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The paradox of legal harmonization

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Abstract The legal landscape is changing, adapting to the global market. Differences between legal systems hinder transnational commerce. Countries reduce legal differences through non-cooperative and cooperative adaptation processes that alternatively lead to legal transplantation or harmonization. Switching costs render unification difficult. Cooperation reduces differences to a greater extent but rarely leads to legal unification. In this paper we unveil a paradox of legal harmonization. When switching costs are endogenous, countries engaging in cooperative harmonization may end up with less harmonization than those pursuing non-cooperative strategies.

Keywords Legal harmonization · Legal transplantation · Transnational contracts · Legal change

JEL Classification K10 · K33 · D70

1 Introduction

Nowadays we live in a world that, contrary to the past, changes fast in time and tends towards globalization. Differences between systems tend to narrow over time. This is especially true in the economic laws and customs that govern transnational commerce. Harmonization of legal regimes was unnecessary in economies characterized by closed national markets. With the gradual abolishment of legal and geographical barriers to trade, present-day commerce

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is gradually moving towards globalization. Transnational exchanges are no longer the exception to the rule, but are as important, in terms of their number and total value, as internal, domestic ones.

A large variety of instruments are utilized to reduce differences among legal systems, harmonizing national legal rules for the creation of a leveled playing field for transnational commerce.

First, legal systems can unilaterally amend their internal rules and adopt rules that are more frequently observed in other legal systems. In the comparative law literature, this form of harmonization is referred to as "*legal transplantation*". Legal transplantation consists in the introduction, in national legal systems, of statutes and principles belonging to other systems, be they legal rules of other countries or customs whose acceptance is widespread.[1] Legal transplantation reduces or potentially eliminates differences between legal systems through the unilateral non-cooperative effort of one system. Examples of legal transplantation include the adoption of the 1804 French Civil Code by Louisiana (under the form of the 1808 Digest of the Civil Laws in Force in the Territory of New Orleans) and the subsequent adoption of the French Code by several European nations. The wholesale transplantation of the 1900 German Civil Code (BGB) in Japan is another example of unilateral adoption of legal principles belonging to a foreign system. More recent examples include Turkey and countries in Central and Eastern Europe and the former Soviet Union after the collapse of the socialist system in the late 1980s. The Turkish actual legal system was established in the years 1924–1930. The various Codes were chosen from what were regarded as 'the best' codifications in their respective areas of law, with no single legal system serving as the general model. Civil law, the law of obligations and civil procedure were taken from Switzerland; commercial law, maritime law and criminal procedure were taken from Germany; criminal law from Italy, and administrative law from France. Likewise, post-socialist countries relied heavily on European and US models to draft their new legal systems.

Second, nations can bilaterally or multilaterally coordinate their efforts by harmonizing or unifying their legal systems. With "*legal harmonization*" nations agree on a set of objectives and targets and let each nation amend their internal law to fulfill the chosen objectives. With "*legal unification*" nations agree to replace national rules and adopt a unified set of rules chosen at the interstate level. Although legal harmonization and legal unification are often pursued with different legal instruments, they both result from cooperative efforts of the countries involved. The results of legal harmonization and legal unification differ however in the degree to which systems are effectively homogenized. Examples of harmonization and unification are frequently observed in the recent development of the national laws of EU member states. With the use of "directives" member states of the EU harmonize their national legal systems by setting common goals and standards. With "regulations" EU countries instead agree to replace their respective national laws with a common rule which becomes directly applicable in the national systems of all member states.

Through these non-cooperative and cooperative adaptation processes, the global legal landscape has undergone—and continues to undergo—substantial changes adapting to an increasingly global market economy. Processes of transplantation, harmonization and unification foster networks of trade, linking diverse legal traditions and often bridging principles of Civil and Common law.[2] Demand for legal harmonization and transplantation is therefore

[1] See Mattei (1997), Sacco (1991) and Watson (1995) for an extensive analysis of legal change through processes of legal trasplantation.

[2] As noticed by Galgano (2005), judge made law is gaining more and more importance in civil law countries. Many observers thus argue that we are witnessing what we could call the *Americanization* of law. Inter-

very strong. Institutional and jurisdictional differences constitute a serious barrier to globalization and the World Trade Organization's agenda is very much concerned with eliminating such differences.[3]

How can legal harmonization and transplantation help increase trade flows? A unified legal system avoids the conflict of laws problems and the often difficult application of private international law and foreign substantive law. This reduces the legal uncertainty associated with international business, generating greater legal predictability and security. Ribstein and Kobayashi (1996) list the benefits due to harmonization and transplantation. Specifically, a more uniform legal system reduces inconsistency costs, generated by diverging state laws.[4] It decreases information and litigation costs, as it makes it easier to ascertain which law applies in each state. It simplifies choice-of-law issues and eliminates the costs of forum shopping. Further, it reduces externality problems due to state laws that may, for example, favor domestic consumers and investors, while hurting foreign producers and issuers. Finally, a more uniform legislation is more likely to take into account interstate social welfare and not only the welfare of a single state.

Notwithstanding the strong pressures in this sense, countries seem to lag behind in the process of legal harmonization and unification. Legal systems remain substantially different in space. Countries are attached to their legal traditions, which are perceived to reflect the norms and accepted usages of their citizens, guaranteeing a stable environment where economic agents could produce and trade with other national partners. Individual transactions are subject to domestic law. When the transaction has points of relevant connection with more than one legal system, conflict of law rules provide a basis for identifying the applicable law. Alternatively, the parties may negotiate and introduce a choice of law clause in their contract.

In all such instances, the diversity of legal systems creates costs to transnational trade. Rodrik (2004) estimates that total transaction costs for advanced countries are about 40% in ad-valorem terms and traditional border-type barriers (like tariffs) count only for 5% of them. The remaining transaction costs may be due to different national currencies but differences in legal systems are certainly playing a major role. Lack of transparency and objectiveness of rules, differences in accounting standards and bankruptcy laws, in regulations for foreign investments, in disclosure requirements and in rules against corruption can seriously hinder trade and financial flows among countries and this can affect growth prospects heavily. This is why many argue that countries have lost much of their independence with globalization.[5]

In this paper we try to explain why countries delay or avoid a process of legal harmonization that could reduce barriers to international trade. In the present globalized market, countries face conflicting incentives. Although it is widely recognized that there is an increasing need to homogenize commercial laws for a uniform regulation of transnational trading

estingly, the harmonization of law is not only between North America and Europe, it also involves eastern countries, especially from Asia and this process, together with the fast rate of economic growth affecting some of these countries (like China and India), might prelude to the end of the western hegemony in the world economy hence on international commercial law.

[3] See Rodrik (2004).

[4] An example of inconsistency costs might be the case of a manufacturer exposed to many different product liability design standards, or that of a company having to deal with varying governance rules.

[5] Tanzi (2004) compares a set of countries which decided to open up in order to take advantage of the globalization process with another set consisting of countries similar to the ones in the first set in terms of income and initial conditions but which decided to remain close. Countries in the first set have now per-capita incomes that are ten or even more times those in the second group.

flows, there are also substantial switching and adaptation costs that may induce countries to preserve their local laws. Although most scholars agree that switching and adaptation costs can be quite substantial, there is often disagreement in the description of such costs—some stressing their financial nature, other focussing on the social and political impediments to legal change.

Among the direct costs of legal change, there are the costs of drafting the new law and the cost of adapting preexisting legal rules and institutions. Furthermore, a change in a primary source of law will often necessitate a change in secondary sources. A legislative change, for example, will often occasion the obsolescence of preexisting case law, necessitating the creation of new case law and revision of legal treaties and commentaries. Unavoidably, the enactment of a new law brings about information and learning costs for judges, lawyers and legal academics. In the short term, until the apparatus of secondary sources is comprehensively updated, legal change can bring about uncertainty, with a resulting surge of litigation due to lack of legal precedents and doubts on the interpretation of the new law by courts.

On a different note, Ogus (2002) argues that large rents are earned by legal practitioners, who might oppose harmonization and unification because that would weaken their local monopoly on the "supply of legal skills". In addition, Ribstein and Kobayashi (1996) argue that higher legal uniformity increases exit costs, in that it reduces exit opportunities, increasing the impact of mandatory rules and limiting efficiency-enhancing lex shopping.

Most recently, Garoupa and Ogus (2006) pointed out that free-riding might be the cause of the lack of full adjustment of legal systems. If one country transplants, it alone bears all the costs whereas other countries gain from reduced legal deformity. Thus, each country prefers harmonization by way of exportation of their own legal rules, rather than importation of others' legal rules. Garoupa and Ogus present a simple model where two countries engage in trade of goods and services and argue that the process of harmonization and transplantation is a coordination game, where, in equilibrium, one country fully adopts the other country's legal system, while the other enjoys the full benefits of legal harmonization at no cost. The authors suggest that the solution to such coordination problem would be the institution of a central authority to which countries should delegate the power to harmonize legal rules. The authors' view is reinforced by the consideration that the major costs seem to be social and political: legal harmonization and unification are seen as a threat to the legal culture and history of a country. According to Legrand (1997), social and political adaptation costs may be so high to make harmonization and unification impossible: legal traditions may be so distant from each other that society would simply resist the proposed legal change. An important ingredient of the theories based on social and political hostility to harmonization is given by the stylized fact that globalization is often seen as a new form of U.S. imperialism, where legal harmonization would represent a form of Americanization of law.[6]

The main point in these theories is that legal differences often stem from different cultures and social preferences. Specific rules are often suited to local traditions and customs, and even if their harmonization may enhance foreign trade opportunities, it may impose quite substantial short-run adaptation costs.[7]

[6]Susan Strange, the international political scientist, in her book "The Retreat of the State" (1996), points out how globalization is generally intended as a synonym of Americanization nowadays. See also Galgano (2005) *supra note* 2.

[7]In this respect, the example presented by Tanzi (2004) is quite interesting. He considers the case where harmonization requires the adoption of clear, objective rules in place of a system based on informal, inter-

That explains why, notwithstanding the undeniable benefits of legal harmonization, countries are not trying to eliminate legal differences to the extent one would expect and rationally choose to bear the costs that the diversity of legal systems creates to international trade. To reduce such costs, private associations often try to cope with the slow process of legal harmonization carried out by national legislative bodies, formulating uniform standards and drafting model codes that could be chosen to regulate transnational transactions (*lex mercatoria*). Due to high information and transaction costs, however, the adoption of such uniform rules for international commerce is not always a viable alternative for individual non-professional traders. Such legal regimes are adopted prevalently by professional traders, who are willing to opt out of the applicable legal regime with express choice of law and choice of forum clauses in their contracts.[8]

Our model shows that the presence of political and social switching costs can lead to a counter-intuitive result, where new institutional or legal differences may be created as a hands-tying strategy to resist legal change. Formally, this implies that, in some circumstances, a country might even decide to incur a cost to raise its own switching costs. For example, more complicated bureaucratic procedures and red tape might be introduced or new institutions like committees or authorities might be created. Such bodies would strongly oppose change, thus increasing political obstacles. Through these strategies adaptation and switching costs would be purposefully increased to resist legal change. In some instances, lawmakers can give constitutional status to some rules, which would require supermajorities or aggravated procedures for their amendment as a way to warrant the preservation of such rules in the face of future legal change. Likewise, the recognition of specific rules as fundamental principles of the system, thus creating a strong presumption against their modifiability, increases prospective switching costs. Finally, in many systems the use of a referendum to approve changes (like those called in several EU countries to approve the new European Constitution) could be strategically used to preserve the status quo. If voters reject the proposed change, political switching costs would become prohibitive.

This result might seem counter-intuitive, given that impediments to international trade flows have repercussions for growth prospects and for per-capita incomes. It would then be plausible to assume that, if countries had the opportunity to do so, they would choose to reduce switching costs to facilitate legal harmonization, at least to the point where the marginal benefit of cost reduction equates the marginal cost of reducing switching costs. Our analysis shows that this is not necessarily the case.

This counter-intuitive result is driven by the strategic nature of countries' efforts to reduce the difference among respective legal systems. We find that efforts are strategic substitutes, i.e. the marginal benefit from increasing one country's effort is decreasing in another country's effort. This implies that a country has the incentive to decrease its own effort when another one increases its own. Vice-versa, a country tends to increase its own effort when another decreases it.[9] By raising switching costs, a country credibly commits itself to a low

personal relations. These changes would be considered by the population almost a social revolution and be likely rejected.

[8]These attempts to harmonize and unify law can lead to very complex scenarios. Consider, for example, the European Union Contract Law, which is now characterized by the co-existence of the national contract law, of the Directives issued by the EU and of the so-called "soft law", the Principles of European Contract Law (PECL) elaborated by the Lando Commission.

[9]This result reminds of Garoupa and Ogus (2006)'s free riding incentives, although we obtain it in a fully-fledged model of transplantation and harmonization, where countries can choose exactly how much to transplant/harmonize and are not forced to choose between either full equalization of legal systems or nothing.

effort, inducing the other countries to increase their effort because of strategic substitutability. Interestingly, the incentive to increase switching costs arises when the other country is expected to exert high levels of harmonization efforts. Countries that can control their own switching costs can thus put themselves in a condition to free ride on other countries' legal harmonization effort.

This conclusion can lead to an interesting paradoxical result. As stated above, legal harmonization and unification are cooperative processes, in contrast to non-cooperative transplantation changes. Being cooperative, such processes require higher levels of harmonization efforts for given adaptation and switching costs. As a consequence, it might well happen that a country has stronger incentives to increase its switching costs when the country expects to enter into a cooperative harmonization plan in the subsequent stage of the game. It is then possible that, due to the strategic incentives to increase their switching costs prior to a cooperative stage, there may actually be less harmonization when countries engage in cooperative efforts than when they proceed non-cooperatively with independent transplantation efforts. Our paradoxical result proves also that the countries' failure to harmonize and reduce legal differences is not a mere coordination problem, as stated by Garoupa and Ogus (2006) and that the institution of a centralized authority would not necessarily help.

We believe that our model provides an accurate description of the processes of legal transplantation and harmonization, giving an account of the fact that legal harmonization proceeds slowly notwithstanding international pressures and that gaps have often to be bridged by means of customary rules and *lex mercatoria.*

We consider the simple case of two countries or legal families A and B that initially have different legal systems. We describe the differences between these legal systems as a "legal distance". The distance between legal systems imposes costs on the countries' ability to foster private transnational transactions.

In order to reduce legal distance, countries can undertake unilateral transplantation of the rules of one system into the other. Alternatively, countries have the opportunity to negotiate a solution under which the preexisting legal systems are harmonized or even unified through international cooperation agreements. The adaptation of legal systems to shorten legal distance, however, is not without costs. In our analysis we consider explicitly the adaptation and switching costs that legal systems have to face when unilaterally or bilaterally adopting a new legal rule.

Cooperative solutions are modelled as alternative or subsequent to non-cooperative unilateral solutions. In negotiating a cooperative legal harmonization or unification agreement, countries maximize their joint welfare subject to the constraint that none of them obtains a payoff from the cooperative agreement that is lower than the payoff of the unilateral non-cooperative transplantation strategy. It is possible to show that there exists a cooperative solution, where countries take their respective non-cooperative solutions as their threat points and where the treaty agreement involves a reduction of the legal distance obtainable via unilateral non-cooperative transplantation. This creates incentives towards cooperative harmonization or unification solutions, which may however be hindered by positive switching costs.

The paper is organized as follows. In Sect. 2 we introduce the model. In Sect. 3, we study the non-cooperative processes of legal change leading to legal transplantation. In Sect. 4, we analyze the cooperative processes of legal change leading to harmonization and unification. In Sect. 5, we provide an explicit example with quadratic cost functions. In Sect. 6, we consider the more complex case where countries can endogenously affect switching costs. The possibility of cooperative harmonization and unification is studied as a two-stage game where one or both countries have the opportunity to affect their respective switching costs

by making a costly investment prior to the beginning of cooperative bargaining. Section 7 concludes offering some ideas for possible future extensions.

2 The model

We consider a simple scenario with two countries that have different legal systems. Country A has legal system a while country B has legal system b.[10] There are legal and contractual transactions between the two countries, as well as transactions that take place within the domestic sphere of each country. The difference in the substantive law of legal systems a and b imposes a cost on both countries A and B, reducing the net benefits from transnational commercial transactions. The difference between the legal systems imposes no cost on the domestic transactions that take place within each system.

We model the difference in the substantive law of the two countries as a continuous variable and refer to it as *legal distance* D. We assume complete and symmetric information, such that countries know each other's legal systems and have knowledge of constitutional and legislative processes that the other country might be required to utilize to carry out legal change.[11] Countries also know the exact value of legal distance D at any moment in time. Moreover, we abstract from efficiency considerations assuming that a and b are equally efficient and concentrate instead on the costs that legal distance imposes on countries' transnational transactions and the switching costs incurred by countries in the process of transplanting, harmonizing, or unifying legal rules to shorten legal distance.[12]

We normalize legal distance, such that when the two systems are one-hundred percent different from one another distance D would be equal to 1. In general, the two systems will differ initially by a percentage δ, where $\delta \in [0, 1]$. Countries can change δ by adopting rules and statutes from the other legal system. When looking at legal change in both non-cooperative and cooperative settings, we denote by x_A the percentage of legal system b adopted by A and by x_B the percentage of legal system a adopted by B. In our model, the quantities of the foreign system that each country transplants into its own domestic law are strategic *substitutes*. The unilateral move of one system (say, system A) towards the other (system B), reduces the incentives for system B to move closer to A. After countries undergo legal change, the remaining distance between legal systems can be defined as the difference between the original distance and the portions of foreign law that have been respectively adopted by B and A, namely

$$D = \delta - x_B - x_A. \tag{1}$$

[10] The terms A and B can also be interpreted as "legal families" (i.e., groups of countries that share a common legal tradition).

[11] In the real world information about legal systems is easily available and the introduction of uncertainty would not necessarily provide interesting insights. In general, uncertainty would increase the expected costs from unilateral transplantation and would likely reduce the extent to which individual countries are willing to adapt one system to another, absent explicit cooperation.

[12] In our setting, assuming that one system is more efficient (e.g. a is better than b) would imply that in equilibrium a higher fraction of a would be adopted by B and that a lower fraction of b would be adopted by A. The process of legal change—whether it is carried out via transplantation, harmonization, or unification—would generally tend towards the more efficient legal system. However, the adoption and spread of the more efficient legal system is not always guaranteed. As we have shown in a different paper (Carbonara and Parisi 2006) the adoption of legal rules is a path-dependent process, where network externalities play a crucial role and it is plausible that more efficient norms are abandoned or are simply unable to spread.

This definition implies that when countries make no effort to approach each other's systems, the distance between legal systems remains δ. Similarly, if only one of the two countries modifies its legal system, the remaining distance will depend entirely on the extent of that country's adaptation efforts. Finally, in case of legal unification where both countries modify their domestic law and successfully eliminate all legal differences, $x_A + x_B = \delta$, the residual distance will be null, $D = 0$. Ideally, such complete form of legal unification could occur through both independent non-cooperative transplantation strategies and cooperative efforts. However, our model shows that, in the presence of adaptation costs, complete unification is a more plausible outcome of cooperative efforts. In a cooperative regime, in fact, countries reduce legal distance more.

To illustrate how the definition of distance adopted here works in practice we present a numerical example. Suppose that initially the two countries are one-hundred percent apart, so that $D = \delta = 1$. Country A adopts 30% of legal system b as part of its own system, whereas B adopts 70% of a, so that $x_A = 0.3$ and $x_B = 0.7$. As an effect of such legal change, the two legal systems will be modified such that country A's new legal system a' will be reflect the 30% of adopted rules from b and 70% of the preexisting rules of a, resulting in $a' = 0.7a + 0.3b$. Likewise, country B's new legal system will be represented by $b' = 0.7a + 0.3b$. It is immediate to see that $a' = b'$ and that the two legal systems have converged de facto adopting a unified common system. In fact, through their reciprocal adaptations, $x_A + x_B = 1$, the differences between their legal systems have been entirely eliminated, $D = 0$. In other, more likely situations, the legal systems may partially converge, leaving some positive difference. Suppose that, initially, $D = \delta = 0.5$ (countries are fifty-percent apart) and that, for example, $x_A = 0.2$ and $x_B = 0.1$. The new composition of system a will be $a' = 0.8a + 0.2b$ and the new composition of system b will be $b' = 0.1a + 0.9b$. The common core of the two systems would thus be represented by the adopted 10% of a and the adopted 20% of b plus the initial 50% they had in common, with a total common share of 80% of rules, with a remaining distance $D = 0.5 - 0.1 - 0.2 = 0.2$.

We can now characterize the payoff functions. Countries obtain a payoff f_i $(i = A, B)$ from engaging in domestic and transnational commercial transactions. To simplify our notations, we assume that transnational transactions will still take place when countries have different legal systems, but at a higher cost. Since transactions are not prevented by legal diversity, the gross benefit from such transactions is assumed not to change with the distance between legal systems. The transaction costs incurred in transnational commerce however depend on the distance between legal systems, such that net payoffs become a decreasing function of legal distance $d_i(D)$, with $d_i'(\cdot) > 0$, $d_i''(\cdot) > 0$, $d_i(0) = d \geq 0$ and $d_i'(0) = 0$. Such transaction cost function captures the information and coordination costs that arise when foreign parties enter into legal transactions with one another. Countries have the chance to reduce distance (hence transaction costs) by adopting (part or the whole) of the legal system of the other country. This "shortening" of legal distance D can take place through non-cooperative unilateral transplantation or else through cooperative harmonization or unification. When countries adopt—via non-cooperative or cooperative action—foreign rules, they face adaptation cost $s_i(x_i)$, where $s_i(0) = 0$, $s_i'(\cdot) > 0$, $s_i'(0) = 0$ and $s_i''(\cdot) > 0$. We assume that the second derivative of $s_i(\cdot)$ is positive, meaning that the cost function $s_i(\cdot)$ is convex.

This assumption is a common regularity assumption, made to guarantee concavity of the payoff function. The alternative assumption (concave $s_i(\cdot)$) would also be interesting. In that case, initial changes would be more difficult (hence costly) than subsequent ones, which is rather plausible. Later changes would occur after the legal system has been adapted to the foreign law and would therefore be made on more favorable grounds. Assuming concavity

of $s_i(\cdot)$ might lead to non-convexities in the objective function and might lead to extreme solutions where a country either adopts the entire foreign system or adopts nothing.

Alternatively, we might assume that the cost of initial legal change is higher due to an initial fixed cost of adaptation, so that total cost is $F + s_i(x_i)$. This would represent a political cost of change a country has to pay to start the process of transplantation/unification and does not depend on the extent of distance reducing effort. In this case, equilibrium effort would not change. However, final welfare would be lower. Similarly, if $s_i'(0) > 0$ and large enough, the marginal cost of initial distance—reducing effort would be so high to offset the marginal benefit of lower legal distance. In that case we would have $x_i = 0$ in equilibrium and country i would exert no effort.[13]

Given x_j, $j \neq i$, country i's problem is to

$$\max_{x_i} w_i(x_i, x_j) = f_i - d_i(D) - s_i(x_i), \tag{2}$$

where the hypotheses on the cost functions guarantee that the welfare function of country i is globally concave in x_i.

3 The process of legal transplantation

Countries can reduce transaction costs caused by legal distance by importing foreign rules and legal doctrines into their domestic system. This form of unilateral adoption of another system's laws is known as legal transplantation. In this case countries act independently of one another in a non-cooperative manner, choosing their own degree of transplantation x_i given the other country's transplantation x_j and initial distance δ, which is exogenously given.

As will be shown in the following, countries always have some positive incentive to transplant some of the other country's legal system into their own to reduce the transaction costs occasioned by differences with other legal systems. However, by acting unilaterally in a non-cooperative manner, the presence of positive switching costs leads to a Nash equilibrium where distance is not fully eliminated and legal systems maintain some difference.

This can be seen by looking at the first order conditions of country A's and country B's optimization problems:

$$\frac{\partial w_A(x_A, x_B)}{\partial x_A} = -d_A'(D)\frac{\partial D}{\partial x_A} - s_A'(x_A) = 0, \tag{3}$$

$$\frac{\partial w_B(x_A, x_B)}{\partial x_B} = -d_B'(D)\frac{\partial D}{\partial x_B} - s_B'(x_B) = 0. \tag{4}$$

Given global concavity of the countries' welfare functions, the Nash equilibrium solution yields transplantation levels x_A^N and x_B^N, where the superscript indicates that these values form a Nash equilibrium.[14]

[13] See proof of lemma in Sect. 3.

[14] We assume that the condition for equilibrium uniqueness and stability is satisfied. Such condition requires that the slope of A's reaction function is larger than the slope of B's reaction function, i.e. $\frac{dx_B}{dx_A}\big|_A > \frac{dx_B}{dx_A}\big|_B$. A sufficient condition for this to happen is $\frac{dx_B}{dx_A}\big|_A > 1 > \frac{dx_B}{dx_A}\big|_B$, that is $\left|\frac{\partial^2 w_A}{\partial x_A^2}\right| > \frac{\partial^2 w_A}{\partial x_A \partial x_B}$ for

The countries' reaction functions are negatively sloped. This can be proved by totally differentiating country i's reaction function, which yields $\frac{dx_j}{dx_i}\big|_i = -\frac{\partial^2 w_i/\partial x_i^2}{\partial^2 w_i/\partial x_i \partial x_j}$. Since $\partial^2 w_i/\partial x_i^2 < 0$, $\text{sign}\left[\frac{dx_j}{dx_i}|_i\right] = \text{sign}\left[\frac{\partial^2 w_i}{\partial x_i \partial x_j}\right]$. Differentiating country i's reaction function with respect to x_j yields $\frac{\partial^2 w_i(x_i,x_j)}{\partial x_i \partial x_j} = -d_i''(D)\frac{\partial D}{\partial x_i}\frac{\partial D}{\partial x_j} < 0$, given $d_i''(D) > 0$ and $\frac{\partial D}{\partial x_i} < 0$. Then according to the terminology introduced by Bulow et al. (1985) x_A and x_B are strategic substitutes. In fact, an increase in x_i means an increase in the degree of legal transplantation carried out by country i, hence a more favorable attitude towards the other country. When a country backs up, reducing the percentage of rules transplanted, the other country faces higher transaction costs and welfare maximization requires higher transplantation effort of its own, in order to reduce the cost of legal diversity.

In a Nash equilibrium, we find that when countries are involved in transnational commercial transactions, they will have incentives to engage in some transplantation, such that both x_A^N and x_B^N would be positive. This can be also seen by observing that the optimal response to any level of partial (or even null) transplantation by the other country is always to transplant a positive percentage. However, in a Nash equilibrium distance always remains positive, meaning that the existence of switching costs and the concavity of welfare functions prevent the two countries from reaching complete legal unification by means of non-cooperative unilateral efforts.[15] Define $D^N = \delta - x_A^N - x_B^N$ the distance in the Nash equilibrium.

Lemma 1 *In the Nash equilibrium, for any* $0 < \delta \leq 1$, $x_A^N > 0$ *and* $x_B^N > 0$ *always.*

Proof From the first order conditions in (3) and (4) it can be readily seen that, for any given x_j, $-d_i'(D)\frac{\partial D}{\partial x_i}|_{x_i=0} - s_i'(0) > 0$ since $s_i'(0) = 0$.[16] Therefore $0 \leq x_i(x_j)$ for all $x_j \in [0, \delta]$. This, together with the conditions for the existence, uniqueness and stability of the Nash equilibrium, implies that $x_A^N > 0$ and $x_B^N > 0$ always. □

Proposition 1 *Given the existence of positive switching costs* $s_i(x_i)$, *in a Nash equilibrium distance* D^N *is positive, implying that there will never be complete legal unification by means of non-cooperative unilateral efforts.*

Proof The proof goes by showing that, for any given level of the other country's transplantation effort x_j it would not be optimal for country i to set $x_i = \delta - x_j$ thus bringing distance to 0. From the first order conditions in (3) and (4), at $D = 0$, $-d_i'(0)\frac{\partial D}{\partial x_i} - s_i'(x_i) < 0$ since $d_i'(0) = 0$. Therefore, for any x_j, the best response is to set x_i so that $D > 0$, i.e. $x_i < \delta - x_j$. This is true for all $x_j \in [0, \delta]$ and therefore it must be true in the equilibrium; $x_A^N + x_B^N < \delta$. □

A and $|\frac{\partial^2 w_B}{\partial x_B^2}| > \frac{\partial^2 w_B}{\partial x_B \partial x_A}$ for B. This condition ensures that the reaction functions cross only once, while also guaranteeing stability of the equilibrium. In fact the equilibrium is stable (locally) if $\frac{\partial^2 w_A}{\partial x_A^2}\frac{\partial^2 w_B}{\partial x_B^2} > \frac{\partial^2 w_A}{\partial x_A \partial x_B}\frac{\partial^2 w_B}{\partial x_B \partial x_A}$ which is implied by the first condition.

[15] Clearly, in case $\delta = 0$ and given that in our model we assume both legal systems are equally efficient, no country would exert any effort.

[16] Notice that $s_i'(0) = 0$ is a sufficient condition for an interior optimum. If $s_i'(0) > 0$ and sufficiently high we might have that $-d_i'(D)\frac{\partial D}{\partial x_i}|_{x_i=0} - s_i'(0) \leq 0$ and $x_i^N = 0$ always.

The result in Proposition 1 should be understood in light of the following considerations. The main assumptions driving our result are that the marginal cost of a change in distance is zero when $D = 0$ and that the gross payoff from commercial transactions f_i is not influenced by legal distance (i.e. transnational contracts become more costly but are not entirely prevented by differences between legal systems). The first hypothesis about transaction costs is a typical regularity assumption satisfied, for example, by all quadratic cost functions. It states that when distance D is zero, an infinitesimally small increase in distance does not produce a sensible increase in total distance costs. It is therefore a very plausible assumption. Dealing with a legal system that is virtually identical to the domestic one does not provoke a substantial increase in costs. The second hypothesis, that legal distance only affects transaction costs for transnational contracts and does not entirely eliminate the surplus from such transactions, can be easily relaxed, introducing a function $f_i(D)$ that is decreasing in the distance, with $f'(D) \leq 0$ and $f''(D) < 0$.[17] Then special cases might occur, where one of the countries has such a high marginal benefit from reducing legal distance that it finds it optimal to transplant the entire legal system of the other country, thus reaching full legal homogeneity. This happens when

$$f_i'(0)\frac{\partial D}{\partial x_i} \geq s_i'(\delta), \tag{5}$$

where the left-hand side of expression (5) represents the marginal benefit of eliminating distance, whereas the right-hand side is the marginal cost and $f_i'(0) < 0$. In the equilibrium we then have $x_i^N = \delta$ and $x_j^N = 0$.[18] A similar result is obtained if $D'(0) > 0$ and large enough.

Proposition 1 shows also that a paradoxical result of "leapfrogging" is ruled out in equilibrium. With leapfrogging countries would "transplant too much" of each other's legal system so that new differences appear the other way round (system A has adopted much of the former system B and vice-versa): despite the substantial efforts of both countries, legal systems would remain different from one another.[19]

4 Harmonization, unification and transnational legal cooperation

Countries often pursue legal harmonization or unification through international cooperative efforts. The creation or mutual recognition of common legal principles can be achieved through international treaties (e.g., the 1980 Rome Convention on the Private International Law of Contracts), delegation to supranational organs (e.g., the EU's delegated authority

[17] The sign of the second derivative represents a sufficient condition for global concavity of the country's welfare function.

[18] It should be noticed that, from a technical point of view, the introduction of $f_i(D)$ in the welfare function can lead to an overinvestment paradox where, in equilibrium, $x_i^N + x_j^N > \delta$. However, such an event would be quite unrealistic, given that in our model the only incentive to invest in legal change is the desire to reduce differences with other legal systems, such that when differences have already been eliminated by the other country there is no remaining reason to implement change. This implies that $f(D)$ is maximized when $D = 0$, so that the reaction function is such that the best response to an effort $x_j = \delta$ by the other country is $x_i = 0$.

[19] Note that $D = \delta - x_A - x_B$ implies that $D < 0$ whenever legal change is characterized by a paradoxical leap-frogging $x_A + x_B > \delta$. If such leap-frogging occurred, excessive reciprocal transplantation by countries would originate new legal differences equal to $x_A + x_B - \delta$. The conditions of our model exclude such paradoxical result, and in equilibrium, $\delta - x_B - x_A \geq 0$.

to issue *directives* with the effect of harmonizing the national laws of member states, or *regulations* with the direct effect of unifying the member states' national rules on a given issue), and by establishing commissions or sponsoring academic projects (e.g., the Lando Commission on the European Law of Contracts; the Trento Common Core Project). Through these cooperative instruments, systems increase to a greater or lesser extent the degree of similarity between their legal systems.

In this section, we model the process of legal change that may take place through these cooperative instruments. In our setting, countries bargain cooperatively to choose a target level of legal change that would reduce differences between their domestic systems. They do so by fixing the percentages of legal change, x_A and x_B, to be implemented in their respective national laws, ultimately determining the distance between their legal systems. These cooperative processes provide an alternative to the non-cooperative process of unilateral transplantation discussed in the previous section. We refer to these cooperative processes of legal change, using the legal terms of *harmonization* and *unification* of legal systems, rather than transplantation. In the process of harmonization and unification countries fix x_A and x_B cooperatively, whereas with transplantation they do so independently. When the process of cooperative legal change leads to the complete equality of legal systems (meaning that distance $\delta - x_A - x_B = 0$) we have *unification*. Such cooperation agreements are assumed to be binding and unilateral withdrawal from a cooperative solution is assumed to be costly. This assumption allows us to avoid ex post enforcement issues.

We model the process of harmonization as a cooperative game, where countries choose x_A and x_B to maximize the sum of individual welfare functions. Being a cooperative solution, harmonization allows countries to reach a higher total surplus. Countries share the surplus from cooperation which goes to augment the payoff otherwise obtainable in the non-cooperative Nash equilibrium.

The sharing of the surplus will take place according to one of the conventional sharing rules of cooperative bargaining. For example countries can share the surplus from cooperation reaching a point on the welfare possibility frontier where the ratio of country A's welfare to country B's welfare is equal to the pre-existing ratio of their non-cooperative equilibrium payoffs. Alternatively, countries could share the surplus from cooperation according to the allocation generated by a Nash bargaining solution. In that case countries would implement legal change that maximizes the product of their respective gains in welfare over the status quo non-cooperative outcome.[20] If countries have the same bargaining power and welfare functions, the sharing under a Nash bargaining solution would assign each country exactly one half of the cooperative surplus. Otherwise, Nash bargaining would yield shares that increase in bargaining power and in the slope of the other country's marginal welfare function.[21]

In this paper we assume that the surplus is allocated according to a sharing rule that assigns a fraction α of total cooperative surplus to A and a fraction $\beta = 1 - \alpha$ to B. This allows interpretations that are consistent with the alternative sharing rules discussed above.[22]

[20] In our case the status quo non-cooperative outcome corresponds to the Nash equilibrium with individual transplantation.

[21] For a thorough analysis of different bargaining rules and outcomes and their comparison with the Nash bargaining solution see Thomson (1994).

[22] If α and β are interpreted as the countries' bargaining power, our solution would resemble the Nash bargaining solution with different bargaining power. Alternatively, α might represent the ratio of A's to B's welfare, in which case we would have a proportional sharing rule.

As a result, the payoff that country i $(i = A, B)$ obtains from cooperative legal change becomes

$$\hat{w}_i = w_i^N + \kappa_i\left(\hat{W} - w_i^N - w_j^N\right) - T, \tag{6}$$

where w_i^N is country i's welfare in the non-cooperative Nash equilibrium ($i = A, B$, $i \neq j$), $\hat{W}$ is total welfare in the cooperative harmonization or unification regime and κ_i is country i's share ($\kappa_A = \alpha$). T represents the fixed transaction costs of negotiating and carrying out the cooperative agreement between the interested countries. These fixed transaction costs may occasionally exceed the obtainable cooperative surplus and could thus prevent cooperative solutions. The presence of transaction costs T could thus explain situations where countries do not coordinate harmonization efforts and prefer to carry out unilateral transplantation strategies, even though, in the absence of T, the cooperative outcome would always be preferred to the non-cooperative outcome, since $\hat{W} - w_i^N - w_j^N > 0$ by definition.

When countries agree on a cooperative solution, they choose x_A and x_B maximizing their joint welfare and then apply the sharing rule to determine $\hat{w}_A$ and $\hat{w}_B$ as in expression (6). The joint-maximization problem for A and B thus becomes

$$\max_{x_A, x_B} \hat{W}(x_A, x_B) = w_A(x_A, x_B) + w_B(x_A, x_B). \tag{7}$$

We assume that once the countries have reached a cooperative solution, such solution will be executed. Whether the cooperative solution is reached through formal treaty agreements, delegation of authority or other instruments, we thus assume that the countries' agreements are enforceable and sustainable also in a one-shot game.

We are now going to show that, when transaction costs T are sufficiently low, countries will reach an agreement involving a lower distance than that obtained through non-cooperative unilateral transplantation. In what follows, the superscript C denotes values obtained via cooperative harmonization or unification processes.[23]

Proposition 2 *In the cooperative equilibrium countries set levels x_A^C and x_B^C such that distance D^C is smaller than distance in the non-cooperative Nash equilibrium D^N.*

Proof We obtain the first order conditions for x_A and x_B from the objective function (7), substituting (2) to $w_i(x_i, x_j)$:

$$\frac{\partial \hat{W}(x_A, x_B)}{\partial x_A} = -\left[d_A'(D) + d_B'(D)\right]\frac{\partial D}{\partial x_A} - s_A'(x_A) = 0, \tag{8}$$

$$\frac{\partial \hat{W}(x_A, x_B)}{\partial x_B} = -\left[d_A'(D) + d_B'(D)\right]\frac{\partial D}{\partial x_B} - s_B'(x_B) = 0. \tag{9}$$

Keeping in mind that (8) and (9) do not represent reaction functions but conditions that x_A and x_B have to satisfy simultaneously in the cooperative equilibrium, it is immediate to see that (8) implies that in the cooperative solution country A will choose higher levels of x_A for any given x_B, compared to the alternative non-cooperative transplantation strategy. The same holds for x_B. This means that the point where (8) and (9) are satisfied simultaneously must lay in the area above the reaction functions of A and B, as Fig. 1 shows.[24] All points in

[23] The assumptions on the cost functions guarantee that the second order conditions are satisfied.

[24] Figure 1 is obtained setting initial distance $\delta = 1$, but can be easily generalized to any value $\delta \in [0, 1]$.

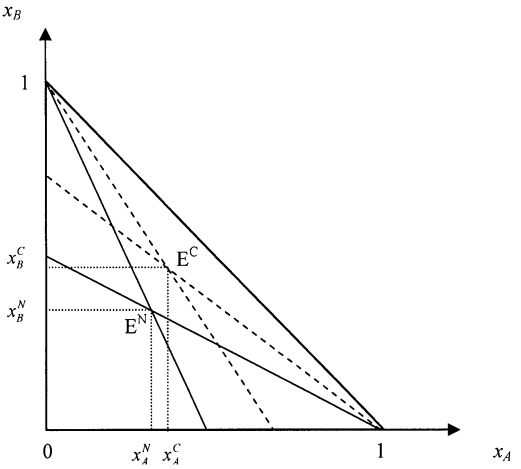


Fig. 1 The cooperative equilibrium E^C must lie above the reaction functions relative to the noncooperative transplantation case and closer to the $x_B = 1 - x_A$. (Reaction functions are drawn using *continuous lines* (*A*'s reaction function is the steeper one); *dashed lines* represent the countries' first order conditions in the cooperative case)

the region above the two reaction functions are closer to the line $x_B = \delta - x_A$, the line representing the locus where $D = 0$, than the Nash equilibrium point N. Hence, the cooperative solution must be characterized by a lower legal distance, $D^C < D^N$. □

It is important to notice that, even if the overall distance is lower in a cooperative solution, the levels of legal change x_A^C and x_B^C carried out by the respective countries can be higher or lower than the corresponding non-cooperative levels. The point is shown in Fig. 2. We can thus have situations where $x_A^C > x_A^N$ and $x_B^C < x_B^N$, so that the larger share of legal transformation is borne by country A (Fig. 2a), situations where both $x_A^C > x_A^N$ and $x_B^C > x_B^N$ such that A and B share the burden increasing their levels of legal change compared to the alternative non-cooperative strategies (Fig. 2b), and finally cases where $x_A^C < x_A^N$ and $x_B^C > x_B^N$, such that B bears the higher cost of legal change (Fig. 2c). Obviously, a case where both $x_A^C < x_A^N$ and $x_B^C < x_B^N$ cannot occur in equilibrium, since it would negate the result in Proposition 2 and lead to higher overall distance under cooperation.

In Sect. 5, we shall discuss the conditions under which each of the three cases presented above are likely to occur, with the use of quadratic cost functions. For the moment, however, it is important to anticipate that there are obvious distributive consequences from the undertaking of cooperative solutions, which creates possible incentives for strategic behavior in the pre-negotiation phase, in order to minimize the ex post burden of legal change in a cooperative equilibrium.

We conclude this section, presenting a result analogous to that in Proposition 1, namely that also in the cooperative equilibrium, distance D^C is likely to be positive, implying that complete legal unification is not viable when positive switching costs are present, unless very specific assumptions about payoff functions are made. The proof of this lemma is similar to the proof of Proposition 1 and is therefore omitted.

Lemma 2 *Given the existence of positive switching costs $s_i(x_i)$ at the cooperative equilibrium distance D^C is positive, implying that complete legal unification does not occur.*

Fig. 2a With $d_A < d_A^B < d_A^A$ then $x_A^C > x_A^N$ and $x_B^C < x_B^N$

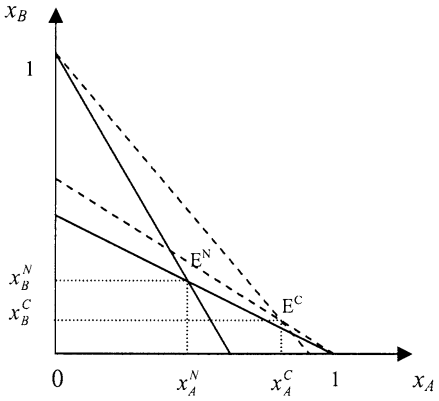


Fig. 2b With $d_A^B < d_A < d_A^A$ then $x_A^C > x_A^N$ and $x_B^C > x_B^N$

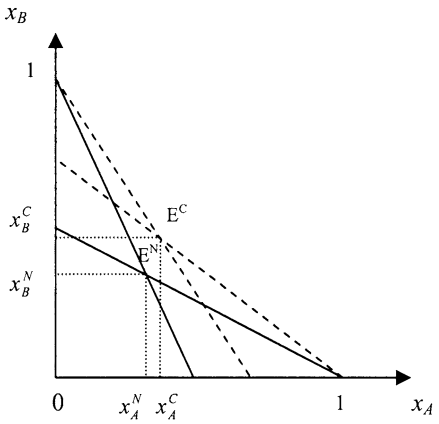
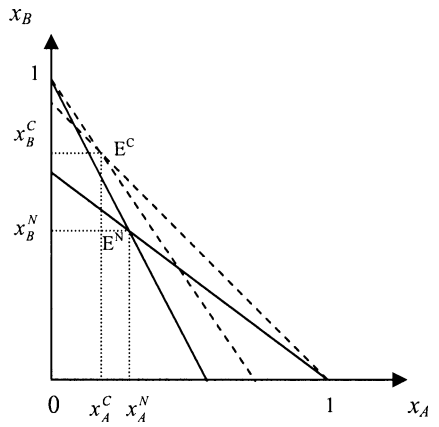


Fig. 2c With $d_A^B < d_A^A < d_A$ then $x_A^C < x_A^N$ and $x_B^C > x_B^N$



5 Optimal legal distance and welfare with quadratic cost functions

In this section we present an example using specific cost functions with the properties of the general cost functions introduced in the previous sections. This will allow us to characterize

with more precision the results obtained above, and to provide further analysis where the general model above does not present enough structure to lead to unambiguous conclusions. We will also conduct some simulations to evaluate the impact of legal distance on welfare and to measure the extent of adaptation and switching costs. We find that reducing legal distance has always a positive impact on total welfare, both in the case of non-cooperative and cooperative efforts.

We assume that the costs from legal distance are quadratic and are equal to $\frac{d_i}{2}(\delta - x_i - x_j)^2$, $i = A, B$, with $d_i > 0$. Similarly, switching costs are $s_i(x_i) = \frac{s_i}{2}x_i^2$, $s_i > 0$. These cost functions present all the characteristics of the general functions $d_i(D)$ and $s_i(x_i)$ introduced in Sect. 2. The objective function for country i becomes

$$w_i(x_A, x_B) = f_i - \frac{d_i}{2}(\delta - x_i - x_j)^2 - \frac{s_i}{2}x_i^2. \tag{10}$$

The equilibrium levels of investment in distance reduction by A and B and the distance both in the case of non-cooperative individual transplantation and of cooperative harmonization and unification are as follows

$$\begin{aligned} x_A^N &= \frac{d_A s_B \delta}{d_B s_A + (d_A + s_A)s_B}, & x_A^C &= \frac{(d_A + d_B)s_B \delta}{s_A s_B + (d_A + d_B)(s_A + s_B)}, \\ x_B^N &= \frac{d_B s_A \delta}{d_B s_A + (d_A + s_A)s_B}, & x_B^C &= \frac{(d_A + d_B)s_A \delta}{s_A s_B + (d_A + d_B)(s_A + s_B)}, \\ D^N &= \frac{s_A s_B \delta}{d_B s_A + (d_A + s_A)s_B}, & D^C &= \frac{s_A s_B \delta}{s_A s_B + (d_A + d_B)(s_A + s_B)}. \end{aligned} \tag{11}$$

It can be checked that the results of this example are consistent with the general qualitative results proved in the previous sections.

From the expressions in (11), the difference between level of legal distance in the non-cooperative transplantation case and in the cooperative harmonization and unification case can be computed

$$D^N - D^C = \frac{s_A s_B (d_A s_A + d_B s_B)\delta}{(d_B s_A + (d_A + s_A)s_B)(s_A s_B + (d_A + d_B)(s_A + s_B))}. \tag{12}$$

It is possible to see that the difference in (12) is always positive. This is an intuitive result, since through bargaining and cooperation countries are induced to choose solutions that bring their legal systems closer together, thus increasing total welfare with respect to the non-cooperative case.

We can now proceed to compare the levels of investment in legal change undertaken by the two countries in the alternative non-cooperative and cooperative cases.

From (11), $x_A^C - x_A^N = \frac{s_A s_B (d_B (d_B + s_B) - d_A^2)\delta}{(d_B s_A + (d_A + s_A)s_B)(s_A s_B + (d_A + d_B)(s_A + s_B))}$. Then $x_A^C > x_A^N$ (implying higher effort under cooperation) if and only if

$$d_A < d_A^A = \sqrt{d_B(d_B + s_B)}. \tag{13}$$

Similarly, $x_B^C - x_B^N = \frac{s_A s_B (d_A^2 - d_B^2 + d_A s_A)\delta}{(d_B s_A + (d_A + s_A)s_B)(s_A s_B + (d_A + d_B)(s_A + s_B))}$ and $x_B^C > x_B^N$ if and only if

$$d_A > d_A^B = \frac{-s_A + \sqrt{4d_B^2 + s_A^2}}{2}. \tag{14}$$

It is possible to show that $d_A^B < d_A^A$. Then the following cases are possible:

1. $d_A < d_A^B < d_A^A$, then $x_A^C > x_A^N$ and $x_B^C < x_B^N$. In this case, country A bears the highest cost of this cooperative agreement. Further, given that distance is smaller in a cooperative regime, this means that A's increase in effort more than compensates for B's reduction: x_A increases more than x_B decreases. According to definitions (13) and (14), this happens when d_A is very low relatively to both d_B and s_B. Since x_A^N is increasing in d_A, a low d_A implies that in the non-cooperative Nash equilibrium country A puts relatively low effort in reducing distance, thus inducing B to put relatively high effort (because of strategic substitutability of efforts). The cooperative bargaining levels this situation. This is the case illustrated in Fig. 2a.
2. $d_A^B < d_A < d_A^A$, then $x_A^C > x_A^N$ and $x_B^C > x_B^N$. In this case d_A is higher than before and relatively high with respect to d_B. The uneven non-cooperative efforts presented in the previous case are less likely to occur here and the cooperative solution leads both countries to increase their legal change efforts. Which country will have to make the larger adaptation effort (i.e., whether $x_A^C - x_A^N$ will be greater or lower than $x_B^C - x_B^N$) depends on the parameter values. This case is illustrated in Fig. 2b.
3. $d_A^B < d_A^A < d_A$, then $x_A^C < x_A^N$ and $x_B^C > x_B^N$. This case mirrors case 1. Here d_A is relatively high, so that x_A^N is likely to be high and x_B^N consequently low. In the non-cooperative Nash equilibrium country B puts relatively low effort in reducing distance, thus inducing A to compensate for it with higher effort. The cooperative bargaining leads to a more balanced effort by the two countries. This is the case illustrated in Fig. 2c.

We now turn to measuring the impact of legal distance and switching costs on welfare. Clearly, such impact depends on the underlying parameters. Using the quadratic functions introduced in this section, we can assess the magnitude of the parameters required to justify a cost of legal distance to be about thirty-five/forty percent in ad-valorem terms, as estimated by Rodrik (2004).

We present three different simulations. In the first, countries are symmetric in their costs of legal distance and their switching costs, whereas is the second and third they are asymmetric. In the second simulation country A has much higher costs from legal distance and it also has higher adaptation and switching costs. In the third simulation, country A has still much higher costs from legal distance but A's switching costs are lower than B's. Parameters are chosen so that, given an initial distance $\delta = 1$, both countries lose forty percent on possible total gains from foreign commercial transactions. We then compute their legal change efforts, measuring their switching costs and the increase in welfare their efforts allow. We find that reducing legal distance, albeit costly, always increases total welfare with respect to the case where countries make no attempts to limit the impact of legal distance. Unsurprisingly, for feasible values of T, legal change under cooperation yields higher total welfare.[25] These results are independent of initial legal distance δ.

The first simulation is presented in Table 1. Legal change and harmonization have a positive impact on welfare for all possible values of initial distance, δ. For example, if $\delta = 1$, total losses are reduced from 40 to 6.9% in the non-cooperative case and to 6.32% in the cooperative case. Aggregate effort is higher under cooperation for all values of δ, given that maximization of joint welfare allows the internalization of the positive externality that

[25] In all simulations we assume that T is small enough that cooperation is always the preferable option, i.e. $T \simeq 0$ or $T \leq \hat{w}_i - w_i^N$. This is without loss of generality, since here we are interested in the analysis of the costs of legal distance on welfare gross of negotiation costs.

Table 1 Symmetric countries. Parameters are $f_A = f_B = 10$; $d_A = d_B = 8$; $s_A = s_B = 6$. Total costs of legal distance equal 40% of total possible earnings from business contracts when $\delta = 1$ and $x_A = x_B = 0$

δ	Total welfare with $x_i = 0$	$w_A^N + w_B^N$ with $x_i \neq 0$	$\hat{W}$ with $x_i \neq 0$	Total loss from legal distance with $x_i = 0$ (percent)	Total loss from legal distance with $x_i \neq 0$ and non-cooperation (percent)	Total loss from legal distance with $x_i \neq 0$ and cooperation (percent)	$x_A^N + x_B^N$	$x_A^C + x_B^C$
0	20	20	20	0	0	0	0	0
0.1	19.92	19.986	19.987	0.4	0.07	0.06	0.073	0.08
0.2	19.68	19.944	19.949	1.6	0.28	0.25	0.145	0.17
0.3	19.28	19.875	19.886	3.6	0.62	0.57	0.22	0.25
0.4	18.72	19.778	19.798	6.4	1.11	1.01	0.29	0.34
0.5	18	19.653	19.684	10	1.74	1.58	0.36	0.42
0.6	17.12	19.5	19.545	14.4	2.5	2.28	0.44	0.5
0.7	16.08	19.32	19.381	19.6	3.4	3.1	0.51	0.59
0.8	14.88	19.11	19.192	25.6	4.44	4.04	0.58	0.67
0.9	13.52	18.87	18.977	32.4	5.6	5.12	0.65	0.76
1	12	18.61	18.737	40	6.9	6.32	0.73	0.84

$$\frac{x_A^N}{x_A^N + x_B^N} = \frac{x_A^C}{x_A^C + x_B^C} = \frac{s_A(x_A^N)}{s_A(x_A^N) + s_B(x_B^N)} = \frac{s_A(x_A^C)}{s_A(x_A^C) + s_B(x_B^C)} = 0.5$$

one country's effort has on the other country's welfare. Moreover, given that parameters are chosen so that $d_A^B < d_A < d_A^A$, both countries exert higher effort in the cooperative regime. Countries are symmetric, hence they split the costs of distance-reduction in equal parts, each exerting 50% of total effort and bearing half of total switching costs.

Table 2 considers the asymmetric case where A has both higher distance costs and switching costs. The comparison of the results in Tables 1 and 2 suggests some interesting conclusions. First of all, total welfare in the non-cooperative case is lower when countries are asymmetric compared to the symmetric case (percentage loss is reduced from 40 to 7.75 when $\delta = 1$). In a non-cooperative setting, B has lower incentives to exert effort with respect to the symmetric case, given that B's loss from legal distance is lower and given that the much higher loss born by A leads to a much greater effort on A's behalf. However, the increase in A's effort with respect to the symmetric case is not enough to compensate the reduction in x_B.[26] In fact, total effort is lower than in the case of symmetric countries. Notice instead that total welfare under cooperation is higher compared to the case with symmetric countries in Table 1 and the total loss from legal distance is reduced. This is because cooperation demands a much higher effort by country B, whose switching costs are lower. A exerts 60% of total effort without cooperation, but its effort drops to 33% with cooperation. In this second simulation, parameters are chosen so that $d_A^B < d_A^A < d_A$, which implies that A decreases its effort with cooperation but B increases its effort with respect to the non-cooperative case. The increase in x_B more than compensates the decrease in x_A given that total effort with cooperation is higher.

[26] This is because A now has much higher switching costs.

Table 2 Asymmetric countries. A has higher distance costs and switching costs. $f_A = f_B = 10$; $d_A = 12$; $d_B = 4$; $s_A = 8$; $s_B = 4$. Total costs of legal distance equal 40% of total possible earnings from business contracts when $\delta = 1$ and $x_A = x_B = 0$

δ	Total welfare with $x_i = 0$	$w_A^N + w_B^N$ with $x_i \neq 0$	$\hat{W}$ with $x_i \neq 0$	Total loss from legal distance with $x_i = 0$ (percent)	Total loss from legal distance with $x_i \neq 0$ and non-cooperation (percent)	Total loss from legal distance with $x_i \neq 0$ and cooperation (percent)	$x_A^N + x_B^N$	$x_A^C + x_B^C$
0	20	20	20	0	0	0	0	0
0.1	19.92	19.984	19.989	0.4	0.077	0.057	0.071	0.09
0.2	19.68	19.938	19.954	1.6	0.31	0.23	0.143	0.17
0.3	19.28	19.86	19.897	3.6	0.7	0.51	0.214	0.26
0.4	18.72	19.752	19.817	6.4	1.24	0.91	0.28	0.34
0.5	18	19.612	19.714	10	1.94	1.43	0.357	0.43
0.6	17.12	19.442	19.589	14.4	2.79	2.06	0.43	0.51
0.7	16.08	19.24	19.44	19.6	3.8	2.8	0.5	0.6
0.8	14.88	19.01	19.268	25.6	4.96	3.66	0.57	0.69
0.9	13.52	18.744	19.074	32.4	6.28	4.63	0.64	0.77
1	12	18.45	18.857	40	7.75	5.71	0.71	0.86

$$\frac{x_A^N}{x_A^N + x_B^N} = 0.6, \quad \frac{x_A^C}{x_A^C + x_B^C} = 0.33, \quad \frac{s_A(x_A^N)}{s_A(x_A^N) + s_B(x_B^N)} = 0.75, \quad \frac{s_A(x_A^C)}{s_A(x_A^C) + s_B(x_B^C)} = 0.33$$

The results from the third simulation are presented in Table 3. In this case A and B's costs of legal distance, d_A and d_B, are exactly the same as in Table 2 but switching costs are reversed: now A has lower switching costs. By inspection, it is easy to verify that total welfare under cooperation is the same as in Table 2, and total effort is also the same. The difference is that now equilibrium effort and total switching costs are allocated differently between countries. A exerts 67% of total cooperative effort, leaving B a mere 33%. More interesting is the case of non-cooperative effort, where total welfare is now higher compared to Table 2. This is due to the fact that total distance reducing effort increases and A, whose switching costs are lower, exerts 86% of total effort compared to 60% in Table 2.[27]

These simulations show that the negative impact of legal distance can be quite substantial and that harmonization efforts are always desirable, notwithstanding positive adaptation and switching costs. Even when marginal switching costs are high with respect to the loss due to legal distance our model predicts that the reduction in losses from legal distance due to the countries' joint effort can amount to more than 80% (from 40 to 5.71%).

[27] From the simulations data presented in Tables 1, 2 and 3 it can be noticed that the percentage of each country's effort and switching costs are independent of initial distance δ. This is a peculiarity of the functional form chosen, that yields effort levels which are linear in δ. Different functional forms would yield different results, where percentages may change with δ. Qualitative results however would not change, namely the percentage of A's effort would be higher in Table 3 and would be the same as B's in Table 1. Moreover, in the cooperative case, A would bear more than half of the total costs in Table 3 and less than half in Table 2.

Table 3 Asymmetric countries. A has higher distance costs but lower switching costs. $f_A = f_B = 10$; $d_A = 12$; $d_B = 4$; $s_A = 4$; $s_B = 8$. Total costs of legal distance equal 40% of total possible earnings from business contracts when $\delta = 1$ and $x_A = x_B = 0$

δ	Total welfare with $x_i = 0$	$w_A^N + w_B^N$ with $x_i \neq 0$	$\hat{W}$ with $x_i \neq 0$	Total loss from legal distance with $x_i = 0$ (percent)	Total loss from legal distance with $x_i \neq 0$ and non-cooperation (percent)	Total loss from legal distance with $x_i \neq 0$ and cooperation (percent)	$x_A^N + x_B^N$	$x_A^C + x_B^C$
0	20	20	20	0	0	0	0	0
0.1	19.92	19.987	19.989	0.4	0.067	0.057	0.08	0.09
0.2	19.68	19.947	19.954	1.6	0.27	0.23	0.15	0.17
0.3	19.28	19.88	19.897	3.6	0.6	0.51	0.23	0.26
0.4	18.72	19.787	19.817	6.4	1.07	0.91	0.31	0.34
0.5	18	19.667	19.714	10	1.67	1.43	0.39	0.43
0.6	17.12	19.52	19.589	14.4	2.4	2.06	0.47	0.51
0.7	16.08	19.347	19.44	19.6	3.27	2.8	0.54	0.6
0.8	14.88	19.147	19.268	25.6	4.27	3.66	0.62	0.69
0.9	13.52	18.92	19.074	32.4	5.4	4.63	0.7	0.77
1	12	18.667	18.857	40	6.67	5.71	0.78	0.86

$$\frac{x_A^N}{x_A^N + x_B^N} = 0.86, \qquad \frac{x_A^C}{x_A^C + x_B^C} = 0.67, \qquad \frac{s_A(x_A^N)}{s_A(x_A^N) + s_B(x_B^N)} = 0.95, \qquad \frac{s_A(x_A^C)}{s_A(x_A^C) + s_B(x_B^C)} = 0.67$$

6 Transplantation versus harmonization when countries can control switching costs

As discussed in the previous analysis, the extent to which countries are willing to reduce legal differences with other legal systems highly depends on the cost of legal adaptation. Switching costs are a crucial variable in a country's decision on legal change. In the preceding analysis, we have assumed that such costs are exogenous and countries optimize given the transaction costs occasioned by differences in legal systems and the switching costs that would be incurred as a result of legal change.

In this section we relax this assumption, endogenizing switching costs. We do so by introducing a stage prior to the non-cooperative (transplantation) or cooperative (harmonization and unification) stage, in which countries have the possibility to change their switching costs by making a costly investment. We consider situations where countries can alternatively increase or decrease their switching cost and find the conditions under which a country may prefer to increase rather than decrease switching costs.

There are two main effects of switching costs that should be highlighted. The first, and more obvious effect is that higher switching costs imply larger costs of reducing legal distance. With an increase in switching costs, legal change effort x_i will decrease, with a resulting increase in legal distance and decrease in country i's welfare. The second effect is due to the fact that a larger marginal switching cost, increasing $s_i(x_i)$ for each level of x_i, implies a downward shift of the reaction function, leading to lower x_i but to an increase in x_j due to strategic substitutability. This effect is observed in both the non-cooperative and cooperative equilibria. Consider, for example, the effect of an increase of $s'_A(x_A)$ in A's

first order condition of the non-cooperative problem (3) or in the corresponding first order condition of the cooperative problem (8).[28]

The presence of these two effects creates conflicting incentives for a country that has the opportunity to affect its own switching costs. On the one hand, there may be non-strategic incentives to make an ex ante investment to reduce subsequent switching costs. On the other hand, strategic incentives may be present to make a costly investment that renders subsequent adaptation more costly.[29]

When countries invest ex ante to reduce switching costs, greater levels of cooperative harmonization or unification can be achieved. Alternatively, countries may strategically choose to increase switching costs. This amounts to a precommitment strategy by one country to reduce its ability to adapt itself to foreign law in the subsequent stage of the game. Countries may rationally choose to raise their switching costs when they expect the other country to compensate the resulting decrease in the level of transplantation by increasing its own transplantation. Raising switching costs is thus a strategic device by which a country tries to take advantage of the other country's incentive to shorten the legal distance via unilateral concessions. This case is likely to happen when the country behaving strategically faces relatively higher costs from legal distance and switching costs, whereas the other country is characterized by opposite conditions. Under such conditions, the high-cost country may have incentives to invest to further increase its switching costs since it expects the low-cost state to undertake a greater effort to reduce distance because of strategic substitutability of effort.

The incentive to raise switching costs strategically may be present in both non-cooperative and cooperative situations. In the former case, investment gives credibility to the country's subsequent non-cooperative choice of transplantation, while in the latter case, investment represents a precommitment strategy affecting the solution of the subsequent cooperative game. Interestingly, the strategic investment in raising switching costs might be higher when states expect the following stage to be cooperative, rather than non-cooperative.

The interesting issue to analyze is whether a country is more likely to raise its switching costs when the second stage is non-cooperative rather than cooperative. Similarly, if a country invests to reduce its switching costs, does it invest more when the second stage is cooperative?

We can interpret an investment to reduce switching costs as a cooperative behavior. A country, by reducing its switching costs, prepares itself to exert a higher effort, thus increasing total welfare. On the contrary, raising switching costs can be seen as a non-cooperative behavior. A country that raises its switching costs (or reduces them less) when the second stage is cooperative, acts strategically tying its hands to undertake lower harmonization efforts in the second cooperative stage. We show that these non-cooperative strategies are the likely outcome.

We also show that there are situations where first-stage opportunistic behavior can lead to the paradoxical result that cooperative harmonization results in a higher legal distance than non-cooperative transplantation. This is likely to happen when the country behaving strategically has sufficiently higher costs from legal distance but lower initial switching costs. In particular, when the second stage is non-cooperative, such country will have to rely more

[28] The same effect can be observed explicitly in the equilibrium values given in expression (11) with quadratic cost functions.

[29] This strategy would be the equivalent of a precommitment or hands-tying strategy (Schelling 1960) that improves the position of the country that undertakes the strategic precommitment at the expense of the other country. In this specific application, overall welfare is reduced by such a strategic choice.

on itself to reduce the substantial costs from legal distance and this might induce a higher investment on switching cost reduction, which explains the paradoxical result.

To analyze the incentives described above we devise a two stage model. In the first stage countries can invest to change their switching cost. To simplify the analysis we assume that only one country, say country A, has this opportunity.[30] We work with the quadratic cost framework presented in the previous section. Initially, country A has switching costs equal to $s_A(x_A) = s_A \frac{x_A^2}{2}$. It can choose to change the marginal cost of x_A, s_A, by making a costly investment k_A. Thus, switching costs would equal $s_A(x_A, k_A) = \frac{s_A + k_A}{2} x_A^2$. Specifically, k_A can take values in the interval $[-k^\circ, k^1]$, with $0 < k^\circ \leq s_A$ and $0 < k^1 < \infty$.[31] Thus when $k_A < 0$, marginal switching costs are reduced. For values of $k_A > 0$, marginal switching costs are instead increased. Changing switching costs is not in itself a costless process. The cost of investment is $r \frac{k_A^2}{2}$, where $r > 0$.

There are several examples of procedures a country may follow to decrease or to increase its adaptation and switching costs. We have already listed several ways by which a country can raise its switching costs, ranging from the creation of new institutions to protect and implement the existing law, to the change in the nature of rules (for example raising norms to the level of constitutional rules), and even to the call of referenda to approve of legal changes.[32] Similarly, there are many ways by which a country could decrease its switching costs. As already stated, changing to a new legal system implies switching costs that strongly depend on the cost of litigation when courts have to settle disputes in the international law and on the information costs to judges, lawyers and legal academics. A country can lower its switching costs by devoting resources to lower litigation costs and to make the newly adopted law known in the country (e.g., teaching it in schools and universities and providing training for existing lawyers and judges in the new legal system).[33]

In the second stage countries choose x_A and x_B either separately, via independent transplantation, or via cooperative harmonization and unification.

The second stage is exactly equal to the games presented in Sects. 3 and 4 above, so we can concentrate on the first stage. Solving the game by backward induction, we obtain the equilibrium values of x_A and x_B as a function of k_A. We then move backwards and analyze A's choice of k_A.

The effect of a change in k_A on A's welfare can be obtained by totally differentiating A's welfare function after substituting the values of x_A and x_B obtained in the second-stage equilibrium. We refer to such values as $x_A^*(k_A)$ and $x_B^*(k_A)$, where the star indicates equilibrium value, in both non-cooperative and cooperative settings. The effect of investing

[30] The case where both countries can change switching costs is discussed below.

[31] We assume that countries can never decrease their marginal cost below zero and that there is an upper limit to their ability of increasing them.

[32] See our discussion of such instruments in the Introduction.

[33] The technology introduced above implies that the cost of changing switching costs is the same in case of increase and decrease. In other words, investing to change marginal switching costs by an amount equal to $|k_A|$ has the same cost $\frac{r}{2} k_A^2$ if $k_A < 0$ and if $k_A > 0$. This assumption is made to simplify the model and to render A's welfare function continuous with respect to k_A. We may expect that the cost of reducing switching costs is actually different from the cost of increasing them. In particular, it is plausible that the cost of increasing switching costs is higher. As long as such costs are not prohibitively high, this would simply reduce the range of parameters where A resorts to increasing switching costs but would not change the quality of the results.

in k_A on $A's$ welfare is given by

$$\frac{dw_A^*(x_A^*(k_A), x_B^*(k_A))}{dk_A} = \frac{\partial w_A^*}{\partial k_A} + \frac{\partial w_A^*}{\partial x_A^*(k_A)} \frac{\partial x_A^*(k_A)}{\partial k_A} + \frac{\partial w_A^*}{\partial x_B^*(k_B)} \frac{\partial x_B^*(k_A)}{\partial k_A}. \tag{15}$$

The effect on w_A^* of the change in country A's second-period action x_A^*, $\frac{\partial w_A^*}{\partial x_A^*(k_A)} \frac{\partial x_A^*(k_A)}{\partial k_A}$, is zero by the envelope theorem, so that expression (15) becomes

$$\frac{dw_A^*(x_A^*(k_A), x_B^*(k_A))}{dk_A} = \frac{\partial w_A^*}{\partial k_A} + \frac{\partial w_A^*}{\partial x_B^*(k_A)} \frac{\partial x_B^*(k_A)}{\partial k_A}. \tag{16}$$

The first term on the right hand side in expression (16) represents the direct (or cost reducing) effect of a change in k_A and is always negative. An increase in k_A increases A's switching costs and is in itself costly, thus reducing A's welfare.

The second term in the right hand side of (16) is the indirect (or strategic) effect and is the result of country B's second-period reaction to A's choice of k_A. The strategic effect can be rewritten fully as

$$\frac{\partial w_A^*}{\partial x_B^*} \frac{dx_B^*}{dx_A} \frac{dx_A^*}{dk_A}, \tag{17}$$

where $\frac{dx_B^*}{dx_A}$ is the slope of B's reaction function and is negative.[34] The term $\frac{dx_A^*}{dk_A}$ is negative, as can be checked from the first order conditions (3) and (8) and the expressions for x_A^N and x_A^C in (11). Finally, we know that $\frac{\partial w_A^*}{\partial x_B^*}$ is positive, since an increase in x_B increases A's welfare by reducing legal distance. The strategic effect of an increase in k_A thus is positive. By raising its costs, a country induces the other country to react, spending more effort in reducing the distance between legal systems. This indirect effect increases the welfare of the country acting strategically.

If the direct effect dominates, so that the total derivative in (16) is negative, A would have incentives to invest to reduce switching costs to the maximum extent, so that $k_A = -k^\circ$ and switching costs become $(s_A - k^\circ)\frac{x_A^2}{2}$. If $k^\circ = s_A$, then switching costs would be totally eliminated by country A in stage 1, paving the way to its subsequent full transplantation or unification strategy. In such a case, A always faces incentives to set $x_A = \delta - x_B$, so that the only equilibrium would be where $x_A = \delta$ and $x_B = 0$. This means that, after investing to reduce its switching costs in the first period, country A would adopt the entire legal system b, with a resulting unification of legal systems.

If the indirect effect dominates, the total derivative in (16) is positive. In this case, A would instead have incentives to increase its switching costs (up to $k_A = k^1$), so that they would become $(s_A + k^1)\frac{x_A^2}{2}$. This would lead to a lowering of the subsequent transplantation and harmonization efforts x_A^*, forcing B to increase its own effort in equilibrium.

Suppose finally that there exists a value $\hat{k}_A$ such that $\frac{dw_A^*(x_A^*(\hat{k}_A), x_B^*(\hat{k}_A))}{dk_A} = 0$.[35] In this case country A would choose $\hat{k}_A \in (-k^\circ, k^1)$, that can take up either positive or negative values, meaning that A can increase or decrease its switching costs in the first period. This is an

[34] In the case of the cooperative solution, $\frac{dx_B^*}{dx_A}$ indicates how the optimal x_B changes as x_A changes and is again negative (see Sect. 4).

[35] We assume that the second order conditions are satisfied and that $\frac{\partial^2 w_A^*(x_A^*(k_A), x_B^*(k_A))}{\partial k_A^2} < 0$.

interesting case, as it allows us to investigate if and how the incentives to change switching costs are affected by the nature—non-cooperative versus cooperative—of the second-stage game.

Before considering how the optimal investment varies in the two regimes, we prove that the effect of a change in k_A on B's equilibrium welfare $w_B^*(x_A^*(k_A), x_B^*(k_A))$ is always negative.[36] In fact

$$\frac{dw_B^*(x_A^*(k_A), x_B^*(k_A))}{dk_A} = \frac{\partial w_B^*}{\partial k_A} + \frac{\partial w_B^*}{\partial x_A^*(k_A)} \frac{\partial x_A^*(k_A)}{\partial k_A} \tag{18}$$

by the envelope theorem. The direct effect $\frac{\partial w_B^*}{\partial k_A}$ is zero, since a change in country A's switching cost does not have a direct impact on B's welfare. The impact is only indirect, through the change in x_A^* and is negative, since $\frac{\partial w_B^*}{\partial x_A^*(k_A)} > 0$ and $\frac{\partial x_A^*(k_A)}{\partial k_A} < 0$. Therefore, whenever it is rational for A to reduce its switching costs, the welfare of both A and B is increased. Conversely, whenever it is rational for A to raise its switching costs in the first stage, the welfare of A is increased but the welfare of B is decreased.

We can now compare A's level of investment r in the cases where the second stage is one of non-cooperative transplantation as opposed to cooperative harmonization or unification.

Given our hypothesis of quadratic cost functions, the first order condition in expression (16) for the case of subsequent non-cooperative transplantation is

$$\frac{dw_A^N}{dk_A} = -\left[rk_A + \frac{(x_A^N)^2}{2}\right] + d_A D^N \frac{\partial x_B^N}{\partial k_A} = 0, \tag{19}$$

where $\frac{\partial x_B^N}{\partial k_A} = \frac{d_A d_B s_B}{(c_B(k_A+s_A)+(c_A+k_A+s_A)s_B)^2} > 0$ from expression (11). The first term, between parentheses, on the right hand side of (19) is the direct effect of an increase in switching costs. The second term is the strategic effect.

In the case where the subsequent stage is one of cooperative harmonization or unification, the first order condition for k_A is

$$\frac{dw_A^C}{dk_A} = -\left[rk_A + \frac{(x_A^C)^2}{2}\right] + d_A D^C \frac{\partial x_B^C}{\partial k_A} = 0, \tag{20}$$

where $\frac{\partial x_B^N}{\partial k_A} = \frac{(d_A+d_B)^2 s_B}{(s_B(k_A+s_A)+(k_A+s_A+s_B)(d_A+d_B))^2} > 0$ from expression (11). Again, the term between parentheses on the right-hand side represents the direct effect of a change in switching costs and the second term represents the strategic effect.

Given the complexity of expressions (19) and (20) we shall study these results with the help of simulations, considering country A's behavior under different sets of parameters.

We present five simulations, where the values of the parameters lead to different optimal choices of k_A. In all simulations we assume that $k^\circ = s_A$. Hence, when $k_A = -k^\circ$ in equilibrium, switching costs are totally eliminated by A.

In Simulation 1 countries are initially symmetric. They both bear the same costs from legal distance and have similar switching and adaptation costs. Values of the parameters are those found in Table 1. From Table 4 it can be seen that, when the second stage is non-cooperative, the optimal k_A, $k_A^N(\delta)$, is negative, meaning that country A invests to reduce

[36] Using the terminology Fudenberg and Tirole (1984) introduced in their famous paper, investment in changing switching costs makes country A tough.

Table 4 Symmetric countries. $f_A = f_B = 10$; $d_A = d_B = 8$; $s_A = s_B = 6$; $r = 0.2$

δ	$k_A^N(\delta)$	$k_A^C(\delta)$	$w_A^N + w_B^N$ with $k_A = 0$	$\hat{W}$ with $k_A = 0$	$w_A^N + w_B^N$ with $k_A \neq 0$	$\frac{x_A^N}{x_A^N + x_B^N}(k_A^N(\delta))$	$\frac{x_A^C}{x_A^C + x_B^C}(k_A^N(\delta))$	$D^N(k_A^N(\delta))$	$D^C(0)$
0	0	0	20	20	20	0	0	0	0
0.1	−0.000902	0	19.986	19.987	19.9861	0.500038	0.5	0.02727	0.01579
0.2	−0.003611	0	19.944	19.949	19.9445	0.500151	0.5	0.05453	0.03158
0.3	−0.008139	0	19.875	19.886	19.8751	0.500339	0.5	0.08178	0.04737
0.4	−0.0145	0	19.778	19.798	19.7781	0.500605	0.5	0.10899	0.06316
0.5	−0.02273	0	19.653	19.684	19.6534	0.500949	0.5	0.13617	0.07895
0.6	−0.03286	0	19.5	19.545	19.5013	0.501373	0.5	0.16331	0.09474
0.7	−0.04493	0	19.32	19.381	19.3217	0.501879	0.5	0.19039	0.11053
0.8	−0.0590	0	19.11	19.192	19.1149	0.50247	0.5	0.2174	0.1263
0.9	−0.0751	0	18.87	18.977	18.8811	0.503149	0.5	0.24433	0.1421
1	−0.0934	0	18.61	18.737	18.6203	0.503921	0.5	0.27117	0.1579

its switching costs. The absolute value of $k_A^N(\delta)$ is increasing in initial legal distance δ. As a result of the reduction in switching costs, countries are not symmetric anymore, A exerts more than fifty percent of total distance-reducing effort and the percentage increases with δ. Total welfare $w_A^N + w_B^N$ is higher than in the case where switching costs are exogenous. When the second stage is cooperative, however, values of the parameters are such that A optimally chooses not to invest ($k_A^C(\delta) = 0$). As stated above, a negative k_A can be seen as a cooperative behavior (i.e., the actually takes steps that reduce future switching costs). Thus, interestingly, when the second stage is non-cooperative, A follows a more cooperative behavior in the first stage. Yet, as Table 4 shows, total welfare is higher and equilibrium legal distance is lower under cooperation for all values of δ.

The second simulation assumes that countries are asymmetric and that A has both higher switching and distance costs. Parameter values are as in Table 2. When the second stage is non-cooperative, $k_A^N(\delta)$ is negative and increasing in δ in absolute value. A exerts a percentage of total effort that is increasing in δ and around 60%. Total welfare increases when A can change its switching costs compared to the case when they are exogenous. Here we observe a substantial change in the results when the second stage is cooperative. In that case A invests to increase its switching costs and $k_A^C(\delta)$ is positive and increasing. Country A's percentage of total effort is decreasing in δ, given that switching costs are increasing in δ. Total welfare under cooperation is lower compared to the case where the second stage is non-cooperative. Total welfare is also lower when compared to the alternative scenario where switching costs are exogenous and the two countries cooperate. However, equilibrium distance is still lower under cooperation. This implies that, notwithstanding smaller legal distance, countries will never agree to undertake cooperative harmonization. This example is interesting because it presents a case where A is willing to reduce switching costs (thus raising its distance-reducing effort) when the second stage is non-cooperative, whereas it would instead choose to increase its switching costs when the interaction between the countries in the second stage is expected to be cooperative. The intuition for this result can be given as follows. Values of the parameters are such that $d_A^B < d_A^A < d_A$ and $x_A^C < x_A^N$; $x_B^C > x_B^N$. Then A has the incentive to reduce switching costs when its effort is higher relative to B's, whereas it free rides on B's effort when B exerts more distance-reducing effort. The results from this simulation can be found in Table 5.

In the third simulation, which uses the same parameter values used in Table 3, countries are again asymmetric and country A has lower switching costs, although it faces higher costs from legal distance. Table 6 presents the results. In this example, country A will always undertake steps to reduce its switching costs, regardless of the cooperative versus non-cooperative nature of the second-period interaction. In absolute value, $k_A^C(\delta) < k_A^N(\delta)$, for all $\delta \in [0, 1]$. According to the terminology introduced above, this implies that cooperation in the second stage still induces a less cooperative attitude in the first stage. Country A's percentage of total effort increases in δ and ranges from 85 to 90% in the non-cooperative case and from 66 to 68% in the cooperative case. Total welfare is higher when the second stage is cooperative and is always higher compared to the case where switching costs are exogenous, regardless of the nature of second-stage interaction. Equilibrium legal distance is smaller when the second stage is cooperative.

We then present two more examples, slightly changing the parameters with respect to those employed in Sect. 5.

In Simulation 4 (Table 7), country A faces higher costs of legal distance and also faces higher switching costs than country B, although both s_A and s_B are quite low. Optimal k_A is always positive, no matter the nature of second-stage interaction and country A always increases its switching costs. Interestingly, in this case A increases its switching costs more

Table 5 Asymmetric countries. $f_A = f_B = 10$; $d_A = 12$; $d_B = 4$; $s_A = 8$; $s_B = 4$; $r = 0.2$

δ	$k_A^N(\delta)$	$k_A^C(\delta)$	$w_A^N + w_B^N$ with $k_A = 0$	$\hat{W}$ with $k_A = 0$	$w_A^N + w_B^N$ with $k_A \neq 0$	$\hat{W}$ with $k_A \neq 0$	$\frac{x_A^N}{x_A^N + x_B^N}(k_A^N(\delta))$	$\frac{x_A^C}{x_A^C + x_B^C}(k_A^N(\delta))$	$D^N(k_A^N(\delta))$	$D^C(k_A^C(\delta))$
0	0	0	20	20	20	20	0	0	0	0
0.1	−0.00196876	0.000437322	19.984	19.989	19.9845	19.9886	0.600059	0.333321	0.0285684	0.0142859
0.2	−0.00788504	0.00174934	19.938	19.954	19.938	19.9543	0.600237	0.333285	0.0571187	0.0285732
0.3	−0.017779	0.00393623	19.86	19.897	19.8605	19.8971	0.600534	0.333224	0.0856325	0.0428632
0.4	−0.0317018	0.00699824	19.752	19.817	19.7521	19.8171	0.600953	0.333139	0.114091	0.0571571
0.5	−0.0497262	0.0109358	19.612	19.714	19.6129	19.7142	0.601496	0.33303	0.142475	0.0714564
0.6	−0.0719491	0.0157492	19.442	19.589	19.4431	19.5883	0.602166	0.332896	0.170764	0.0857624
0.7	−0.0984927	0.0214392	19.24	19.44	19.2426	19.4395	0.602969	0.332739	0.198937	0.100076
0.8	−0.129508	0.0280063	19.01	19.268	19.0119	19.2678	0.603911	0.332557	0.226971	0.1144
0.9	−0.16518	0.0354513	18.744	19.074	18.751	19.073	0.604997	0.332351	0.25484	0.128734
1	−0.20573	0.0437748	18.45	18.857	18.4603	18.8552	0.606236	0.332122	0.282518	0.14308

Table 6 Asymmetric countries. $f_A = f_B = 10$; $d_A = 12$; $d_B = 4$; $s_A = 4$; $s_B = 8$; $r = 0.2$

δ	$k_A^N(\delta)$	$k_A^C(\delta)$	$w_A^N + w_B^N$ with $k_A = 0$	$\hat{W}$ with $k_A = 0$	$w_A^N + w_B^N$ with $k_A \neq 0$	$\hat{W}$ with $k_A \neq 0$	$\frac{x_A^N}{x_A^N + x_B^N}(k_A^N(\delta))$	$\frac{x_A^C}{x_A^C + x_B^C}(k_A^N(\delta))$	$D^N(k_A^N(\delta))$	$D^C(k_A^C(\delta))$
0	0	0	20	20	20	20	0	0	0	0
0.1	−0.00866	−0.00292	19.987	19.989	19.9867	19.9886	0.857408	0.666829	0.0221901	0.0142798
0.2	−0.03483	−0.01173	19.947	19.954	19.9469	19.9543	0.85821	0.667319	0.0441857	0.0285235
0.3	−0.07911	−0.02657	19.88	19.897	19.881	19.8975	0.859572	0.668146	0.0657818	0.042694
0.4	−0.1426	−0.04771	19.787	19.817	19.7898	19.8182	0.86153	0.669328	0.086751	0.0567514
0.5	−0.2269	−0.07553	19.667	19.714	19.6744	19.7168	0.864146	0.670889	0.106828	0.0706516
0.6	−0.3346	−0.11058	19.52	19.589	19.5363	19.5939	0.86751	0.672867	0.125684	0.084344
0.7	−0.46929	−0.15361	19.347	19.44	19.3778	19.4501	0.871754	0.675311	0.142894	0.0977689
0.8	−0.63653	−0.20564	19.147	19.268	19.2017	19.2863	0.877082	0.67829	0.157861	0.110853
0.9	−0.84516	−0.26809	18.92	19.074	19.0122	19.1036	0.883821	0.681901	0.169693	0.123502
1	−1.11064	−0.34298	18.667	18.857	18.8153	18.9035	0.892546	0.686282	0.176892	0.13559

Table 7 Asymmetric countries. $f_A = f_B = 10$; $d_A = 12$; $d_B = 4$; $s_A = 2$; $s_B = 0.2$; $r = 0.2$

δ	$k_A^N(\delta)$	$k_A^C(\delta)$	$w_A^N + w_B^N$ with $k_A = 0$	$\hat{W}$ with $k_A = 0$	$w_A^N + w_B^N$ with $k_A \neq 0$	$\hat{W}$ with $k_A \neq 0$	$\frac{x_A^N}{x_A^N + x_B^N}(k_A^N(\delta))$	$\frac{x_A^C}{x_A^C + x_B^C}(k_A^N(\delta))$	$D^N(k_A^N(\delta))$	$D^C(k_A^C(\delta))$
0	0	0	20	20	20	20	0	0	0	0
0.1	0.00085261	0.0001779	19.9988	19.9991	19.99	19.9991	0.230694	0.0909017	0.00370405	0.0011236
0.2	0.0034018	0.0007064	19.9954	19.9964	19.9599	19.9964	0.230468	0.0908799	0.0074102	0.00224726
0.3	0.0076319	0.00158	19.9896	19.9919	19.9097	19.9919	0.230094	0.0908438	0.0111205	0.00337103
0.4	0.013521	0.002794	19.9816	19.9856	19.8389	19.9856	0.229575	0.0907938	0.014837	0.00449495
0.5	0.02104	0.004344	19.9712	19.9775	19.7473	19.9775	0.228917	0.0907299	0.0185615	0.00561907
0.6	0.030149	0.006226	19.9585	19.9676	19.6345	19.9676	0.228124	0.0906526	0.0222958	0.00674345
0.7	0.04081	0.008435	19.9435	19.956	19.4998	19.9559	0.227203	0.0905619	0.0260416	0.00786814
0.8	0.05296	0.010966	19.9263	19.9425	19.3428	19.9424	0.226162	0.0904582	0.0298005	0.00899317
0.9	0.066562	0.013816	19.9067	19.9272	19.1626	19.9271	0.225009	0.0903418	0.0335736	0.0101186
1	0.081542	0.016978	19.8848	19.9101	18.9586	19.91	0.223752	0.0902129	0.0373623	0.0112445

Table 8 Asymmetric countries. $f_A = f_B = 10$; $d_A = 12$; $d_B = 4$; $s_A = 2$; $s_B = 4$; $r = 0.2$

δ	$k_A^N(\delta)$	$k_A^C(\delta)$	$w_A^N + w_B^N$ with $k_A = 0$	$\hat{W}$ with $k_A = 0$	$w_A^N + w_B^N$ with $k_A \neq 0$	$\hat{W}$ with $k_A \neq 0$	$\frac{x_A^N}{x_A^N + x_B^N}(k_A^N(\delta))$	$\frac{x_A^C}{x_A^C + x_B^C}(k_A^N(\delta))$	$D^N(k_A^N(\delta))$	$D^C(k_A^C(\delta))$
0	0	0	20	20	20	20	0	0	0	0
0.1	−0.01059	−0.00329	19.9928	19.9938	19.9928	19.9939	0.85779	0.66703	0.01245	0.00768
0.2	−0.04287	−0.01328	19.9712	19.9754	19.9715	19.9755	0.85978	0.66814	0.01245	0.01532
0.3	−0.09852	−0.03037	19.9353	19.9446	19.9367	19.945	0.86322	0.67006	0.0246	0.0228
0.4	−0.1807	−0.05531	19.885	19.9015	19.8894	19.9029	0.86835	0.67287	0.0361	0.03024
0.5	−0.29515	−0.0893	19.8203	19.8462	19.8315	19.8497	0.875	0.67674	0.04653	0.03739
0.6	−0.45208	−0.1343	19.7413	19.7785	19.7656	19.7861	0.88574	0.68193	0.05532	0.0442
0.7	−0.67256	−0.19346	19.6478	19.6985	19.6965	19.7134	0.9004	0.68888	0.061524	0.0505
0.8	−1.01338	−0.27266	19.54	19.6062	19.6326	19.6336	0.92403	0.6984	0.063406	0.05609
0.9	−2	−0.38407	19.4178	19.5015	19.6	19.5504	1	0.7123	0	0.0604
1	−2	−0.56379	19.2813	19.3846	19.6	19.4726	1	0.73581	0	0.06196

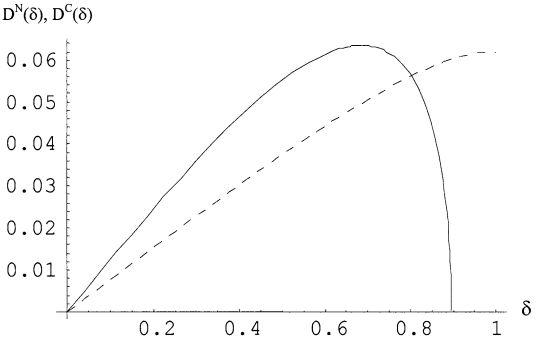


Fig. 3 Legal distance is hump-shaped when the second stage is non-cooperative. Figure obtained with parameter values: $f_A = f_B = 10$; $d_A = 12$; $d_B = 4$; $s_A = 2$; $s_B = 4$; $r = 0.2$

when the second stage is non-cooperative, rather than cooperative: $k_A^C(\delta) < k_A^N(\delta)$ for all $\delta \in [0, 1]$. Country B's distance reducing effort is always higher than A's. However, given the values of the parameters in this simulation, we observe $d_A^B < d_A^A < d_A$. This implies that $x_A^C < x_A^N$ and $x_B^C > x_B^N$. Thus, country A increases its switching costs more when its distance reducing effort is higher, i.e. in the non-cooperative case. Given the fact that A increases its switching costs in the first stage, and it increases them more when the second stage is non-cooperative, total welfare is always lower when switching costs are endogenous, and it is higher when the second stage is cooperative.

Finally, Simulation 5 presents an example where, for high initial distance ($\delta > 0.894427$), $k_A^N(\delta) = -s_A$ and A brings its switching costs to zero. Thus, when $\delta > 0.894427$, $x_A^N = \delta$ and $x_B^N = 0$. In equilibrium, A totally eliminates legal distance, adopting all B's legal rules to the extent that they differed from A's preexisting legal regime. Table 8 shows that $k_A^C(\delta)$ and $k_A^N(\delta)$ are always negative and that, in absolute value, $k_A^C(\delta) < k_A^N(\delta)$ for all $\delta \in [0, 1]$ and $x_B > x_A$, in both the cooperative and the non-cooperative regime. This example is particularly interesting in that legal distance when the second stage is non-cooperative is hump shaped (see Fig. 3). For low values of δ, $D^N(\delta) > D^C(\delta)$, $D^N(\delta)$ is increasing up to $\delta = 0.6825$, but then it decreases rapidly, reaching $D^N(\delta) = 0$ at $\delta = 0.894427$. There exists a value $\delta^* = 0.802$ such that $D^N(\delta^*) = D^C(\delta^*)$. For $\delta > \delta^*$, $D^C(\delta) > D^N(\delta)$. Thus, for high values of initial legal distance δ, countries engaging in cooperative harmonization in the second stage end up with less harmonization than those interacting in a non-cooperative manner. This is the paradoxical result highlighted above. It is obtained when A has higher costs from legal distance than B but lower initial switching costs, which give it the incentive to exert higher effort in all regimes. Contrary to what observed in Simulation 4, total welfare is always higher when switching costs are endogenous. Cooperation in the second stage yields a higher total welfare for $\delta < 0.894427$ but total welfare is at a maximum under non-cooperation when $\delta > 0.894427$, a situation where A invests enough to eliminate switching costs and brings legal distance to zero. Therefore, when $\delta > 0.894427$, no country will agree to cooperative harmonization.

So far we assumed that only country A can change its switching costs. When both countries have the opportunity and incentives to eliminate switching costs in the first stage, legal unification would obtain in the subsequent non-cooperative or cooperative stage. However, this would create the possibility of having multiple equilibria, inasmuch as any pair $\{x_A, x_B\}$ could be a Nash equilibrium in the non-cooperative transplantation game as long as $x_A^N = \delta - x_B^N$. Similarly, the solution to a cooperative game could be given by any pair $\{x_A^C, x_B^C\}$ as long as the sum of harmonization efforts adds up to δ.

The case where A's and B's optimization problems with respect to k_A and k_B have an interior solution for each level of the opponent's investment k_i is definitely more complex.

We assume that changing switching costs by k_B costs B an amount of resources equal to $r\frac{k_B^2}{2}$ (equivalent to A's cost of change $r\frac{k_A^2}{2}$). In that case we would define a best response function $k_A(k_B)$ for A and $k_B(k_A)$ for B. It is possible to check from the first order condition in (19) that $k_A(k_B)$ is decreasing (so that k_A and k_B are strategic substitutes) if and only if $(d_A + k_A + s_A)(k_B + s_B) - d_B(k_A + s_A) > 0$. A similar condition holds for $k_B(k_A)$.[37] Clearly, the solutions to the problem are very different according to the strategic nature of the game. We might have cases where one country responds to another country's increase in switching costs by reducing its own. But we may also have cases where both countries strategically increase their costs, and end up with a higher legal distance relative to the case where countries do not control their switching costs.

Real life situations are likely to be characterized by asymmetries. Countries are likely to differ in their willingness to change their legal system and to be open to the adoption of foreign legal principles. Usually their willingness to change depends on the degree of openness of their economies, where more open countries are generally more prone to undertake legal change.[38] Although the analysis of the issue of legal harmonization in such asymmetric settings should be the subject of future research, we can anticipate some of the main insights from the study of the limiting case where only A can control switching costs. In our setting, A can be viewed as a closed country, trying to minimize legal change, exploiting other countries' willingness to adapt their own legal systems to reduce distance.

7 Conclusions

Differences between legal systems increase transactions costs for parties involved in transnational contracts. Legal systems can reduce these transaction costs in a variety of ways. First, countries can reduce legal differences by unilaterally transplanting foreign rules and legal principles. This form of legal change does not necessitate cooperation between countries. Second, countries can undertake cooperative efforts to reduce differences between legal systems leading to the harmonization and possible unification of legal systems. Through these alternative non-cooperative and cooperative adaptation processes diverse legal traditions can converge towards each other bridging historic differences and legal rules. In this article, we have studied the process of legal adaptation, looking at the features of these alternative solutions. The availability of a common legal language increases the frequency and the profitability of commercial transactions. This means that an increase in the scope of transnational commerce relative to domestic commerce boosts the countries' incentives to promote legal homogeneity. The presence of switching and adaptation costs however can delay or impede legal unification. When adopting a new legal rule, preexisting rules and principles need to be abrogated or modified, with non trivial information costs for the legal community and the parties involved. The existence of positive switching costs often prevents countries from reaching solutions where the distance between their respective legal systems is fully eliminated.

Another friction in the process of legal harmonization is given by the transaction costs of negotiating and carrying out the cooperative agreement between the interested countries. These transaction costs if sufficiently high, can prevent international cooperation leading

[37] In order to determine the sign of $\frac{dk_A}{dk_B}\big|_A$ and $\frac{dk_B}{dk_A}\big|_B$ one needs to check sign$\left[\frac{\partial^2 w_i}{\partial k_i \partial k_j}\right]$. If $\frac{\partial^2 w_i}{\partial k_i \partial k_j} < 0$ then k_A and k_B are strategic substitutes, vice-versa they are strategic complements.

[38] Notice that openness of a country is not necessarily correlated with switching costs.

to legal harmonization. This may explain why there are situations where countries don't pursue a cooperative solution and choose to reduce legal distance unilaterally through legal transplantation.

In negotiating a cooperative legal harmonization or unification agreement, countries maximize their joint welfare. We have shown that if international negotiation costs are not excessively high, there exists a cooperative solution, where countries take their respective non-cooperative solutions as their threat points and where the treaty agreement involves a reduction of the legal distance obtainable via unilateral non-cooperative transplantation. This may create incentives towards cooperative harmonization or unification solutions even for countries that have already undertaken steps toward unilateral transplantation.

After studying the features of non-cooperative and cooperative forms of legal adaptation, we have considered cases with endogenous switching costs. When countries have the opportunity to affect their respective switching costs endogenously, interesting results can be obtained. Although countries generally have interest to invest ex ante to reduce switching costs, occasionally they may actually have interest to increase their own switching costs. The latter, less intuitive, strategy amounts to a precommitment strategy that reduces a country's ability to adopt foreign law at a later stage, via transplantation or harmonization. Countries may in fact rationally choose to tie their hands increasing their own switching costs when expecting the other country to compensate a decrease in level of legal change by increasing its own level. Through this strategy a country thus tries to take advantage of the other country's response and willingness to reduce distance at its own cost. The incentive to raise switching costs strategically may be present in both non-cooperative and cooperative situations and strategic precommitment investments are often higher when states expect the following stage to be cooperative, rather than non-cooperative. Finally, a paradoxical result may occur as a consequence of countries' strategic investments affecting future switching costs. Countries engaging in cooperative harmonization may end up with less harmonization than those pursuing non-cooperative transplantation. This raises some skepticism on the effectiveness of real-life cooperative legal harmonization agreements.

Future research should consider the combined effect of asymmetries in the countries' propensity to introduce foreign principles in their own legal systems and in switching costs on the equilibrium levels of harmonization. Further work should also consider the effect of multidimensional legal diversity where more than two states are involved in the process of legal harmonization. There, legal differences may materialize in a multidimensional space, necessitating a reinterpretation of the concept of legal distance adopted in the present study and leading to a more complex optimization problem. The sequence of individual states' moves would become relevant inasmuch as distance should be weighted according to the number of countries that adopt a given legal solution. The order with which countries undertake legal change would likewise affect the direction of global legal evolution.

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