value is equal to the exit cost, and its slope is equal to 0.

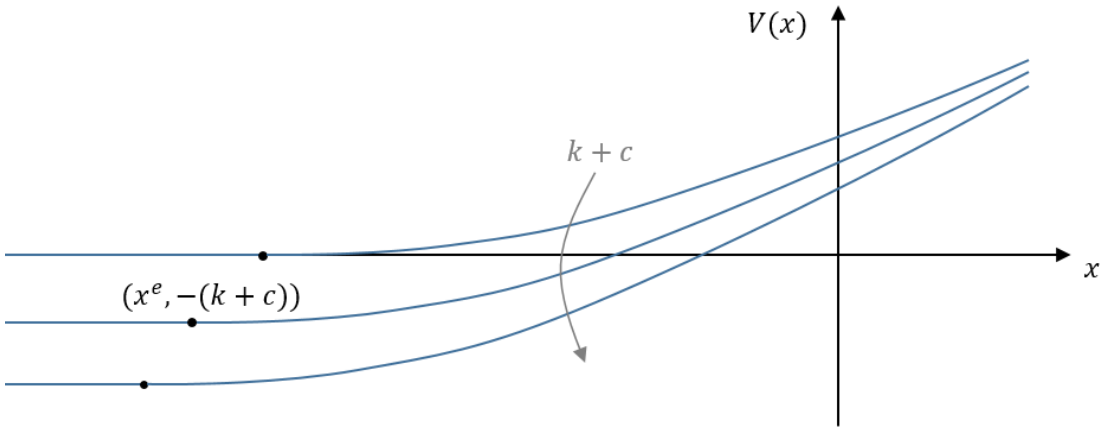


Figure 1. The value from the agreement as a function of the state *x*, for different values of the exit cost $k + c$

The probability of exit

Optimal exercise of the exit option leads to an exit time $T^e = Min\{t: x(t) = x^e\}$. Exit occurs when the state of the world first drops to x^e, so that the probability of exit occurring before time T is given by the probability of attaining x^e before T: $P(T^e \leq T) = P(m(T) \leq x^e)$, where $m(T) = Min\{x(t)|t \leq T\}$. We show in the Appendix that

$$P_t(T^e \leq T) = 2P_t(x(T) \leq x^e) = 2\Phi(x^e; x(t), \sigma^2(T-t)) \qquad (16)$$

where $\Phi(x; \mu, \sigma^2)$ is the cumulative distribution function (cdf) of the normal distribution with mean μ and variance σ^2, and $x(t)$ is the value of the state at the moment the probability is calculated. The interpretation is that the probability of exit by time T is twice the probability of being at the optimal exit state or worse at time T. The ex-ante probability of exit by time T is $P_0(m(T) \leq x^e) = 2\Phi\left(-\theta - r(k+c) + \frac{1}{\beta}; x(0) = 0, \sigma^2(T-t)\right)$ and is illustrated in Figure 2 for different values of $k + c$.

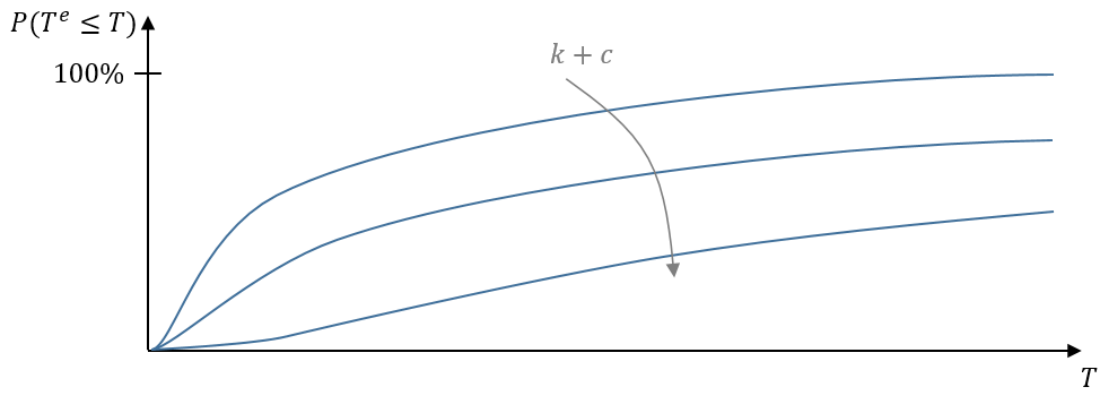


Figure 2. The probability of exit by time T, for different values of the exit cost $k + c$

The higher the exit cost, the lower the probability of exit. However, as can be seen from the graph, the probability of exit ultimately converges to 1 over time, regardless of the exit cost. This is intuitive since the variance of a Brownian motion increases linearly over time and hence the probability of attaining the optimal exit state increases. Of course, this result is only valid if the link between the state of the world and payoffs is truly exogenous, as in our model. If the substantive terms of an agreement can be renegotiated efficiently, then the union may persist indefinitely in spite of large changes in the state of the world.

Enforcement problems: the possibility of a secession war

Up to now, we have assumed the agreement was fully binding. An entity could only exit by paying the ex-ante agreed exit penalty c. However, given the nature of currency unions and (con)federations, which cannot be enforced by supranational courts, the agreement may not be fully binding. In particular, the entities may decide to renegotiate, or an entity wishing to exit may do so forcefully.

By "secession war", we denote any unilateral exit which does not respect a pre-agreed exit clause and has not been negotiated (if there is no exit clause). Hence our use of the term also includes figurative secession wars. We model a secession war as a pair of costs (w, d), where w is the cost the exiting entity would have to incur to win the secession war (including both the direct costs and the reputational costs) and d is the corresponding damage to the remaining entity.

The direct costs of a secession war will depend crucially on the type of agreement: getting out of a currency union can be done much more easily than out of a federation. Even among currency unions and federations large variations can be expected depending on the set-up and context. Currency unions with a common currency issued by one central bank will be much harder to get out of than currency unions based on freely interchangeable but separate currencies. Similarly, overseas regions will incur less costs in seceding unilaterally than regions which are fully contained within a federation.

The reputational costs of a secession war depend both on the international norm against unilateral exit and on the circumstances. For instance, regions with oppressed ethnic minorities will generally incur low reputational costs, as they will be quickly welcomed by the international community (Buchanan, 1997; Sorens, 2016). Barring specific geopolitical concerns, they tend to be quickly recognized by the UN and the WTO. Rich regions wishing to escape from fiscal transfers will not be treated so favorably.

Clearly, if an entity has the choice between using an exit clause and engaging in a secession war, it will pick the option with the lowest cost. Hence exit clauses with costs $c + k$ above w will be ineffective as they cannot be enforced: the exit clause will never be used, but a secession war will occur if the state drops below $x^e(w) = -\theta - rw + \frac{1}{\beta}$ and a negotiated exit is not forthcoming. The higher the cost w, the less relevant the secession war option and hence the lower the enforcement problem.

The consequences of exit for the entity without exit option

Until now, we have only considered the entity with exit option and dropped the index i from all formulas. We now reintroduce the index i for the entity with the exit option, and introduce the index j for the entity subject to potential exit by entity i. For j, the value $V_j(x_i, x_j)$ of being in the agreement depends on both x_i and x_j. This is because j's benefit flow depends on x_j, but will be stopped by i depending on x_i. Just like (7), over an infinitesimal period dt the expected change in value combined with the benefit flow should add up to the normal return $rV_i(x_i, x_j)dt$:

$$E[dV_j] + (x_j + \theta_j)dt = rV_j(x_i, x_j)dt \tag{17}$$

Ito's lemma in two dimensions (Øksendal, 1991) gives

$$\begin{aligned} dV_j &= \frac{\partial V_j}{\partial t}dt + \frac{\partial V_j}{\partial x_i}dx_i + \frac{\partial V_j}{\partial x_j}dx_j \\ &+ \frac{1}{2}\left[\frac{\partial^2 V_j}{\partial x_i^2}(dx_i)^2 + \frac{\partial^2 V_j}{\partial x_j^2}(dx_j)^2 + 2\frac{\partial^2 V_j}{\partial x_i \partial x_j}dx_i dx_j\right] \end{aligned} \tag{18}$$

Now, since V_j is time-independent and using the properties of the Brownian motions x_A and x_B, $E[dV_j] = \frac{1}{2}dt\left[\sigma_i^2\frac{\partial^2 V_j}{\partial x_i^2} + \sigma_j^2\frac{\partial^2 V_j}{\partial x_j^2} + 2\rho\sigma_i\sigma_j\frac{\partial^2 V_j}{\partial x_i \partial x_j}\right]$. Fill this out in (17) to obtain the partial differential equation

$$\frac{1}{2}\left[\sigma_i^2\frac{\partial^2 V_j}{\partial x_i^2} + \sigma_j^2\frac{\partial^2 V_j}{\partial x_j^2} + 2\rho\sigma_i\sigma_j\frac{\partial^2 V_j}{\partial x_i \partial x_j}\right] + x_j + \theta_j = rV_j(x_i, x_j) \tag{19}$$

If i exits, j receives the exit penalty c and incurs one-off cost k_j. Since i will exit at $x_i^e = -\theta_i - r(k_i + c_i) + \frac{1}{\beta_i}$, the appropriate value-matching condition is

$$\forall x_j\colon\ V_j(x_i^e, x_j) = c_i - k_j \qquad \textbf{\textit{VM}}\ (20)$$

The solution for $V_j(x_i, x_j)$ needs to satisfy both the partial differential equation (19) and the value-matching condition VM (20). Since j undergoes i's exit decision, there is no smooth-pasting condition for optimality. The general solution of (19) consists of a particular solution and any linear combination of solutions to the homogeneous equation. A particular solution is again $V_{jp}(x_i, x_j) = \frac{x_j + \theta_j}{r}$, the perpetuity value of the agreement.

If the Brownian motions are uncorrelated and $\rho = 0$, then the partial differential equation is separable and analytical solutions can be obtained for the homogeneous equation as well. As before, one solution for the homogeneous equation is $e^{\beta_i x_i}$ with $\beta_i = -\sqrt{\frac{2r}{\sigma_i^2}}$. Since the particular solution $V_{jp} = \frac{x_j + \theta_j}{r}$ contains x_j but VM (20) does not, we should identify a solution for the homogeneous equation which also contains x_j. One can verify that $x_j e^{\beta_i x_i}$ is such a solution. Combining the particular solution with the two solutions of

the homogeneous problem, we get $V_j(x_i, x_j) = \frac{x_j+\theta_j}{r} + Ce^{\beta_i x_i} + Dx_j e^{\beta_i x_i}$. Using VM (20), $C = \left(c_i - k_j - \frac{\theta_j}{r}\right) e^{-\beta_i x_i^e}$ and $D = -\frac{e^{-\beta_i x_i^e}}{r}$, so that

$$V_j(x_i, x_j) = \frac{x_j + \theta_j}{r} + \left(c_i - k_j - \frac{x_j + \theta_j}{r}\right) e^{\beta_i (x_i - x_i^e)} \quad (21)$$

Given the initial state of the world $x_i = x_j = 0$, the ex-ante expected value for j is $V_j(0,0) = \frac{\theta_j}{r} + \left(c_i - k_j - \frac{\theta_j}{r}\right) e^{-\beta_i x_i^e}$. The first order condition corresponding to the optimal exit penalty from j's perspective is $\left(1 + r\beta_i \left(c_i - k_j - \frac{\theta_j}{r}\right)\right) e^{-\beta_i x_i^e} = 0$. It is easy to verify that this penalty is $c_i = \frac{\theta_j}{r} + k_j - \frac{1}{r\beta_i}$ and that it indeed corresponds to a maximum. This is the exit penalty preferred by j if only i has an exit option. It is larger the higher j's type θ_j, the higher the one-off costs of separation k_j, and the higher optimal forbearance $-\frac{1}{\beta_i} = \sqrt{\frac{\sigma_i^2}{2r}}$. The inclusion of these terms in i's exit penalty will ex-ante give maximal incentives to i to take j's welfare into account.

Socially efficient exit

Recalling that the increments ϵ_{At} and ϵ_{Bt} of the Brownian motions $x_A(t)$ and $x_B(t)$ are jointly normally distributed for all t, the combined benefit flow π_C can be written as

$$\pi_C(t) = \pi_A(t) + \pi_B(t) = x_C(t) + \theta_C \quad (22)$$

where $x_C(t) = x_A(t) + x_B(t)$ is again a Brownian motion and $\theta_C = \theta_A + \theta_B$. The variance σ_C^2 of the combined Brownian motion x_C depends on the correlation ρ between the Brownian motions x_A and x_B: $\sigma_C^2 = \sigma_A^2 + \sigma_B^2 + 2\rho\sigma_A\sigma_B$.

The social planner's continuation value is defined in terms of the Brownian motion $x_C(t)$. At the time of exit, the entities incur the one-off costs k_i and k_j. Hence the social value of exit is $-k_C = -(k_i + k_j)$. The value-matching and smooth-pasting conditions are

$$V_C(x_C^e) = -2k \Leftrightarrow \frac{x_C^e + \theta_C}{r} + Be^{\beta_C x_C^e} = -k_C \qquad \textbf{\textit{VM}} \ (23)$$

$$V_C'(x_C^e) = 0 \Leftrightarrow \frac{1}{r} + \beta_C B e^{\beta_C x_C^e} = 0 \qquad \textbf{\textit{SP}} \ (24)$$

Resulting in the socially efficient exit state $x_C^e = -\theta_C - rk_C + \frac{1}{\beta_C}$ with $\beta_C = -\sqrt{\frac{2r}{\sigma_A^2+\sigma_B^2+2\rho\sigma_A\sigma_B}}$. The condition for socially efficient exit can be expressed in terms of the underlying states x_A and x_B:

$$x_C = x_C^e \Leftrightarrow x_A + x_B = -(\theta_A + \theta_B) - rk_C + \frac{1}{\beta_C} \qquad (25)$$

The social continuation value is $V_c(x_C) = \frac{x_C+\theta_C}{r} - \frac{e^{\beta_C(x_C - x_C^e)}}{r\beta}$. Socially efficient exit requires taking into account the states of both entities, as well as the total one-off costs of separation of $k_C = k_i + k_j$.

State-contingent exit penalties

In the Appendix, we derive *i*'s optimal exit behavior if only *i* has an exit option but the penalty can be made state-contingent. We show that if the penalty is of the form $c_i(x_j) = ax_j + b$, then i will exit in states (x_i^e, x_j^e) satisfying

$$x_i^e + arx_j^e = -\theta_i - r(b + k_i) + \frac{1}{\lambda_i}, \qquad \lambda_i = -\sqrt{\frac{2r}{\sigma_i^2 + a^2r^2\sigma_j^2 + 2ar\rho\sigma_i\sigma_j}} \qquad (26)$$

For this condition to lead to socially efficient exit as in (25), one finds $a = \frac{1}{r}$, so that $\lambda_i = \beta_i$ and $b = \frac{\theta_j}{r} + k_j$. Hence the socially efficient exit penalty for i is

$$c_i^* = \frac{x_j + \theta_j}{r} + k_j \qquad (27)$$

The higher the state of the other entity x_j, the higher the exit cost should be to induce entity i to take socially efficient exit decisions. Conversely, if entity *j* is in a very bad state, entity i would receive a positive payment for ending the agreement. The second term of c_i^*, equal to k_j, reflects that for socially efficient exit i needs to be incentivized to take *j*'s one-off costs of *i*'s exit into account.

Under the socially efficient exit penalty c_i^*, i's option value coincides with the social planner's option value:

$$c_i = c_i^* \Rightarrow V_i(x_i, x_j) = \frac{x_i + \theta_i}{r} - \frac{e^{\beta_C(x_c - x_C^e)}}{r\beta}, \qquad V_j(x_i, x_j) = \frac{x_j + \theta_j}{r} \tag{28}$$

This is because i has the same costs and benefits from stopping the agreement as the social planner: the payment of $k_i + k_j$, and the loss of the perpetuity value $\frac{x_i + x_i}{r}$. The loss of x_i/r is direct: by stopping the agreement, i stops his benefit flow. The loss of x_j/r is indirect: the socially efficient exit penalty requires that i pay x_j/r to j.

Optimal exit in a game-theoretical setting

In the previous section, we formally analyzed the case where only one entity had an exit option. In this section, we discuss exit in a game-theoretical setting. The analysis in this setting depends crucially on the possibility of a negotiated exit.

The role of negotiated exit

If there are no obstacles to negotiating exit, socially efficient exit will occur irrespective of a potential exit clause. However, since the exit clause represents an outside option it may affect the side-payments made to forestall or obtain exit, similar to the distribution of property rights in Coase (1960). Imagine an agreement with an exit clause, and suppose entity i is in a low state while entity j is in a high state. If the exit cost is below the level that would induce socially efficient exit by i, entity j will make a side-payment to entity i for not exercising its exit option. The lower the exit cost, the higher this side-payment will need to be. Conversely, if the exit cost is above the level that would induce socially efficient exit by i, entity i will have to make a side-payment to entity j relative to the socially efficient exit penalty in order to be allowed to exit at the socially efficient state.

If the negotiation of exit is frictionless, secession wars will never occur, although their possibility may affect the side-payments made for socially efficient exit. However, in reality many obstacles may limit the

scope for negotiating exit. Politicians or voters may be loss-averse or boundedly rational (Herweg & Schmidt, 2015). Moreover, transfers may be costly and entities' states may be privately observed (Bordignon & Brusco, 2001). The importance of such impediments to a negotiated exit is ultimately an empirical matter. But because these impediments are hard to measure, we prefer not to formally model the role of negotiated exit and provide a discussion instead.

If negotiating exit is not frictionless, the possibility of an inefficient secession war reemerges, and with it the scope for exit clauses to improve social welfare. In particular, setting the exit cost $c + k$ equal to the cost of a secession war w would be welfare enhancing: when i's state drops to $x_i^e(w)$, it will pay the penalty $c = w$ to j, instead of starting a secession war which costs d to j. If the state of the world is fully contractible, efficiency could be further increased in the absence of renegotiation by making entity i's exit cost conditional on j's state as in (28). However, since the lack of observability of j's state by i may precisely be one of the impediments to a negotiated exit, it seems optimistic to assume that state-contingent exit clauses could fully restore social efficiency.

The possibility of an anti-secession war

We have argued that agreements may not be fully binding because of the possibility of a secession war and of a negotiated exit. A further enforcement problem is the possibility of an anti-secession war. Even if the agreement includes an exit clause, an entity trying to make legal use of this clause may be faced with an anti-secession war by the remaining entity. This is what occurred to some extent during the break-up of the Soviet Union, which half-heartedly tried preventing the secession of some Soviet republics.

The risk of an anti-secession war is higher the higher the state of the remaining entity and the lower the exit cost, and hence poses a lower limit on enforceable exit costs. Similar to a secession war, an anti-secession war can be modeled as a pair of costs: (1) the cost the remaining entity would have to incur to prevent secession by the other entity (including both the direct costs and the reputational costs) and (2) the corresponding damage to the entity which tried to secede legally but failed. The stronger the international

norm against preventing legal secession, the higher the reputational cost of trying to prevent legal secession and hence the less relevant the anti-secession war option as an enforcement problem.

Exit clauses in a game-theoretical setting

If both entities have an exit option, entity i's optimal exit strategy will depend on entity j's exit strategy and vice versa. In such a setting, no analytical solutions are available because the exit options are no longer perpetual: entity i's (stochastic) exit time is the expiration date of entity j's exit option. However, some general characterizations are possible based on our formal decision theoretical model.

If both entities are in a good state the exit option is not valuable to either and the agreement will continue. If i is in a bad state while j is in a good state, i may want to exercise its exit option. If an ex-post negotiated exit is not possible, then i will exit sooner the lower the exit penalty. The lower the impediments to a negotiated exit, the closer i's exit decision will be to the socially efficient exit state. If the ex-ante agreed to exit penalty is low, j will make a side-payment to i for staying in the agreement. If the exit penalty is high, i will make a side-payment to be allowed to exit. If both i and j are in a bad state, then it seems likely that a free exit will be negotiated even if there are some impediments to ex-post negotiations.

Discussion

Given our results, one may wonder why exit clauses are not more prevalent in real-world political agreements. We discuss four main reasons here. First, the politicians negotiating political agreements may wish to tie their successors' hands. In our model, we assumed that each entity participating in the political agreement could be represented as a unitary actor. In practice, political agreements may have heterogeneous effects on different parts of the population within one entity. If that is the case, politicians whose electorate favors the agreement may want to prevent exit in the future by not having an exit clause.

Second, political agreements may not be rationally designed. This may be especially true for federal countries which have existed for a long time. But even for modern federations and currency unions there may be a norm against exit clauses (particularly with exit penalties) in currency unions and (con)federations

because they are perceived as going against the spirit of collaboration embedded in such unions. Third, exit clauses may not be prevalent in the real world because some of the conditions of our theory do not hold. In particular, the cost of a secession war may be uncertain. Fourth, powerful entities may be able to impose their terms upon the other participants. Given favorable substantive terms of the union, they would expect to benefit a lot from the agreement and hence have a high type θ. In turn, this would lead them to prefer a high exit cost for the others. Expecting to be able to renegotiate easily if the agreement would ever stop being beneficial to themselves, they may prefer not to have an exit clause altogether, and impose this upon the other participants. Empirical research is needed to assess the true role of each of the four reasons mentioned above.

Conclusion

In the presence of stochastic shocks, exit clauses can play a beneficial role in political agreements. The argument that exit clauses necessarily decrease the perceived stability of an agreement is unsound: without exit clauses, exit may still occur through secession wars or through a negotiated exit. The inclusion of exit clauses when agreements are drafted can improve ex-ante social welfare. In particular, appropriate state-contingent exit penalties can enable socially efficient exit. If exit penalties cannot be made state-contingent, appropriate fixed exit penalties can still increase social welfare by avoiding secession wars.

In spite of their advantages, exit clauses may be lacking from most present currency unions and (con)federations because of several reasons: (1) the benefits of the union may be spread unevenly within the entities, and politicians negotiating on behalf of those who benefit may want to tie the hands of their successors, (2) there may be norm-based reasons against exit clauses, because they go against the spirit of collaboration embedded in political unions, (3) there may be informational problems we did not model, and (4) powerful entities may for their own benefit impose both the substantive terms of the agreement and the lack of an exit clause.

We leave for future research a formal study of the ex-ante negotiation of exit clauses. Given the distributional implications of exit clauses, the bargaining process will be important for the final outcome,

and socially efficient exit clauses are not guaranteed. In particular, high types will prefer high-cost exit clauses, while low types will prefer low-cost exit clauses. However, to the extent that ex-ante information is limited and the entities are negotiating behind a veil of ignorance, their ex-ante preferences will be closer to the social optimum and negotiations will be easier.

A second suggestion for future research is to make the link between the state of the world and payoffs endogenous. In this article, we have modeled the payoff-relevant state of the world as fully exogenous. In practice the entities may be able to affect how the state of the world affects their payoffs by renegotiating the terms of the agreement. For instance, a federal country's laws affect how the state of the world maps to interregional transfers and hence to the benefits from the agreement. If at some point the prevailing transfers make the federation undesirable to an entity, this entity will most likely try to renegotiate the federal laws before considering exit from the federation.

References

Aghion, P., & Bolton, P. (2003). Incomplete social contracts. *Journal of the European Economic Association*, *1*(1), 38–67.

Alesina, A., & Spolaore, E. (2003). *The Size of Nations*. Cambridge, Mass: MIT Press.

Athanassiou, P. (2009). Withdrawal and expulsion from the EU and EMU: some reflections. *ECB Legal Working Paper Series*, (10).

Bordignon, M., & Brusco, S. (2001). Optimal secession rules. *European Economic Review*, *45*(10), 1811–1834.

Buchanan, A. (1997). Theories of Secession. *Philosophy & Public Affairs*, *26*(1), 31–61.

Chen, Y., & Ordeshook, P. C. (1994). Constitutional secession clauses. *Constitutional Political Economy*, *5*(1), 45–60.

Coase, R. (1960). The Problem of Social Cost. *Journal of Law and Economics*, *3*, 1–47.

Cohen, B. J. (1993). Beyond EMU: the Problem of Sustainability. *Economics & Politics*, *5*(2), 187–203.

Desmet, K., Breton, M. Le, Ortuño-Ortin, I., & Weber, S. (2011). The stability and breakup of nations: a

quantitative analysis. *Journal of Economic Growth*, *16*, 183–213.

Dixit, A. K. (1989). Entry and Exit Decisions under Uncertainty. *Journal of Political Economy*, *97*(3), 620.

Dixit, A. K., & Pindyck, R. S. (1994). *Investment under uncertainty*. Princeton, N.J: Princeton University Press.

Drèze, J., De Grauwe, P., & Edwards, J. (1993). Regions of Europe: a Feasible Status, to be discussed. *Economic Policy*, *8*(17), 265–307.

Filippov, M., Ordeshook, P., & Shvetsova, O. (2004). *Designing Federalism: A Theory of Self-Sustainable Federal Institutions*. Cambridge University Press.

Goetz, C. J., & Scott, R. E. (1977). Liquidated Damages, Penalties and the Just Compensation Principle: Some Notes on an Enforcement Model and a Theory of Efficient Breach. *Columbia Law Review*, *77*(4), 554–594.

Habtu, A. (2005). Multiethnic Federalism in Ethiopia: A Study of the Secession Clause in the Constitution. *Publius: The Journal of Federalism*, *35*(2), 313–335.

Helfer, L. R. (2005). Exiting treaties. *Virginia Law Review*, *91*(7), 1579–1648.

Herweg, F., & Schmidt, K. M. (2015). Loss Aversion and Inefficient Renegotiation. *The Review of Economic Studies*, *82*(1), 297–332.

Koremenos, B. (2016). *The Continent of International Law: Explaining Agreement Design*. Cambridge University Press.

Mörters, P., & Peres, Y. (2010). *Brownian Motion*. Cambridge University Press.

Øksendal, B. (1991). *Stochastic Differential Equations*. New York: Springer.

Powell, W. W., & DiMaggio, P. J. (1983). The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality in Organizational Fields. *American Sociological Review*, *48*(2), 147–160.

Rainer, H. (2007). Should we write prenuptial contracts? *European Economic Review*, *51*(2), 337–363.

Sorens, J. (2016). Hearing: U.S. Policy Toward National Self-Determination Movements. *House Committee on Foreign Affairs, March 15*, 1–6.

Sunstein, C. R. (1991). Constitutionalism and Secession. *The University of Chicago Law Review*, *58*(2),

633–670.

Sunstein, C. R. (2001). Should Constitutions Protect the Right to Secede? A Reply to Weinstock. *The Journal of Political Philosophy*, *9*(3), 350–355.

Weinstock, D. (2001). Constitutionalizing the Right to Secede. *The Journal of Political Philosophy*, *9*(2), 182–2003.

Young, R. (1994). How Do Peaceful Secessions Happen ? *Canadian Journal of Political Science / Revue Canadienne de Science Politique*, *27*(4), 773–792.

Appendix

Optimal exit with a notice period N

Exit clauses specifying an exit penalty c are not the only option. Another type of exit provision is a notice period: exit is free but needs to be announced N periods in advance. In this case, the expected value of exit at state x is equal to

$$V^N(x) = -k + \int_0^N (x+\theta)e^{-rt}dt = -k + \frac{1}{r}(1-e^{-rN})(x+\theta) \qquad (29)$$

By the same reasoning as (11), the continuation value is $V(x) = \frac{x+\theta}{r} + Be^{\beta x}$. The following value-matching and smooth-pasting conditions determine the constant B and the optimal exit state x^e:

$$V(x^e) = V^N(x^e) \Leftrightarrow \frac{x^e+\theta}{r} + Be^{\beta x^e} = -k + \frac{1}{r}(1-e^{-rN})(x+\theta) \qquad \textbf{\textit{VM}}\ (30)$$

$$V'(x^e) = [V^N]'(x^e) \Leftrightarrow \frac{1}{r} + \beta Be^{\beta x^e} = \frac{1}{r}(1-e^{-rN}) \qquad \textbf{\textit{SP}}\ (31)$$

Solving this system of two equations one finds:

$$x^e = -\theta - rk + \frac{1}{\beta}, \qquad B = -\frac{e^{-rN-\beta x^e}}{r\beta} \qquad (32)$$

This shows that a notice period does not deter exit: the optimal exit state is identical to the one with exit penalty $c = 0$. Of course, a notice period may have benefits which we have not modeled here, such as lowering the one-off separation costs k. The continuation value is $V(x) = \frac{x+\theta}{r} - \frac{e^{\beta(x-x^e)-rN}}{r\beta}$. The longer the notice period, the less valuable the exit option and hence the lower the continuation value: $\frac{\partial V}{\partial N} < 0$.

The probability of exit

Using Bayes' rule and defining $\tau = T - T^e, y(\tau) = x(T^e+\tau) - x^e$:

$$P_t(m(T) \le x^e) = \frac{P_t(m(T) \le x^e \cap x(T) \le x^e)}{P_t(x(T) \le x^e | m(T) \le x^e)} = \frac{P_t(x(T) \le x^e) P_t(m(T) \le x^e | x(T) \le x^e)}{P_t(x(T^e+\tau) \le x^e | T_e \le T)}$$

$$= \frac{P_t(x(T) \le x^e)}{P_t(x^e + y(\tau) \le x^e | \tau \ge 0)}$$

It follows from $y(\tau) = x(T^e + \tau) - x^e$ that $dy = dx = \sigma\epsilon_t\sqrt{dt}$ so that $y(\tau)$ also follows a Brownian motion with $y(0) = x(T^e) - x^e = 0$ and variance σ^2. Hence the probability of the state dropping to or below x^e by time T is given by:

$$\begin{aligned} P_t(m(T) \leq x^e) &= \frac{\Phi(x^e; x(t), \sigma^2(T-t))}{P_t(y(\tau) \leq 0 | \tau \geq 0)} = \frac{\Phi(x^e; x(t), \sigma^2(T-t))}{1/2} \\ &= 2\Phi(x^e; x(t), \sigma^2(T-t)) \end{aligned} \tag{33}$$

State-contingent exit penalties

If the penalty c can be made state-contingent, then i's continuation value will depend on x_j even in the decision-theoretical setting. Assume only i has an exit option but the exit cost c_i is a function of x_j, specifically

$$c_i(x_j) = ax_j + b \tag{34}$$

As in (7), in order for i to stay in the agreement for dt longer at state (x_i, x_j), the expected change in continuation value combined with the benefit flow should add up to the normal return $rV_i(x_i, x_j)dt$

$$E[dV_i] + (x_i + \theta_i)dt = rV_i(x_i, x_j)dt \tag{35}$$

Ito's lemma in two dimensions gives

$$\begin{aligned} dV_i &= \frac{\partial V_i}{\partial t}dt + \frac{\partial V_i}{\partial x_i}dx_i + \frac{\partial V_i}{\partial x_j}dx_j \\ &+ \frac{1}{2}\left[\frac{\partial^2 V_i}{\partial x_i^2}(dx_i)^2 + \frac{\partial^2 V_i}{\partial x_j^2}(dx_j)^2 + 2\frac{\partial^2 V_i}{\partial x_i \partial x_j}dx_i dx_j\right] \end{aligned} \tag{36}$$

Now, since V_i is time-independent and using the properties of the Brownian motions x_A and x_B, $E[dV] = \frac{1}{2}dt\left[\sigma_i^2\frac{\partial^2 V_i}{\partial x_i^2} + \sigma_j^2\frac{\partial^2 V_i}{\partial x_j^2} + 2\rho\sigma_i\sigma_j\frac{\partial^2 V_i}{\partial x_i \partial x_j}\right]$. Fill this out in (35) to obtain the partial differential equation

$$\frac{1}{2}\left[\sigma_i^2\frac{\partial^2 V_i}{\partial x_i^2} + \sigma_j^2\frac{\partial^2 V_i}{\partial x_j^2} + 2\rho\sigma_i\sigma_j\frac{\partial^2 V_i}{\partial x_i \partial x_j}\right] + x_i + \theta_i = rV_i(x_i, x_j) \tag{37}$$

As in the main text, a particular solution is $V_p(x_i, x_j) = \frac{x_i+\theta_i}{r}$, the perpetuity value of the agreement. For the homogeneous part, which corresponds to the option value of exit, try $V_h(x_i, x_j) = e^{\lambda_i x_i + \lambda_j x_j}$ to obtain

$$\sigma_i^2\lambda_i^2 + \sigma_j^2\lambda_j^2 + 2\rho\sigma_i\sigma_j\lambda_i\lambda_j = 2r \tag{38}$$

This gives $V_i(x_i, x_j) = \frac{x_i+\theta_i}{r} + Ce^{\lambda_i x_i + \lambda_j x_j}$ with C to be determined and λ_i, λ_j satisfying (38).

Since upon exit i has to pay the penalty $c(x_j) = ax_j + b$ and incurs the one-off cost k_i, the value-matching condition at an exit state $x^e = (x_i^e, x_j^e)$ is

$$V(x^e) = -c(x_j^e) - k_i \Leftrightarrow \frac{x_i^e + \theta_i}{r} + Ce^{\lambda_i x_i^e + \lambda_j x_j^e} = -c(x_j^e) - k_i \qquad \textbf{\textit{VM}} \text{ (39)}$$

There are two smooth-pasting conditions because i should take both x_i and x_j into account when thinking about exit. The penalty does not depend on x_i, but it does depend on x_j, so that

$$\begin{aligned} &\frac{\partial V_i}{\partial x_i}(x^e) = 0 \Leftrightarrow \frac{1}{r} + C\lambda_i e^{\lambda_i x_i^e + \lambda_j x_j^e} = 0 \\ &\frac{\partial V_i}{\partial x_j}(x^e) = -\frac{\partial c}{\partial x_j} \Leftrightarrow C\lambda_j e^{\lambda_i x_i^e + \lambda_j x_j^e} = -a \end{aligned} \qquad \textbf{\textit{SP}} \text{ (40)}$$

Combining conditions (38), ***VM*** (39) and ***SP*** (40), one finds

$$\lambda_i = -\sqrt{\frac{2r}{\sigma_i^2 + a^2r^2\sigma_j^2 + 2ar\rho\sigma_i\sigma_j}}, \qquad \lambda_j = ar\lambda_i \tag{41}$$

Filling this out, one finds that optimal exit for i is defined in terms of the following linear combination of x_i and x_j

$$x_i^e + arx_j^e = -\theta_i - r(b + k_i) + \frac{1}{\lambda_i} \tag{42}$$

The higher a or the more c_i is made contingent on x_j, the higher the weight of x_j in i's exit decision. Entity i's continuation value depends on its own state x_i for the perpetuity value, and on the linear combination of x_i and x_j for the option value

$$V_i(x_i, x_j) = \frac{x_i + \theta_i}{r} - \frac{e^{\lambda_i\left[(x_i + arx_j) - (x_i^e + arx_j^e)\right]}}{r\lambda_i} \tag{43}$$

It is easy to verify that with a non-state contingent exit penalty $c_i(x_j) = c$, i.e. $a = 0, b = c$, the solution reduces to non-state contingent solution presented in the main text.