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The Political Economy of Patent Buyouts

Amal Ahmad* Dominik Naeher† Sebastian Vollmer‡

Abstract

Incentivizing innovation through buyouts may alleviate the social costs associated with patent power, but the political economy and feasibility of this potentially important financing mechanism have been understudied. We study an international setting of countries with different innovation and financing capabilities, and where financing governments rely on taxes to fund buyouts and care about the electoral popularity of their decisions. Subsequent distributional conflict arises between countries as some may benefit from the now-public knowledge without contributing equally to financing, whereas taxpayers within a country may disagree over the desired extent of tax financing for buyouts. We show that these conflicts reduce the feasibility of buyouts relative to patents, identify the conditions under which this harms global welfare, and discuss possibilities for overcoming these constraints. The international public good and public financing dimensions of buyouts emerge as essential for understanding their potential to supplant patents and to improve social welfare.

Keywords: Innovation, intellectual property rights, patents, buyouts, global public goods, public finance

JEL Codes: F13; H87; L1; O31; O34; O38

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1 Introduction

It has long been acknowledged that patents, while incentivizing innovation, fail to lead to the first best outcome for society because they rely on the distortion-creating incentives of monopoly (Nordhaus, 1969; Wright, 1983; Shavell and van Ypersele, 2001). The monopoly structure generally results in too little innovation (dynamic loss) and in too-high pricing (static loss) relative to the social optimum. One area in which these issues are particularly salient is global health, as many life-saving drugs are inexpensive to manufacture once innovated but patents associated with their innovation can generate high prices which limit access to these technologies (Stiglitz and Jayadev, 2010; Quigley, 2015). In addition, the incentives for patent-driven investment in innovation tend to be too small relative to what is socially optimal, particularly when the burden of disease falls heavily on poor populations. For example, the latter has been argued to be a major contributing factor to the low private investment in HIV/AIDS vaccine research relative to the disease's high global health burden (Kremer and Snyder, 2006).

Within economics, a large 'optimal design' literature has explored how patent length and breadth can be structured to limit deadweight loss and the underprovision of innovation, but these losses cannot be eliminated altogether (Rockett, 2010). In practice, and in the case of pharmaceuticals in particular, innovating countries often pursue a mix of intellectual property rights and price subsidies to facilitate production of and domestic access to patented technology (Roin, 2014). This can limit the social losses from underproduction and overpricing to consumers in these countries, but it does not eliminate them, and the effects of imposing patents on consumers in the developing world can be particularly severe (Chaudhuri et al., 2006).

This article contributes to the theoretical literature exploring why patents, despite creating potentially large social costs, remain the predominant mode of incentivizing innovation, and we focus on buyouts as a potential alternative. In a buyout, the government transfers an ex-post reward to the innovating firm in exchange for placing the knowledge in the public domain and permitting competitive production of the subsequent good.[1]

It is straightforward to show that, in a single economy setting, a social welfare maximizing government that transfers the amount which equates the firm's rewards with the social benefit of innovation can supplant monopoly power and incentivize innovation and production at the socially optimal level (Wright, 1983; Shavell and van Ypersele, 2001; Galasso, 2020). As perfectly calculated and executed buyouts eliminate underproduction

[1] This arrangement has also been termed a 'prize' or a 'reward' in the literature. For consistency we will refer to it as a buyout throughout the article.

and deadweight loss, for the choice between patents and buyouts to be nontrivial it is necessary that there are costs to buyouts that can obstruct their feasibility. The literature on buyouts, discussed further below, has emphasized how information problems about the appropriate size of the transfer, or commitment problems relating to the credibility of the transfer from the government to innovating firms, can impede buyouts as an alternative to patents. In this literature, if certain mechanisms could mitigate the domestic information or commitment problem, buyouts would emerge as a welfare-improving substitute to intellectual property rights.

In this article, we depart from the focus on government-firm frictions and explore previously unstudied distributional implications of buyouts that emerge from their public good and public financing dimensions. First, placing knowledge in the public domain in a multi-country world where not all countries contribute equally to buyout financing will result in a loss of profits for the financing country and in positive externalities for the rest. Second, because buyouts are publicly financed, they may engender domestic conflict over the desired extent of tax financing, and such conflict will be influential if the government cares not simply about total welfare but about the welfare of politically important groups. In contrast, intellectual property rights finance innovation through market sales of subsequent private goods, and therefore circumscribe the externality associated with publicly available knowledge as well as the need for public financing.

It is our core argument that these political economy tradeoffs are critical to understanding the feasibility of buyouts as an innovation financing mechanism. Exploring these issues requires moving away from the literature's assumptions of a closed economy and of a benevolent government. We present a model which departs from both assumptions and solve it sequentially, in two steps.

We begin by tackling the question of buyouts from an international perspective while maintaining the assumption of (national) welfare maximizing governments. Using an exposition of two countries which differ in their size and innovation and financing capacity, we show that as a buyout reduces domestic monopoly distortion but also results in loss of profits in international markets, it is no longer necessarily welfare-maximizing for the innovating country relative to patents. We also consider a 'subsidy' regime —in which firms are subsidized only to facilitate competitive production domestically while their patent rights are maintained, for use in international markets[2]— and which is equivalent conceptually to a national buyout. Our model shows that if a subsidy is possible, this becomes the dominant choice as it mutes the tradeoff between reducing domestic dead-

[2]This scenario is inspired by the practice used in many advanced economies of using price subsidies to facilitate production of and access to drugs, while keeping monopoly power intact (Roin, 2014).

weight loss and preserving profits from abroad. We discuss how regime choice in this context affects the non-innovating country as well as total world welfare.

The result that buyouts are no longer necessarily pursued even in the absence of domestic frictions between the government and firms stands in stark contrast to the previous literature, in which buyouts are always resorted to in the absence of such frictions. We outline how intersovereign transfers, if they are possible and credible, would result in globally optimal buyouts as transfers internalize the global externality, but we also discuss why in practice such transfers are rare and difficult to implement.

We then add the possibility of *domestic* distributional concerns, by relaxing the assumption of a benevolent government, and presenting the solution of a democratic setting where parties choose policy to maximize their electoral victory probability instead of national welfare. With different voter groups and varying preferences over the extent of the tax-financing burden of buyouts or subsidies, we show that if all groups are equally important in the political calculus then the policy choices do not change from those undertaken by a benevolent planner. However, to the extent that some voter groups are more politically powerful, for example due to higher swing densities, government involvement in innovation financing becomes additionally informed by these considerations.

In the presence of strategic electoral concerns, the likelihood that buyouts or subsidies are pursued becomes even smaller if groups which bear a higher tax-financing burden, and which view these options as less appealing than the median voter does, are more politically powerful. In this case, subsidies (akin to a national buyout) are also no longer a dominant strategy from the financing government's perspective relative to patents. Regime choice will now depend on the intersection of distributional *and* political concerns. Finally, intersovereign transfers no longer result in the globally optimal buyout regime, as transfers alleviate the global externality but not domestic conflict over public financing.

In light of these findings, buyouts of innovations that are useful internationally may be understood as belonging to the category of publicly financed goods with global externalities, with subsequent conflicts over the distribution of benefits and costs *between* countries and also *within* the taxpaying base of a country. Because an altruistic donor may help bridge the gap between pursued and optimal innovation levels, we also briefly discuss the relationship between this scenario and philanthropic initiatives seeking to expand access to patented products, mostly in the healthcare and pharmaceutical sectors.

To situate our contribution, as noted earlier the theoretical literature on buyouts has focused on challenges in a single-economy setting with a welfare-maximizing government, and particularly on information frictions that arise between the government and innovating firms when the government lacks information on the benefits and costs of innovations. In this case, a buyout may generate lower welfare than patents despite the latter's distortionary effects (Wright, 1983; Scotchmer, 1999; Shavell and van Ypersele, 2001). Studies have outlined a variety of institutional mechanisms that can mitigate the information problem and improve the optimality of buyouts, depending on assumptions about the nature of the problem (Kremer, 1998; Chari et al., 2012; Weyl and Tirole, 2012; Galasso et al., 2016, 2018). In departure from the information asymmetry literature, Galasso (2020) explores how commitment problems between the government and firms may obstruct the feasibility and effectiveness of a buyout even if the government has perfect information.[3]

Another body of literature uses trade models to explore patent enforcement versus infringement in an international setting, but with little discussion of buyouts as an alternative to patents.[4] In a simple North-South model where a Northern firm can innovate while a Southern firm can imitate its innovation if patents are not enforced by the government of the South, the interests of the North and South will generally conflict, with the South benefiting from the ability to imitate technology and the North harmed by it (Chin and Grossman, 1988). Similar conflicts of interest arise in situations where the North can choose whether or not to require protection in the South (Deardorff, 1992), where the decision to invest in R&D in the North is not one-off but dynamic (Helpman, 1993), and where both Northern and Southern firms can innovate to different degrees and patent protections are decided simultaneously as they trade (Grossman and Lai, 2004).[5]

Finally, although there is a wide literature which studies how the government's *political* objectives inform policy choice, to our knowledge no work has studied this with respect to patent buyouts or innovation subsidies. The closed-economy literature on patent buyouts and the international trade models on patent enforcement versus infringement both assume governments are driven by national welfare maximization. Therefore, they do not consider other objectives which may be salient in driving policy choices. In contrast, we take into account that many economies at the frontier of innovation *also* tend to be democracies, and we show how this has nontrivial implications for the state's involvement

[3]This occurs if the government, facing a relatively small budget, is subject to stochastic shocks that may require it to divert resources to an alternative unforeseen investment.

[4]An exception is Scotchmer (2004), in which innovators from both South and North compete on innovations in each country. However, this article simply assumes that buyouts are less efficient in financing innovation than patents, i.e. that global buyouts are not Pareto optimal. The key political economy problem thus becomes *too little* patent protection in the world (due to national treatment of inventors). The distributive concerns are therefore very different from those we consider. Scotchmer also does not consider domestic conflict and how the public financing of buyouts may impact regime choice.

[5]Careful empirical measurement of welfare effects on the South of patent protection is limited. Notable exceptions are Chaudhuri et al. (2006), who construct demand curves to estimate large negative effects in India of TRIPS-triggered protection of antibacterial medicines, and Kyle and McGahan (2012) who use variation across countries in the timing of patent laws and in the severity of disease to show that patent protection is associated with increases in R&D in wealthy countries but not in developing countries.

in innovation financing via buyouts or subsidies.

In sum, our article augments the literature on buyouts with insight from trade and political economy, to show how international and domestic redistributive concerns can obstruct globally optimal buyouts even in the absence of any government-firm frictions. To show concretely the complementarities with and contributions to the extant literature, we also present extensions of our model which combine our political economy lens with imperfect information and commitment issues.

The article proceeds as follows. Section 2 models patent buyouts in an international setting with benevolent governments and, alternatively, with governments oriented toward electoral concerns. Section 3 solves the model for equilibrium investment levels and innovation regime choice and demonstrates that both international and domestic redistributive considerations can limit the feasibility and pursuit of buyouts. Section 4 shows the robustness of the findings to extensions that involve information and commitment frictions, linking the model to prior research on these challenges. Section 5 discusses the scope and possible limitations of our theoretical design, and the last section concludes.

2 Model

We model two countries (or regions), the industrialized North (N) and the less developed South (S). Innovation consists of the development of new products, and all capacity to innovate is concentrated among firms in the North. Once a product has been invented, it can be produced by firms in all countries, possibly subject to intellectual property rights such as patents. The products are consumed by n consumers in the world, of which the fraction $\gamma \in (0, 1)$ live in the North and the rest live in the South. In this section, we outline the integrated model of innovation and production, of the different possible innovation financing regimes, and of consumers' relevant electoral preferences around innovation financing, setting the ground for solving the model for innovation regime choices in Section 3.

2.1 Innovation and production

There is a continuum of products indexed by $z \in \mathbb{R}^{\geq 0}$. To invent a product, firms must incur a research cost $R(z) > 0$. Once a product z_i is innovated at cost $R(z_i)$, it can be produced at production cost $c(q_i)$ where q is quantity. In turn, market demand is $p_i = d(q_i)$ where p_i is the price, and the demand function is general with the only assumption that $d' < 0$. We denote subsequent optimal surplus (i.e., that associated with competitive production) as

$$S_i^o = \int_0^{q_i^*} (d(q_i) - c(q_i))dq, \tag{1}$$

where q_i^* is defined by $d(q_i^*) = c(q_i^*)$. Dividing S_i^o by research cost and number of consumers n, we obtain optimal per-capita surplus per research cost

$$s(z_i) = \frac{S_i^o}{nR(z_i)}. \tag{2}$$

In choosing which products to develop, firms will focus on products with the highest values of $s(z)$. Without loss of generality, and following Deardorff (1992), let products be indexed in descending order of $s(z)$ so that the first product ($z = 0$) features the highest value of $s(z)$. The level of total innovation can therefore be measured by a cutoff value $\hat{z}$, so that if the products $z \in [0, \hat{z}]$ are invented, the *total* research cost incurred by firms in the North is given by

$$I(\hat{z}) = \int_0^{\hat{z}} R(z)dz. \tag{3}$$

It is now possible to re-express $s(z)$ as a function of the total research cost I, so that $s(I)$ represents the optimal per-capita surplus per unit of research cost of the last (marginal) invention. To see this, consider the example of three products z_A, z_B, and z_C, where $s(z_A) > s(z_B) > s(z_c)$.[6] Plotting s as a function of I in descending order of $s(z)$ therefore yields the graph in Figure 1. Due to the ordering, s is a weakly decreasing step function of I, while the horizontal axis shows that I is the sum of the research costs.

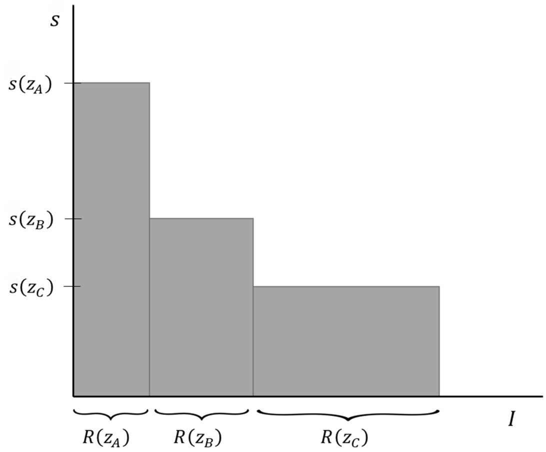
The area shaded under each bar is $s(z_i) \cdot R(z_i) = \frac{S_i^o}{n}$, the per-capita optimal surplus for the specific product, so that the sum of the shaded areas is the sum of per-capita optimal consumer surplus across all products, $\sum_i \frac{S_i^o}{n} = \frac{S^o}{n}$. With many inventions, the latter can be calculated as the integral of $s(I)$ from zero to I. Multiplying through by n provides the total optimal surplus across all products

$$S^o(I) = n\int_0^I s(I)dI; \qquad s' < 0. \tag{4}$$

Another variable of interest is the profit share of surplus. Let $\Pi(I)$ denote the profit that producing firms make *before* netting out any innovation costs I. Given our assump-

[6] For a numerical illustration, suppose z_A generates $S_A^o/n = 20$ and $R = 2$ is incurred in its invention, z_B generates $S_B^o/n = 15$ and $R = 3$ is incurred in its invention, and z_C generates $S_C^o/n = 18$ and $R = 6$ is incurred in its invention. The respective optimal per-capita surplus per dollar of research cost ($s(z)$) for these products is 10, 5, and 3. Descending order therefore implies z_A, z_B, z_C.

Figure 1: Optimal surplus s as a function of total research cost I



tion of competitive markets for production in each country, then if there are no barriers to the use of innovations, all firms will produce the subsequent good, sell at the competitive price, and make zero profit from production. Coupled with costly innovation expenses, this results in a net loss for an innovating firm so that no firm chooses to innovate without additional rewards. Under monopoly production enabled by patents, however, profits will be strictly positive. In line with the above, we denote

$$\Pi(I) = n \int_0^I \pi(I) dI; \qquad \pi' < 0. \tag{5}$$

With monopoly production, we denote the *remaining* consumer surplus and the associated deadweight loss as $\zeta(I)$ and $l(I)$, respectively. The subsequent equality between total surplus and the sum of its possible parts implies

$$\pi(I) + \zeta(I) + l(I) = s(I). \tag{6}$$

In a publicly financed regime, $\pi(I) = l(I) = 0$ and so $\zeta(I) = s(I)$.

2.2 Consumption and domestic preferences

We assume that consumers feature identical preferences for the innovated products but are heterogeneous in income. We distinguish three income groups, $J \in \{R, M, P\}$ with incomes $y^R > y^M > y^P$, and where α^J is the respective population share such that $\sum_J \alpha^J = 1$. There is a proportional income-tax system, so that if innovation is publicly financed, each taxpayer in the financing country pays a fraction τ of income toward this.

For consumers, welfare depends on the level of innovation I and the way it is financed, as the latter will determine whether, for example, consumers face any deadweight loss from the total surplus ($l > 0$ and $\zeta < s$) or not, have a tax-financing burden ($\tau > 0$) or not, etc. In the next subsection, we define how the welfare of a consumer in group J, denoted by ω^J, depends on the level of I and innovation regime. For now, we treat the constituent parts of $\omega^J(I)$ as a blackbox and explore how $\omega^J(I)$ may be relevant to domestic political considerations. Let there be a simple democratic structure where consumers are also voters who take into account the effect of economic policy on them.[7] There are two political parties A and B, I_p is the *public* investment for innovation campaigned for by party $p \in \{A, B\}$ in a given electoral cycle, and $\sigma^{jJ} \gtrless 0$ is a measure of the ideological bias toward party B of person j in group J. Then for publicly financed innovation regimes, voter j in group J prefers party A if

$$\omega^J(I_A) > \omega^J(I_B) + \sigma^{jJ}. \tag{7}$$

We assume that under a patent regime individuals vote solely on the basis of ideological preferences as they do not consider innovation financing to be part of the political platform. In this case, voter j in group J votes for party A if $\sigma^{jJ} < 0$.[8]

Like Persson and Tabellini (2002), we let individual ideological bias σ^{jJ} have a group-specific distribution on the uniform support $\left[\delta - \frac{1}{2\phi^J}, \quad \delta + \frac{1}{2\phi^J}\right]$ where $\delta \in \mathbb{R}$ measures average relative popularity of candidate B in the whole population (across groups) and $\phi^J > 0$ measures group-specific swing density. Groups with a higher value ϕ^J are more swing-voter-dense because their votes are more tightly clustered around the population mean. Party B's popularity δ is also itself a random variable which has a uniform distribution on $\left[\delta^* - \frac{1}{2\psi}, \quad \delta^* + \frac{1}{2\psi}\right]$ with parameters $\delta^* \in \mathbb{R}$ and $\psi > 0$. This implies that the average bias for party B in any given election cycle is not known ex-ante, but is drawn from a distribution with a long-run mean of δ^*. A higher value of ψ implies there is greater concentration around δ^*, and so less spread or uncertainty about which δ materializes in any given cycle.

The relevant election cycle is as follows. Parties announce policy platforms while knowing the distributions of σ^{jJ} and δ but not their realizations, then people vote, then policy is followed through on. To see how investment choice impacts voting, note, from Eq. (7), that the swing voter in group J is the one indifferent between the two parties so that $\sigma^J = \omega^J(I_A) - \omega^J(I_B)$. As all voters in group J with preferences $\sigma^{jJ} < \sigma^J$ prefer

[7] We focus on the North. This is for simplification and as its strategic choices are most pertinent to innovation financing in the baseline model.

[8] Even if voters responded differently to a patent regime, the results of the model hold because, as we show below, parties act symmetrically, such that electoral victory probabilities are equalized.

party A, and given the distribution for σ, the overall vote share party A receives is

$$v_A = \sum_J \alpha^J \phi^J \Big[\sigma^J - \delta + \frac{1}{2\phi^J}\Big]. \tag{8}$$

Given Eq. (8), the probability that A wins the election is thus:[9]

$$Prob[v_A \geq 0.5] = \frac{1}{2} + \psi \left[\frac{\sum_J \alpha^J \phi^J [\omega^J(I_A) - \omega^J(I_B)]}{\sum_J \alpha^J \phi^J} - \delta^* \right]. \tag{9}$$

This shows A is more likely to win to the extent that its public innovation choices improve consumer (voter) welfare over and above those of its opponent, and this impact increases with the population shares but also swing density of the concerned group.

2.3 Innovation regimes

The level of innovation reached in equilibrium will depend on the amount that firms in the North invest in research, which is endogenously determined according to the regime used to incentivize innovation. We consider four regimes types: a global patent regime, a global buyout regime (financed entirely by the North), a national subsidy regime (akin to a national buyout), and a buyout regime with international transfers. In the first three cases, the North is the only strategic actor; in the fourth case, surplus transfers between countries are possible, forming a strategic interaction space between the two countries.

Global patent protection In a regime of global patent protection, the innovating firms become monopoly producers in both countries.[10] The total research investment in this case is determined by Northern firms' profit maximization. At an aggregated level, the optimal value of I then solves

$$Max_I \quad \Pi(I) - I, \tag{10}$$

where $\Pi(I)$ is defined in Eq. (5) and derived from Northern and Southern markets.

[9]It follows that the probability that B wins is $1 - Prob[v_A \geq 0.5] = \frac{1}{2} + \psi \left[\frac{\sum_J \alpha^J \phi^J [\omega^J(I_B) - \omega^J(I_A)]}{\sum_J \alpha^J \phi^J} + \delta^* \right]$.

[10]It does not matter for our analysis how the production is organized geographically, as long as all monopoly profits flow to the innovating firm in the North. For example, production may take place only in the North and the product is then exported to the South. Alternatively, the innovating firm may develop production capacity in the South or license out production to a producer in the South (retaining full monopoly profits).

Domestically-financed global patent buyout Under a patent buyout, the Northern government purchases the patent from the innovator and places it into the global public domain. Without monopoly rights, the product can be produced and sold by firms anywhere in the world. Given the assumed existence of competitive markets for production, this implies zero profit for all producers. If there is no mechanism available to transfer surplus between countries, the government of the North designs and finances (via domestic taxes) the buyout by itself.

In this case, $\zeta(I) = s(I)$, $\tau > 0$, and Northern consumers' welfare is equal to

$$\omega^{J,Buyout}(I) = \int_0^I s(I)dI - \tau y^J. \tag{11}$$

Aggregating over all γn consumers results in total Northern welfare

$$W^{N,Buyout}(I) = \gamma n \sum \alpha^J \left[\omega^{J,Buyout}(I)\right] = S^N(I) - \gamma n \tau y, \tag{12}$$

where $y \equiv \sum \alpha^J y^J$ is average income.

If the government of the North maximizes national welfare, the targeted investment level under a buyout (and thereby τ) will be chosen as follows:

$$\begin{aligned} Max_I \quad & W^{N,Buyout}(I) \\ s.t. \quad & I \leq \gamma n \tau y \end{aligned} \tag{13}$$

The constraint requires that taxes cover innovation costs. The South plays no role for the chosen value of I because buyouts wipe out international profits, and any welfare effects on consumers in the South remain unconsidered by the Northern government.

If, in contrast, policy choices are electorally motivated, then I and the associated taxes are chosen by each party in the North to maximize the probability of election victory, subject to the taxation sufficiency constraint. The maximization problem then reads

$$\begin{aligned} Max_I \quad & Prob\left[v_p\left(\omega^{J,Buyout}(I)\right) \geq 0.5\right] \\ s.t. \quad & I \leq \tau \gamma n y \end{aligned} \tag{14}$$

Individual consumer welfare is again defined in Eq. (11), but the difference is in how welfare is now *aggregated* for optimization. In the objective function (13), individual welfare is simply aggregated into (12) so that each person's preferences factor equally, whereas in the objective function (14), it can be shown that individual welfare is weighed by swing densities for aggregation, with more swing groups weighing more heavily in the choice of taxation and innovation levels.

National subsidy (national buyout) Instead of a global buyout strategy the North may also implement a national subsidy program which, in our model, is equivalent in implications to a *national* buyout; that is, a buyout that removes patent protection only in the North while keeping patents intact in the rest of the world. In a national subsidy regime, the government of the North offers to pay the innovators the difference between the monopoly price and the socially optimal price (i.e., the price that would prevail in a competitive market) for each unit of product sold in the *domestic* market. Legally, firms retain monopoly powers, which in a multi-country world has the advantage for the North that firms can still sell as monopolists to consumers abroad.

In this case, $\zeta(I) = s(I)$ and $\tau > 0$ for Northern consumers, but in addition, there are profits from the South. Assuming each owns an equal fraction of the producing firms (and thus profits), consumer j's welfare in the North becomes

$$\omega^{J,Subsidy}(I) = \int_0^I s(I)dI - \tau y^J + \frac{1-\gamma}{\gamma}\int_0^I \pi(I)dI, \tag{15}$$

where the last part is the per-voter share of profits from the South,[11] and, aggregated over γn, this results in Northern welfare

$$W^{N,Subsidy}(I) = \gamma n \sum \alpha^J \left[\omega^{J,Subsidy}(I)\right] = S^N(I) + \Pi^S(I) - \gamma n \tau y. \tag{16}$$

With a welfare maximizing government, the objective function is therefore

$$Max_I \quad W^{N,Subsidy}(I) \tag{17}$$

$$s.t. \quad I \leq \tau\gamma n y$$

With electoral concerns, on the other hand, the objective function once more revolves around electoral victory chances subject to the taxation constraint:

$$Max_I \quad Prob\left[v_p\left(\omega^{J,Subsidy}(I)\right) \geq 0.5\right] \tag{18}$$

$$s.t. \quad I \leq \tau\gamma n y$$

Buyout with international transfer Finally, we allow for international surplus transfers so that the governments of the North and the South can cooperate on financing a patent buyout. The model then becomes strategic, involving two actors. The contract

[11] Having groups benefit differently from profits, such as higher income groups owning larger firm shares, does not change the qualitative results in the propositions.

specifies the amount of a lump-sum transfer $T \in \mathbb{R}$ from the South to the North, and the level of innovation $I > 0$ that the government of the North must implement through a buyout if the contract is accepted. We focus on the scenario where the North acts as the principal and offers a contract to the South, but it can be shown that a situation where the South is the principal does not change outcomes about I or subsequent regime choice, only impacting the T associated with the contract.

The timing is as follows. First the government of the North offers a contract $\{I, T\}$. Second, the government of the South decides whether to accept the contract. If the contract is accepted, the South transfers T to the North and the North implements a buyout such that the specified level of innovation I is reached. If the contract is rejected, then no transfer takes place and the North is free to implement any of the other possible innovation regimes. That is, the North then either keeps global patent protection intact, implements a national subsidy program, or finances a patent buyout by itself (choosing freely the size of the buyout and associated level of innovation). Finally, innovation and production take place according to the prevailing property rights regime.

In the case that a transfer is accepted by the South, then $\zeta(I) = s(I)$ and $\tau > 0$ for Northern consumers but, in addition, the tax-paying burden is relieved to an extent by the transfer T. Therefore, while the Northern consumers' individual and collective welfare is still equal to Eqs. (11) and (12), respectively, T can create a wedge between I and the required tax financing, reducing the requisite τ for any I. More precisely, if it chooses to implement a buyout regime with transfers, a welfare maximizing government will generate a contract in $\{I, T\}$ that achieves

$$\begin{aligned} Max_{I,T} \quad & W^{N,Buyout}(I) \\ s.t. \quad & I \leq \tau\gamma ny + T \\ & \text{Participation constraint of South} \end{aligned} \tag{19}$$

The constraints state that (i) the transfer decreases the extent to which a buyout is financed with Northern taxes, and (ii) the South must be at least as well off in this regime as it would be under the outside option pursued by the North in the absence of transfers (which will be determined below). With electoral concerns, the contract satisfies

$$\begin{aligned} Max_{I,T} \quad & Prob\Big[v_p\Big(\omega^{J,Buyout}(I)\Big) \geq 0.5\Big] \\ s.t. \quad & I \leq \tau\gamma ny + T \\ & \text{Participation constraint of South} \end{aligned} \tag{20}$$

3 Solution

The solution consists of specifying, for each innovation regime, the level of innovation and associated outcomes. We then determine which regime emerges in equilibrium when different innovation regimes are possible, and the implications for domestic and world welfare. We begin with the findings of the international setting assuming welfare-maximizing governance, after which we summarize how findings are amended when electoral considerations, and therefore the domestic distributional setting, are taken into account.

3.1 Innovation regimes in an international setting

The following proposition compares a patent system to a global buyout.

Proposition 1. *It is possible for the North to fare better under global patent protection than under a domestically-financed global buyout. This can hold even if the world as a whole would be better off with a global buyout.*

Proof. Let I^P and I^B be the investment choices under a patent regime and buyout regime, respectively. Solving the maximization problem in Eq. (10) generates the first-order condition $\pi(I^P) = \frac{1}{n}$, while solving Eq. (13) generates the first-order condition $s(I^B) = \frac{1}{\gamma n}$. Given that (i) the π and s curves are downward sloping, (ii) $\pi(I) < s(I)$, and (iii) $\gamma < 1$, there will be a cutoff value of γ below which $I^B < I^P$, and above which $I^B > I^P$.

Using the expressions for Northern welfare under different regimes and subtracting $W^{N,Patent}(I^P)$ from $W^{N,Buyout}(I^B)$ yields:

$$
\begin{aligned}
W^{N,Buyout} - W^{N,Patent} =& \big[\gamma n \int^{I^B} s(I)dI - I^B\big] - \big[n \int^{I^P} \pi(I)dI + \gamma n \int^{I^P} \zeta(I)dI - I^P\big] \\
=& n\left[\gamma \int_{I^P}^{I^B} s(I)dI + \gamma \int^{I^P} l(I)dI - (1-\gamma) \int^{I^P} \pi(I)dI\right] \\
& - (I^B - I^P) \gtreqless 0
\end{aligned} \tag{21}
$$

where the second line arises from $\zeta(I) = s(I) - \pi(I) - l(I)$. Eq. (21) permits the possibility that $W^{N,Buyout} - W^{N,Patent} < 0$, in which case the social planner would maintain patents. As shown, the likelihood of this increases when $I^B < I^P$ (so when γ is smaller than the cutoff value), when $l(I)$ is small, and when $\pi(I)$ is large.

In contrast, the difference in world welfare under the two regimes is (letting the superscript W denote *world*):

$$
\begin{aligned}
W^{W,Buyout} - W^{W,Patent} =& \big[\gamma n \int^{I^B} s(I)dI - I^B + (1-\gamma)n \int^{I^B} s(I)dI\big] \\
& - \big[n \int^{I^P} \pi(I)dI + \gamma n \int^{I^P} \zeta(I)dI - I^P + (1-\gamma)n \int^{I^P} \zeta(I)dI\big] \\
=& n\big[\int^{I^B} s(I)dI - \big(\int^{I^P} \pi(I)dI + \int^{I^P} \zeta(I)dI\big)\big] - (I^B - I^P) \\
=& n\left[\int_{I^P}^{I^B} s(I)dI + \int^{I^P} l(I)dI\right] - (I^B - I^P) \gtrless 0
\end{aligned}
\tag{22}
$$

Comparing Eqs. (21) and (22), it is possible to have $W^{N,Buyout} - W^{N,Patent} < 0$ even though $W^{W,Buyout} - W^{W,Patent} > 0$, and this likelihood increases when $\pi(I)$ is large. $\square$

This result is in stark contrast to the findings in the closed-economy literature on buyouts, that buyouts are pursued over patents if the government is able to pay the innovator the 'correct' amount. In contrast, Proposition 1 shows that once we move to a world of multiple countries, this is not necessarily the case anymore. It can be rational for the North (in the absence of international surplus transfers) to abstain from implementing a patent buyout, even if such a buyout would increase global welfare relative to a patent regime. Importantly, this holds despite the government knowing the social value of each invention and the absence of commitment issues or other frictions.

The intuition behind this result is based on three factors, all of them explicit in the proof. First, the choice of regime affects firms' incentives to invest in research. As shown above, for sufficiently small values of γ it holds that $I^B < I^P$. Although this implies lower costs of innovation, it also reduces consumer surplus in the North as each additional product that is invented generates surplus. Second, implementing a buyout eliminates the static deadweight loss associated with monopoly pricing, but this potential gain is smaller, the smaller the (averted) deadweight loss. Third, with a buyout the North loses the monopoly profit obtained from the South. Note that smaller values of γ further reduce the gain to the North from eliminating deadweight loss in the (small) domestic market while increasing the costs of foregoing profit from the (large) Southern market.

The implications for the world of moving from a patent to a buyout is also indeterminate, with a buyout having two opposing effects on consumer surplus in the South. The elimination of monopoly pricing tends to increase consumer surplus in the South but if a buyout leads to a lower level of innovation than the one achieved under a patent system, this hurts all consumers, including those in the South. Accordingly, the proof of Proposition 1 shows that the effect on world welfare can be positive or negative. Especially if monopoly profits are large, patents may be inferior from a global perspective but the

North, considering only its own welfare, chooses to maintain global patents.

The results in Proposition 1 are based on a comparison of the international welfare distributions under a patent system and a buyout. Additionally, however, the North might also implement a national subsidy program in which consumers in the North pay competitive prices while consumers in the South pay monopoly prices. The next proposition summarizes the results when these three regimes are compared.

Proposition 2. *When subsidies are an option, they emerge as the dominant strategy for the North over both patents and domestically-financed global buyouts. Subsidies will be pursued even if the world as a whole would be better off with a global buyout.*

Proof. Let I^S be the investment choice under a subsidy regime. Solving the maximization problem in Eq. (17) generates the first-order condition $s(I^S) + \frac{1-\gamma}{\gamma}\pi(I^S) = \frac{1}{n}$. Compared to the first-order conditions for I^P and I^B shown in Proposition 1, and given that (i) the curves are downward sloping, (ii) $\pi < s$, and (iii) $\gamma < 1$, it holds that $I^S > I^P$ and $I^S > I^B$.

Northern welfare from subsidies $W^{N,Subsidy}(I^S)$ relative to patents $W^{N,Patent}(I^P)$ is:

$$\begin{aligned}W^{N,Subsidy} - W^{N,Patent} =& \big[\gamma n \int^{I^S} s(I)dI + (1-\gamma)n \int^{I^S} \pi(I)dI - I^S\big] \\ &- \big[n \int^{I^P} \pi(I)dI + \gamma n \int^{I^P} \zeta(I)dI - I^P\big] \\ =& n\Bigg(\gamma\Big[\int_{I^P}^{I^S} s(I)dI + \gamma \int^{I^P} l(I)dI\Big] + (1-\gamma)\int_{I^P}^{I^S} \pi(I)dI\Bigg) \\ &- (I^S - I^P) > 0\end{aligned} \tag{23}$$

Northern welfare from subsidies $W^{N,Subsidy}(I^S)$ relative to buyouts $W^{N,Buyout}(I^B)$ is:

$$\begin{aligned}W^{N,Subsidy} - W^{N,Buyout} &= \big[\gamma n \int^{I^S} s(I)dI + (1-\gamma)n \int^{I^S} \pi(I)dI - I^S\big] - \big[\gamma n \int^{I^B} s(I)dI - I^B\big] \\ &= n\left[\gamma \int_{I^B}^{I^S} s(I)dI + (1-\gamma)\int^{I^S} \pi(I)dI\right] - (I^S - I^B) > 0\end{aligned} \tag{24}$$

Assuming the welfare difference effects (which are multiplied by population) are greater than investment differentials, Eqs. (23) and (24) are positive precisely because $I^S > I^P$ and $I^S > I^B$, respectively. This establishes subsidies as a dominant strategy.

World welfare from subsidies relative to patents is described by:

$$
\begin{aligned}
W^{W,Subsidy} - W^{W,Patent} =& \Big[\gamma n \int^{I^S} s(I)dI + (1-\gamma)n \int^{I^S} \pi(I)dI - I^S + (1-\gamma)n \int^{I^S} \zeta(I)dI\Big] \\
& - \Big[n \int^{I^P} \pi(I)dI + \gamma n \int^{I^P} \zeta(I)dI - I^P + (1-\gamma)n \int^{I^P} \zeta(I)dI\Big] \\
=& n\left[\gamma \int_{I^P}^{I^S} s(I)dI + (1-\gamma) \int^{I^S} \pi(I)dI + (1-\gamma) \int_{I^P}^{I^S} \zeta(I)dI\right] \\
& - (I^S - I^P) > 0
\end{aligned} \tag{25}
$$

where Eq. (25) is positive by virtue of $I^S > I^P$. Relative to a buyout, we obtain:

$$
\begin{aligned}
W^{W,Subsidy} - W^{W,Buyout} =& \Big[\gamma n \int^{I^S} s(I)dI + (1-\gamma)n \int^{I^S} \pi(I)dI - I^S + (1-\gamma)n \int^{I^S} \zeta(I)dI\Big] \\
& - \Big[\gamma n \int^{I^B} s(I)dI - I^B + (1-\gamma)n \int^{I^B} s(I)dI\Big] \\
=& n\left[\int_{I^B}^{I^S} s(I)dI - (1-\gamma) \int^{I^S} l(I)dI\right] - (I^S - I^B) \gtrless 0
\end{aligned} \tag{26}
$$

Eq. (26) is indeterminate in sign, and more likely negative with large $l(I)$ and small γ. In this case, the dominant strategy extols costs on the world relative to buyouts. □

Subsidies as a dominant strategy in the absence of international transfers is an intuitive result, as the strategy allows the North to eliminate the static deadweight loss associated with monopoly pricing at home (as a buyout would) while maintaining monopoly profits abroad (as a patent regime would). It is therefore preferable to both. As shown in the proof, a subsidy also increases welfare of the North by generating a higher level of innovation I than achieved under a buyout or a patent system. This increase in innovation benefits the North because each additional product that is invented generates domestic consumer surplus as well as additional profits from the Southern market.

The implications for the world therefore depend on the effect on the South. Relative to a patent regime, Southern welfare is strictly greater under a (Northern) subsidy because the South is subject to static losses arising from monopoly pricing under both regimes, while dynamic losses are smaller under a subsidy program due to higher innovation. This is why a subsidy unambiguously raises global welfare relative to a mere patent system. In contrast, whether a subsidy also leads to higher welfare in the South (and globally) relative to a buyout is indeterminate and depends on the extent of deadweight loss from monopoly pricing in the South. With large deadweight losses, the benefit to the South from a subsidy regime with high innovation is attenuated by the cost of monopoly pricing.

And with a sufficiently large Southern market (low γ), global welfare is is also lower, so that the North's dominant strategy of national subsidies is harmful to global welfare.

The next proposition clarifies how the results change when international surplus transfers are feasible.

Proposition 3. *If international surplus transfers are possible, then the equilibrium outcome is Pareto optimal and involves a global buyout with $T > 0$ that stipulates the globally efficient level of innovation. The exact size of T and resulting distribution of welfare depend on the relative bargaining power of each country.*

Proof. Let I^T be the investment choice under a transfer regime. In the maximization problem in (19), and given the results of Proposition 2, the participation constraint of the South is that its welfare under a transfer net of the transfer paid to the North be at least equal to its welfare under the alternative, subsidies, i.e. to $W^{S,Subsidy}$. The maximization problem for the North can thus be reformulated into the Lagrangian

$$\mathcal{L}^N = \gamma n \int^{I^T} s(I)dI + T - I^T - \lambda\big[(1-\gamma)n \int^{I^T} s(I)dI - T - W^{S,Subsidy}\big]. \tag{27}$$

Taking the derivative $\frac{\partial \mathcal{L}}{\partial I^T} = 0$ yields $\gamma n s(I^T) - \lambda(1-\gamma)ns(I^T) = 1$. Taking the derivative $\frac{\partial \mathcal{L}}{\partial T} = 0$ gives $\lambda = -1$. Substituting $\lambda = -1$ into the former first-order condition, we find that the investment amount chosen satisfies

$$s(I^T) = \frac{1}{n}. \tag{28}$$

Given the proofs for Propositions 1 and 2, Eq. (28) implies that I^T is greater than any of I^S,I^P, and I^B. To see that I^T is also Pareto optimal (i.e., world's first best), note that the first-best investment I^{FB} is chosen to maximize world optimal surplus net of investment:

$$W^{W,FirstBest}(I^{FB}) = n \int^{I^{FB}} s(I^{FB}) - I^{FB}. \tag{29}$$

This generates the first-order condition

$$s(I^{FB}) = \frac{1}{n}. \tag{30}$$

From Eqs. (28) and (30), we conclude that $I^T = I^{FB}$.

To show that $T > 0$, taking the derivative $\frac{\partial \mathcal{L}}{\partial \lambda} = 0$ and substituting $W^{S,Subsidy} = (1-\gamma)n \int^{I^S} \zeta(I)dI$ yields the value $T = (1-\gamma)n \int^{I^T} \left[\int^{I^T} s(I)dI - \int^{I^S} \zeta(I)dI\right]$, which is positive.

The investment level I^T is independent of the transfer amount. To show that it is independent of bargaining structure more broadly, note that if the South had the bargaining power to set a contract, its corresponding Lagrangian would be $\mathcal{L}^S = (1-\gamma)n\int^{I^T} s(I)dI - T - \lambda\big[\gamma n\int^{I^T} s(I)dI - I^T + T - W^{N,Subsidy}\big]$. Taking the derivative $\frac{\partial\mathcal{L}^S}{\partial I^T}$ yields $(1-\gamma)ns(I^T) - \lambda\gamma ns(I^T) = 1$ while the derivative $\frac{\partial\mathcal{L}^S}{\partial T}$ again gives $\lambda = -1$. Substituting the latter into the former we obtain once more the first-order condition $s(I^T) = \frac{1}{n}$. Only T, which depends on the participation constraint, and the resulting welfare distribution among countries —with the South now appropriating all the surplus from the transition to a transfer system— change. $\square$

Combining the results in Proposition 3 with those in Proposition 2 implies that the presence of a technology for international surplus transfer is both necessary and sufficient for achieving a globally Pareto optimal outcome in the model. Without transfers, the North's dominant strategy of subsidies leads to an inefficiently low level of innovation, where some products that would be worthwhile to invent from a global welfare perspective remain unexploited. If transfers are possible, it is in the best interest of both countries to cooperate on financing a buyout which generates the globally efficient level of innovation; that is, all products z are invented for which the global optimal consumer surplus (achieved under competitive pricing) is greater than the research cost. Importantly, this result is independent of the model's parameter values, not depending, for example, on the relative size of the North or South or on $\pi(I)$ and $l(I)$ magnitudes.

3.2 Adding domestic distributional concerns

With electoral concerns, note first that, because in equilibrium both parties make symmetric choices, $I_A = I_B$, and given Eq. (9), the victory probabilities for A and B are:

$$Prob[v_A \geq 0.5] = \frac{1}{2} - \psi\delta^*, \tag{31}$$

$$Prob[v_B \geq 0.5] = \frac{1}{2} + \psi\delta^*. \tag{32}$$

Therefore, electoral victory chances ultimately reflect fundamental (ideological) preferences, and this holds irrespective of whether the parties engage in investment in a domestically-financed buyout, in a subsidy, or a transfer-facilitated buyout regime.[12] Moreover, the probabilities of victory for A and B are those in Eqs. (31)-(32) also for a patent regime.[13] The main difference between regimes is therefore optimal invest-

[12]Within a given public investment regime, parties still choose $I_A = I_B > 0$ because to do otherwise results in loss of votes to the opponent. It is not an equilibrium strategy to choose $I = 0$ within domestically-financed buyout, subsidy, or transfer-facilitated buyout regimes.

[13]This can be seen with our assumption that voters vote only on ideological preference, so that $\omega(I_A) = \omega(I_B) = 0$. However, it would also hold more broadly as long as actions by the parties are symmetric,

ment level —by the government or firms— and subsequent welfare implications, while electoral victory chances are equalized in equilibrium. Given equal chances of victory for Northern parties among all regimes, we assume governments weakly prefer regimes with higher national welfare.

Second, the model revolves around politically important heterogeneity among voters, in this case differences in swing-density, ϕ^J. For ease of notation, we use

$$\Delta \equiv \frac{\left(\sum_J \alpha^J \phi^J y^J\right)}{\left(\sum_J \alpha^J \phi^J\right) y} \tag{33}$$

to denote an expression that recurs repeatedly in the solutions (see below) and which captures the extent of voter swing heterogeneity. To understand this expression, note that the denominator is average swing density in the population $(\sum_J \alpha^J \phi^J)$ multiplied by overall average income (y). In contrast, the numerator is an expression of population- and swing-weighted income; that is, each group's income is weighted by its population share *and* its swing density. If all groups have the same fixed swing density, i.e. $\phi^J = \bar{\phi}$, so that there is no heterogeneity in their political importance, the expression reduces to[14]

$$\Delta = \frac{\bar{\phi}\left(\sum_J \alpha^J y^J\right)}{\bar{\phi}\left(\sum_J \alpha^J\right) y} = 1. \tag{34}$$

In contrast, differential densities imply $\Delta \neq 1$. If the wealthier group is more swing-dense then $\Delta > 1$ (swing-weighted income is higher than average income) and vice versa.

In what follows, we summarize the main findings in Propositions 4-6, which are structured to be parallel to Propositions 1-3.

Proposition 4. *The presence of electoral concerns (i.e., when $\Delta \neq 1$) changes the scope for buyouts relative to patents. Specifically, buyouts are more likely relative to patents when $\Delta < 1$ but less likely when $\Delta > 1$, and the divergence increases in $|\Delta - 1|$.*

Proof. Let $I^{\overline{P}}$ and $I^{\overline{B}}$ be the investment choices under a patent regime and a buyout regime with electoral considerations, respectively. As firms still operate on the basis of profit maximization, Eq. (10) yields the first-order condition $\pi(I^{\overline{P}}) = \frac{1}{n}$. Therefore, $I^{\overline{P}} = I^P$. With a buyout, the government's electoral considerations in Eq. (14) generate the first-order condition $s(I^{\overline{B}}) = \frac{\Delta}{\gamma n}$. Comparing with the proof for Proposition 1, this highlights that, if $\Delta > 1$, then investment under buyouts is lower than under welfare maximization $(I^{\overline{B}} < I^B)$, and vice versa if $\Delta < 1$.

as $\omega(I_A)$ and $\omega(I_B)$ cancel out in the electoral victory probability in Eq. (9).

[14] This is owing to the definition of average income, $y \equiv \sum_J \alpha^J y^J$, and since $\sum_J \alpha^J = 1$.

Given equalized victory probabilities, regime choice hinges on welfare outcomes for the North. Welfare functional forms by regime do not change; only the values of investment do (responding to different maximization objectives). Relying on the forms in Proposition 1 we can calculate the difference in welfare between a buyout and patent regime as

$$\begin{aligned} W^{N,Buyout} - W^{N,Patent} =& n\left[\gamma \int_{I^P}^{I^{\overline{B}}} s(I)dI + \gamma \int^{I^P} l(I)dI - (1-\gamma)\int^{I^P} \pi(I)dI\right] \\ & - (I^{\overline{B}} - I^P) \gtrless 0 \end{aligned} \tag{35}$$

Comparing Eq. (35) with Eq. (21) , if $\Delta > 1$ and therefore $I^{\overline{B}} < I^B$, then the expression in Eq. (35) is smaller, reducing the advantage of buyouts over patents; the reduction increases with a higher $\Delta - 1$. The opposite holds if $\Delta < 1$ and $I^{\overline{B}} > I^B$, in which case the relative advantage of buyouts rises with $-(\Delta - 1)$. □

Proposition 4 implies that it is now even more likely that the North will abstain from implementing a buyout *if* wealthy groups are also more powerful politically (i.e. $\Delta > 1$). The intuition behind this is that the wealthier pay a higher absolute amount of their income under a flat-rate tax (and even more so under a progressive tax), so that they have lower relative benefit per unit of innovation and prefer less public financing. The government, extra-sensitive to the demands of these groups, would attenuate their public innovation spending under a buyout regime. By contrast, investment choices under a patent regime —driven by profit considerations— are unaffected by this dimension. As a result, the welfare advantage that accrues from buyouts potentially increasing innovation levels, will diminish. Given (second-order) welfare concerns, the North will therefore be less likely to replace a patent regime with a global buyout.

The implications for the South, and therefore the world, continue to be ambiguous. To the extent that the higher income group in the North is more politically important, implying $I^{\overline{B}} < I^B$, Southern consumer surplus gains from innovation are diminished relative to the solution in Section 3.1. The opposite holds if the lower income group is more politically important, with the South reaping greater benefits from the externality associated with buyouts. In this latter case, a choice in the North of patents over buyouts (which is still possible if, for example, profit margins under a patent regime are sufficiently large) would mean foregoing even larger global gains than previously calculated.

The next proposition summarizes the results when a subsidy regime (akin to a national buyout) is also a possible option for the North.

Proposition 5. *With electoral concerns, subsidies are a dominant strategy over domestically-financed buyouts and patents only if* $\Delta < 1$. *If* $\Delta > 1$, *subsidies are dominant over buyouts but not over patents. The likelihood of a patent regime increases in* $\Delta - 1$.

Proof. Let $I^{\overline{S}}$ be the investment choice under a subsidy regime with electoral concerns. Solving the maximization problem in Eq. (18) generates the first-order condition $s(I^{\overline{S}}) + \frac{1-\gamma}{\gamma}\pi(I^{\overline{S}}) = \frac{\Delta}{n}$. Compared to the first-order condition for I^S in Proposition 2, and given that the left-hand side is downward sloping, then $\Delta > 1$ implies $I^{\overline{S}} < I^S$. Conversely, $\Delta < 1$ implies $I^{\overline{S}} > I^S$. Northern welfare from subsidies relative to patents is

$$\begin{aligned} W^{N,Subsidy} - W^{N,Patent} =& n\left(\gamma\Big[\int_{I^P}^{I^{\overline{S}}} s(I)dI + \gamma\int^{I^P} l(I)dI\Big] + (1-\gamma)\int_{I^P}^{I^{\overline{S}}} \pi(I)dI\right) \\ & - (I^{\overline{S}} - I^P) \gtrless 0 \end{aligned} \tag{36}$$

If $\Delta < 1$, so that $I^{\overline{S}} > I^S$, then along with the proof in Proposition 2 that $I^S > I^P$, this implies $I^{\overline{S}} > I^P$, making Eq. (36) positive. Otherwise, Eq. (36) may be negative, and this is increasingly likely as a higher $(\Delta - 1)$ renders $I^{\overline{S}} < I^P$.

Northern welfare from subsidies relative to buyouts is:

$$W^{N,Subsidy} - W^{N,Buyout} = n\left[\gamma\int_{I^{\overline{B}}}^{I^{\overline{S}}} s(I)dI + (1-\gamma)\int^{I^{\overline{S}}} \pi(I)dI\right] - (I^{\overline{S}} - I^{\overline{B}}) > 0 \tag{37}$$

Eq. (37) is always positive by virtue of $I^{\overline{S}} > I^{\overline{B}}$, which can be seen by comparing the first-order condition for $I^{\overline{S}}$ with that in the proof of Proposition 4 for $I^{\overline{B}}$. □

Proposition 5 implies that, even if it is possible for the North to implement a subsidy (or national buyout), this will no longer necessarily be its dominant strategy. In particular, while subsidies are still more desirable for the North than a domestically-financed global buyout, they are no longer necessarily preferable to a global patent regime.

The intuition behind this result is as follows. Between subsidies and global buyouts, investment under both is impacted by electoral concerns, and it remains true that investment under subsidies is higher. Therefore, for the North, a subsidy still has the same two advantages over buyouts: it preserves international profits while eliminating static deadweight losses associated with monopoly pricing at home, and it also increases welfare by generating a higher level of innovation than under buyouts. As before, each additional product invented generates domestic surplus as well as monopoly profits from markets abroad. However, between subsidies and global patents, only the former's investment levels are impacted by electoral concerns. If the wealthier group is sufficiently important for electoral victory, then investment under a subsidy may be *lower* than under a patent regime. In this case, it is possible that the welfare loss from lower innovation under a subsidy outweighs the gain from removing monopoly deadweight losses, so that global patents are preferable from a Northern welfare perspective.

Finally, the next proposition accounts for the possibility of international transfers.

Proposition 6. *With electoral concerns, transfer contracts set by the Northern government do not generate a Pareto optimal global buyout, and total investment in innovation deviates from the globally efficient level. Global welfare is lower than its optimal level, and the gap increases with* $|\Delta - 1|$.

Proof. Let $I^{\overline{T}}$ be the investment choice under a transfer regime with electoral concerns, and $\overline{T}$ be the corresponding transfer amount. We need to show that $\Delta \neq 1$ implies $I^{\overline{T}} \neq I^{FB}$. To do this, note first that the maximization problem in Eq. (20) can be rewritten in the form of the ensuing constrained first-order condition:

$$\sum_J \alpha^J \phi^J \frac{\partial \omega^J}{\partial I^{\overline{T}}} = 0 \tag{38}$$

$$s.t. \quad I^{\overline{T}} \leq \tau\gamma n y + \overline{T}$$

Participation constraint of South

where now we can be agnostic about whether the fallback level of the South is its welfare under subsidy or buyout, so we can leave it as $W^{S,fallback}$.

To clarify the components of ω^J and solve the above, we note that with both constraints in Eq. (38) being binding, consumer welfare in the North with a transfer is $\omega^J = \int^{I^{\overline{T}}} s(I)dI - \frac{I^{\overline{T}} - \overline{T}}{\gamma n y} y^J$, where $\overline{T}$ meets the South's participation constraint so that $\overline{T} = (1-\gamma)n \int^{I^{\overline{T}}} s(I)dI - W^{S,fallback}$. Substituting the expression for $\overline{T}$ into w^J, and then taking the derivative with respect to $I^{\overline{T}}$, we obtain

$$\frac{\partial \omega^J}{\partial I^{\overline{T}}} = s(I^{\overline{T}}) - \frac{y^J}{\gamma n y} + \frac{(1-\gamma)}{\gamma y} s(I^{\overline{T}}) y^J. \tag{39}$$

Substituting Eq. (39) into the first-order condition in Eq. (38) yields

$$\sum_J \alpha^J \phi^J \Big(s(I^{\overline{T}}) - \frac{y^J}{\gamma n y} + \frac{(1-\gamma)}{\gamma y} s(I^{\overline{T}}) y^J \Big) = 0, \tag{40}$$

which can be simplified to

$$s(I^{\overline{T}}) + \frac{\Delta}{\gamma}(1-\gamma) s(I^{\overline{T}}) = \frac{\Delta}{\gamma n}. \tag{41}$$

We can see immediately that if $\Delta = 1$, the above reduces to $s(I^{\overline{T}}) = \frac{1}{n}$, so that $I^{\overline{T}} = I^{FB}$. Otherwise, if $\Delta \neq 1$, then $s(I^{\overline{T}}) \neq \frac{1}{n}$, so that $I^{\overline{T}} \neq I^{FB}$. It follows that world welfare is lower than the first best and increasingly so as $|\Delta - 1|$ rises. □

Proposition 6 implies that the presence of a technology for international surplus transfers is no longer sufficient for achieving a Pareto optimal outcome when investment decisions are affected by electoral concerns. In particular, a transfer contract $\{I^{\overline{T}}, \overline{T}\}$ designed by the Northern government and driven by domestic distributional considerations will lead to suboptimal investment and world welfare levels.

The key intuition for this result is as follows. Previously, in the baseline international model, the key disincentive toward a global buyout for the North lay in the international distribution implications, in particular that the South would benefit from the buyout without paying for it. In this case, transfers from the South to the North entirely removed the externality regardless of which entity designed the contract. In contrast, under electoral concerns, the Northern government is acting not only to minimize 'free-riding' by the South, an issue which transfers would address, but also to strategically appease important voter groups. The latter is a domestic political economy dimension that transfers do not get rid of; that is, transfers do not eliminate the fact that some domestic taxation is required to implement a global buyout (otherwise, the participation constraint of the South would not be met) nor do they remove conflict between different Northern voter groups over the desired extent of taxation.

3.3 Summary and simulation

Our model shows that, because buyouts may have global externalities and are publicly financed, the choice of innovation regime depends on the effect on international profit as well as domestic welfare redistribution; these considerations arise even in the absence of the information and commitment problems considered in the literature on buyouts. Abstracting from distributional issues underestimates the challenges toward instituting buyout regimes even when buyouts are globally welfare enhancing.[15]

To conclude this section, we present a numerical simulation to illustrate the North's tradeoff between a patent regime and a domestically-financed global buyout (Proposition 1). This sheds light on how different parameter values in our model impact the patent-buyout binary that is often considered in the (closed-economy) literature, but similar exercises can be conducted for the other propositions. As simulation requires moving

[15]We note that, in solving the model, we focus on the case where a patent regime implies full intellectual property rights protection in both the North and South. Any deviation from this assumption (e.g., counterfeit products in the South) would tend to reduce the incentives of Northern firms to invest in innovation, thereby making a patent system relatively less attractive to the North with respect to the international welfare distribution. However, unless monopoly profits are reduced to zero, the presence of (some) counterfeit products does not critically affect our main (qualitative) findings. In addition, the domestic electoral considerations we study remain unaffected by counterfeit products.

from general to a closed-form specifications, we introduce the following additional functional form assumptions. Following Deardorff (1992), we assume that the speed by which diminishing returns to innovation occur is constant, so that $s(I)$ can be represented by a linear function of the form

$$s(I) = f - gI. \tag{42}$$

The intercept $f > 0$ indicates how valuable inventions are in general; that is, how productive the innovation technology is.[16] The slope parameter $g > 0$ indicates the speed by which diminishing returns to innovation set in.

With this linearity assumption (and the implied linearity of demand), monopoly profit and consumer surplus under monopoly pricing are given as fixed shares of the optimal consumer surplus (i.e., the one derived under competitive pricing) in each country.[17] Solving the model using the linear expression from equation (42) in place of the general term $s(I)$ used in Section 2 shows that Eq. (21), which compares total welfare of the North under patents versus under a domestically-financed buyout, now takes the form

$$W^{N,Buyout} - W^{N,Patent} = \frac{\gamma n^2 f^2 (3\gamma - 2) + 4(\gamma - 1)^2}{8\gamma n g}. \tag{43}$$

Similarly, the change in *global* welfare when moving from a patent system to a buyout, previously described by Eq. (22), is now given as

$$W^{W,Buyout} - W^{W,Patent} = \frac{\gamma^2 (n^2 f^2 - 4) + 4(2\gamma - 1)}{8\gamma^2 n g}. \tag{44}$$

We use these results to simulate the equilibrium outcomes and associated welfare implications for different parameter value combinations.

The results are presented in Figure 2. Panel (a) shows the North's welfare gain under a domestically-financed buyout compared to patents (Eq. 43). Positive values imply that the North will implement a buyout whereas negative values imply a patent system in equilibrium. Panel (b) shows the corresponding values for global welfare (Eq. 44).

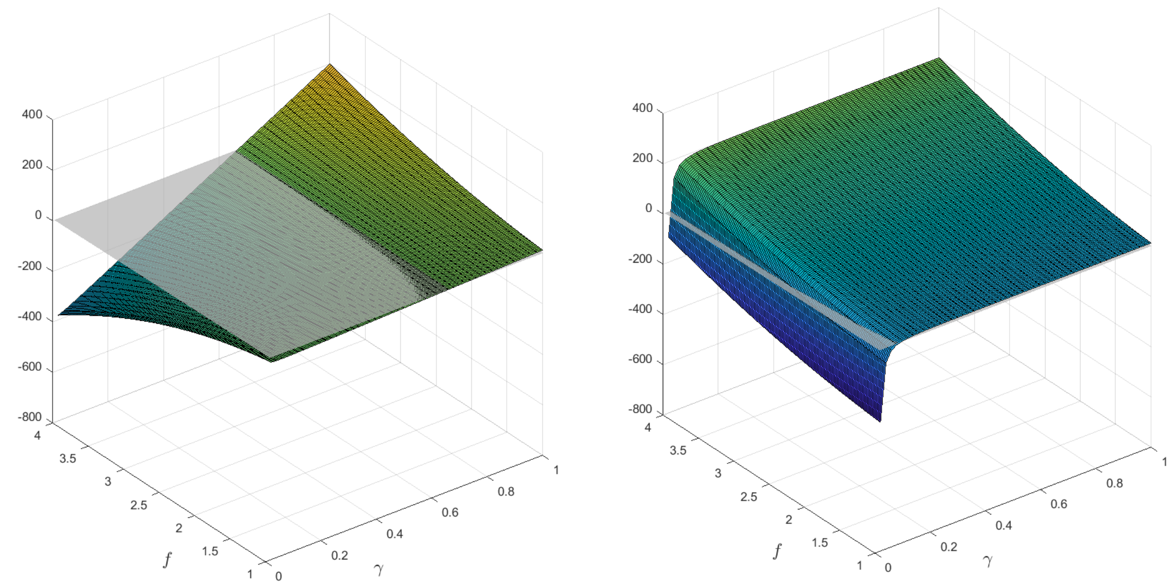
We observe that, in line with the results of Proposition 1, there are many parameter value combinations for which the North prefers a patent system although global welfare would be greater with a buyout. These are all the combinations which fall below the white horizontal plane in Panel (a) but above it in Panel (b). We also observe, from Panel (a), that sufficiently large values of γ always lead to a buyout whereas small values

[16]Formally, f is the optimal per-capita consumer surplus per unit of research cost of the highest priority invention; that is, of the product z with the highest value of $s(z)$.

[17]Specifically, as is known for the linear case, the monopoly profit amounts to one half of the optimal consumer surplus while the remaining surplus is split equally between consumers and deadweight loss.

Figure 2: Simulations for different values of γ and f

(a) $W^{N,Buyout} - W^{N,Patent}$ (b) $W^{W,Buyout} - W^{W,Patent}$



Note: Simulations based on parameter values: $\gamma \in (0, 1)$, $f \in (1, 6)$, $n = 20$, $g = 0.2$.

of γ lead to patents. This illustrates the function of bigger Northern markets (higher γ), explained earlier, in (i) augmenting the gains from buyout elimination of domestic deadweight loss, (ii) limiting the cost from buyout elimination of international profit loss, and (iii) encouraging high innovation and subsequent Northern consumer surplus under a buyout. Finally, we see that with the linear functional form assumptions made above, the cutoff value of γ, which determines whether the North chooses a buyout or not, lies in the interval $(\frac{1}{2}, \frac{2}{3})$; this also holds for any fixed values for n and g (omitted). In particular, this suggests that the results in Proposition 1 do not critically depend on γ taking extreme values close to zero or close to one.

4 Extensions

In the previous literature, the widespread absence of buyouts observed in practice has been mostly attributed to two main channels: information asymmetries regarding the appropriate size of buyouts, and commitment problems impeding the credibility of future transfers from the government to the innovating firms. So far, we have abstracted from information and commitment problems to show that, even in their absence, it can be rational for governments to prefer patents over buyouts, due to the global externalities and political economy considerations captured in our model. In this section, we link our insights back to this literature and discuss how information and commitment problems may affect countries' optimal strategies in our setting.

4.1 Information asymmetries

We consider three types of information asymmetries: (1) between governments and domestic firms, (2) between the governments of different countries, and (3) between differentiated voter groups within a country.

Between the (financing) government and firms This is the standard information asymmetry explored in the literature. To see how such an asymmetry amends our framework, suppose the Northern government does not know consumer's demand functions and does not observe market signals such as sold quantities, so that it faces uncertainty about $s(I)$. For publicly financed innovation regimes, the government therefore has to form expectations $E[s(I)]$ when choosing the targeted investment level I. For example, in a buyout, a welfare-maximizing government's first-order condition would be amended from $s(I) = \frac{1}{\gamma n}$ (Proposition 1) to

$$E[s(I)] = \frac{1}{\gamma n}. \tag{45}$$

Given that $s(I)$ is decreasing in I, it follows that the value of I chosen under imperfect information is larger than the value obtained under full information when $E[s(I)] > s(I)$, and is inadequately small when $E[s(I)] < s(I)$. In both cases, as Northern welfare is optimized under a buyout when I is set such that $s(I) = \frac{1}{\gamma n}$, there is a welfare loss for the North relative to the outcome under full information. Similar arguments apply to the choice of I under a subsidy regime. In contrast, and assuming (as the literature does) that firms have information about demand functions, then in a patent-based system I is determined under full information.

Thus, the first result from introducing government-firm asymmetric information to our setup mirrors the core result of the single-economy setting (e.g. Shavell and van Ypersele, 2001): the asymmetry reduces the desirability of buyouts —and publicly financed regimes in general— relative to patents.[18] The difference here is that information problems are not *necessary* for explaining low buyout feasibility; rather, they compound the existing political economy implications that we consider.

Second, while the above issue of regime choice involves assessing Northern welfare (and

[18] The same result would emerge if the asymmetry would exist not in terms of access to information *per se*, but in higher costs of processing available information for governments than for firms, which is a common assumption in the literature on centralized planning under imperfect information (Feldman and Serrano, 2006, Ch. 5.5; Naeher, 2023).

this is lower under imperfect as opposed to full information), our international setting gives rise to the distinct possibility that asymmetric information nonetheless may lead to improvements in *global* welfare. This is possible because, in our setting, global welfare is *not* equal to Northern welfare as it also encompasses the South. To see this, consider the case where the North (still) finds it optimal to implement a domestically-financed global buyout under imperfect information, but the chosen investment level I remains below the global optimum (see Proposition 1). In this case, if information asymmetries cause the government to expect $s(I)$ to be higher than it really is (but not too high), this generates a shift in equilibrium I closer to the globally optimal investment level than under perfect information, increasing global welfare. Intuitively, asymmetric information leading to an overvaluation of Northern benefit from the government's point of view generates a positive externality to the South which benefits from the higher innovation, potentially improving world welfare (if the South's gain is greater than the North's loss) relative to full information. In sum, the implications globally will depend on the type of information problem and its interaction with the determinants of world welfare.

An additional insight from the international setup relates to the feasibility of using market signals to bridge potential information asymmetries. Previous studies highlight that governments can use market signals such as prices and sold quantities to inform the design of patent buyouts when *ex ante* information about the social value of innovations is lacking (Shavell and van Ypersele, 2001; Chari et al., 2012; Galasso et al., 2016). We note that, while in the single-economy models underlying these studies it seems relatively harmless to assume that governments can observe such market signals, moving to an international setting means that any national government considering to implement a buyout would also need to observe these signals on foreign markets to choose the optimal buyout amount. If in practice obtaining such information from abroad is subject to additional transaction costs or other frictions, then the feasibility of buyouts relative to patents will be further diminished in the international setting.

Between the North and the South In addition to the standard question of government-firm information asymmetries, a novel possibility arises with our international setting, of information quality differences between *sovereigns*. Suppose, for instance, that the government in the South has less information than the government in the North on the social value of innovations considered for a buyout, and that this asymmetry is non-trivial due to some cost of transmission of (credible) information. Analogous to the above, we can model the South as operating on the basis of expectations $E[s(I)]$ while the Noth has information about $s(I)$.

This asymmetry would not affect equilibrium choices in global or national buyout regimes as these derive only from the calculations of the North, but it would impact the structure of any intersovereign transfer contracts, which the South's strategic calculations factor into. To see this, suppose again the North has bargaining power to set the contract $\{I, T\}$. While the North's maximand in Eq. (19) remains the same, the participation constraint of the South is amended to be a function of the latter's expectations $E(s)$ as opposed to $s(I)$. It can be shown that the first-order condition that defines optimal I then changes from $s(I) = \frac{1}{n}$ (Proposition 3) to

$$\gamma s(I) + (1-\gamma)E[s(I)] = \frac{1}{n} \tag{46}$$

In the case that the South underestimates the benefit from innovation, so that $E[s(I)] < s(I)$, the optimal I chosen will be lower than under full information, and vice versa if the South overestimates the benefit. In both cases, investment will diverge from the first best so that $I^T \neq I^{FB}$, erasing the result from Proposition 3 that an internationally-financed buyout generates the Pareto optimal global outcome. We note that remedying the gap via information transmission would still be possible if the surplus from the global first best (which accrues to the North as the one with the bargaining leverage) is, relative to the North's welfare with the next best option, greater than the cost of credible information transmission; however, the situation becomes more complex if the South is to design the contract and capture the surplus. Therefore, ultimately the impacts of this type of asymmetry would depend on the interplay of the direction and magnitude of the information problem with the intersovereign transfer bargaining structure.

Between differentiated voter groups An additionally novel type of information asymmetry that arises in our model as a possibility is one between voter groups; this has not been explored in the prior literature as the latter does not model domestic distributional concerns among voter groups. Specifically, suppose that information quality is correlated with individual income (Angelucci and Prat, 2024), such that wealthier voters tend to have more realistic expectations of the value of innovations than poorer voters. Analogous to above, this can be incorporated in our model by assuming that voters form expectations about $s(I)$ when deciding which political party to vote for. Amending Eqs. (7) and (11) accordingly, voter j in group $J \in \{R, M, P\}$ will prefer party A if

$$E^J[\omega^J(I_A)] > E[\omega^J(I_B)] + \sigma^{jJ}, \tag{47}$$

with

$$E^J[\omega^J(I)] = \int_0^I E^J[s(I)]dI - \tau y^J \tag{48}$$

being the group-specific expected consumer welfare in the case of a buyout regime (where the superscript J on the expectation operator indicates that voters from different groups may hold different expectations due to asymmetric information). In equilibrium it continues to hold that $I_A = I_B$. However, to maximize their vote share, both parties now have to announce investment levels in line with voters' expectations (irrespective of whether the parties themselves share these expectations). The first-order condition underlying the parties' vote-maximizing strategy now features $E^J[\omega^J(I)]$ in place of $\omega^J(I)$ so that, in the case of a domestically-financed buyout, the solution must fulfill

$$\sum_J \alpha^J \phi^J E^J[s(I)] = \frac{\sum_J \alpha^J \phi^J y^J}{\gamma n y}. \tag{49}$$

Recall that $s(I)$ is decreasing in I. Thus, whenever a voter group (say $J = P$) has expectations $E^P[s(I)] > s(I)$ (keeping the expectations of the other two groups fixed at the true value $s(I)$), the chosen value of I will be larger than the value chosen under full information, and vice versa if $E^P[s(I)] < s(I)$. The magnitude of this effect depends positively on α^P and ϕ^P. In other words, if information asymmetries lead some voters to overestimate (underestimate) the social value of innovation, then the outcome with electoral concerns will feature a higher (lower) investment level under a buyout, and this deviation is amplified by a higher population share and by a higher swing density of the less-informed voters.

Finally, suppose there are information asymmetries at the individual voter level, such that all voters feature idiosyncratic expectations $E^{j,J}[s(I)]$. We consider the case where the expected values within each group $J \in \{R, M, P\}$ are symmetrically distributed around the true value $s(I)$ but the variance is larger in group P than in the other two groups (capturing lower information quality in P). In this case, the correlation between income and information quality is, in itself, not crucial in determining I. What matters is how voters' expectations relate to the distribution of swing voters. If the direction of voters' expectation errors is independent of political preferences (i.e., swing voters are equally likely to over- or underestimate $s(I)$), then the assumed symmetry implies that expectations above the true value $s(I)$ and those below will cancel each other out, so that parties will chose (in expectation) the same level of I as with perfect information. If, on the other hand, swing voters are more likely to overestimate the value of innovation, then the chosen level of I will be higher than the one under perfect information (and vice versa if swing voters more often underestimate $s(I)$).

4.2 Commitment problems

Analogous to the above discussion, commitment problems may arise between the (financing) government and its firms as is standard in the literature but also, in our international setup, between sovereigns. We focus on this latter possibility and its effect on transfer-financed buyouts.

Recall that our model in Section 2 implicitly assumes international transfers are financed by government revenues (such as taxes) in the countries featuring less innovation capacity. In practice, however, there are often severe challenges toward the mobilization of domestic resources in low-income countries, including weak institutions and low taxation paying norms (Besley and Persson, 2014). Even if governments in those countries can in principle mobilize enough resources, the transfers agreed in exchange for implementing a buyout must be credible from the perspective of the innovating country, but credibility is compromised if the (here, Southern) government faces potentially unexpected shocks that may require diversion from a small budget (along the lines of Galasso, 2020).

In our model, intersovereign commitment problems can be readily incorporated by specifying that, when the Northern government designs the contract $\{I, T\}$ to maximize the objective in expression (19), it operates under the assumption that with probability $\theta \in (0, 1)$ the agreed transfer T will fail to materialize. It may further be realistic to assume that $\theta(T)$ and $\theta' > 0$, so that the credibility problem is accentuated with higher requisite transfers. This changes the first constraint in Eq. (20) from $I^T \leq \tau\gamma ny + T$ to $I^T \leq \tau\gamma ny + \big(1 - \theta(T)\big)T$. It can be shown that the first-order condition then changes to

$$s(I)\Big[1 - (\theta + T\theta')(1 - \gamma)\Big] = \frac{1}{n}. \tag{50}$$

Given a downward sloping $s(I)$, this implies that the chosen level of I will remain below I^{FB}, with the difference increasing with the extent of the commitment problem. As $\theta \to 1$ (and its derivative approaches zero), the first-order condition devolves to Eq. (13), i.e. that of a global buyout with no transfers.

Therefore, internationally-financed buyouts no longer generate the global first best. Furthermore, they may not even lead to Pareto improvements relative to regimes based on global patent protection if the extent of the underlying externality (and therefore requisite transfer) is large. Without a supra-sovereign enforcer of agreements between sovereigns, it is difficult to see how such commitment problems can be overcome.[19]

[19]Potentially, the feasibility of internationally-financed buyout could be restored in a repeated game setting if the North has a credible way to punish default on T by the South (a formal treatment is left for future research).

5 Scope and limitations

This section discusses the assumptions underlying our model, focusing on robustness to alternative modelling choices. The discussion is mostly framed in terms of the results with welfare maximizing governments, but similar conclusions can be drawn about the variant with electoral concerns in the features it shares with the baseline model.

Identical demand functions The model follows the literature in assuming that consumers feature the same inverse demand functions (in all countries and across all goods). With respect to this assumption, if the quantity of some invented product demanded per consumer was different across countries, then the magnitudes of the tradeoffs facing the North in choosing between different innovation regimes would change. While sufficiently small derivations would leave our main qualitative findings intact, larger deviations may affect the results in Propositions 1 and 2. To see this, consider the two extreme cases of an innovation set X that generates products only demanded by consumers in the North, and an innovation set Y that generates products only demanded in the South. In the case of Y, moving from a patent system to a buyout without transfers would eliminate any research investment for this invention, as the North would not enjoy any of the surplus associated with Y. In this case, and deviating from the results in Proposition 1, welfare of the South (and globally) would always be greater under a patent regime than under a buyout, and the North would not in any case implement a buyout. Similarly, for X the North would always implement a buyout. At the same time, the key result in Proposition 3 would remain intact, as a Pareto-improving buyout with international transfer could be implemented both for X and for Y (where for X the required transfer would be zero).

Symmetric production costs The model moreover assumes that patent buyouts lead to the same competitive pricing of invented products in all countries. This implies that the geographical organization of production is irrelevant; that is, it does not matter whether all production capacity is concentrated in the North and products are exported to the South, or the South also features some production capacity.[20] The model is therefore unable to capture important considerations in the context of industrial development and employment. At the same time, relaxing the assumed symmetry in production would keep most of our key qualitative insights intact. For example, suppose that consumers in

[20]This applies if producers make zero profits under a buyout (i.e., when production takes place in a competitive environment) and if all profits generated under a patent system flow to the North (e.g., through licensing; see also footnote 10).

the South would face higher prices under a buyout than consumers in the North because the cost of production is higher in the South than in the North (e.g., due to less productive technology and infrastructure) or because markets for production are not fully competitive in the South (and shipping products across countries entails transportation costs). The existence of such price differences will tend to reduce the benefits of a buyout to the South and thus affect the results of the model quantitatively. At the same time, the qualitative insights obtained from Propositions 1 - 3 would largely remain the same. In particular, the North would still prefer a system with subsidies over a domestically-financed buyout (Proposition 2), and the globally efficient level of innovation will only be reached in the presence of international transfers (Proposition 3).

Market frictions Innovations in the model are readily purchased and consumed by n individuals (distributed with share γ in the North) if their associated utility exceeds the cost. This feature abstracts from the fact that some consumers may face binding constraints in financing the consumption of new products, and that these constraints may systematically differ between countries. If there are individuals who are constrained from paying the equivalent of their marginal benefit obtained from consuming an innovation (e.g., due to credit market frictions) but these constraints are not considered in our model, then the model will tend to overestimate the value of innovation. Moreover, if these constraints were mostly concentrated in countries with less innovation capacity, this would reduce the benefits of a global buyout to those countries (as well as globally) relative to what our model implies.[21] The same applies to other constraints, including those related to institutions. For example, many health-based innovations are primarily delivered through national health systems. If, on the supply side, the involved institutions are associated with a limited capacity to procure, distribute or maintain the respective products (e.g., due to organizational or human capital issues, even in the absence of financial constraints among consumers), then effective demand in these countries will be smaller than implied by our model.[22]

[21] To see this, consider a household in the South with a valuation of an innovation below the monopoly price but above the competitive price. When moving from a system of global patent protection to a buyout, the model assumes that the household will purchase the innovation, contributing to a rise in the South's consumer surplus. However, if market frictions such as credit constraints prevent the household from purchasing the product, then the increase in consumer surplus associated with a buyout will be lower than implied by the model.

[22] For instance, Marcus et al. (2022) find persistently low use of statins, which protect against cardiovascular disease, in low and middle-income countries even after prices for these drugs fell after patent expiry, due to poor diagnostics and lack of sufficient integration of statins into the primary health care systems of these countries. More generally, organizational problems in the healthcare institutions of developing countries can be severe even when financial constraints are not (Ahmad, 2021).

Static framework and partial equilibrium Our theoretical insights are based on a static model which abstracts from dynamics over time. This does not mean that the model is unable to capture both the static and the dynamic losses associated with patents, as the latter are reflected in the size of I. However, the static nature of the model prevents us from studying some of the aspects that have been considered by previous work in the literature, such as the roles of patent length and the timing of buyouts (i.e., the possibility for governments to pursue a mixed strategy where innovators are allowed to enjoy monopoly power for a certain period of time until the government decides to implement a buyout, possibly depending on uncertain market conditions).

In addition, our model takes the volume and distribution of demand (captured by the parameters n and γ), the contribution of innovation to social surplus (captured by the general function s), and the cost of innovation (R) as determined exogenously to the model and fixed with respect to the innovation regime in place. While this is in line with the approach taken by many other studies in the literature on patent protection and buyouts (e.g., most of the studies cited in Section 1), it is important to note that such an approach abstracts from general equilibrium effects that might determine those variables. For example, one may be concerned that innovation regimes which increase total investment into research also reduce the research cost for subsequent innovations. Similarly, an innovation regime which lowers prices may (over time) affect the structure of demand, possibly differently in different countries. Modelling such processes would require a richer model in which demand and innovation regime are jointly determined, which is left for future research.

Political heterogeneity The model assumes that voters differ in their political importance due to groups' varying swing densities. It should be noted that, while it is convenient to frame the analysis in terms of swing densities, we could have alternatively assumed that groups have the same swing densities but, for instance, different campaign financing abilities (which increase with wealth), and that such lobbying powers impact party vote shares. In this case, it can be shown that a government with electoral concerns would also undertake investment decisions that deviate from those undertaken with pure (equal) aggregation of individual welfare, weighing more heavily instead the stronger lobbying groups. In equilibrium, parties would still act symmetrically and receive vote shares that reflect fundamentals. This therefore would keep the main qualitative insights in Propositions 4 - 6 intact. In essence, our findings rely critically on heterogeneity in voters' political importance, but the exact nature and source of that heterogeneity are not crucial.

6 Conclusion

Innovators must be compensated for investing in innovation, but it has long been understood that doing so by granting monopoly power via patents is distortionary and inefficient. In contrast, a buyout in which the government directly transfers the requisite surplus to the innovator could in principle circumscribe the need for monopoly power. Prior literature has focused on patent buyouts in single-country models and under the assumption that governments maximize social welfare, and has shown that if the government can calculate and commit to transferring the social surplus to the innovator, then buyouts are clearly welfare enhancing.

In this article, we consider two previously unstudied political economy tradeoffs that can arise from how buyouts are financed and benefited from, and explore how these can hinder the implementation of buyouts which would otherwise enhance global welfare. First, placing knowledge in the public domain in a multi-country world where not all countries can contribute equally to buyout financing would result in loss of profits for the financing country and in positive externalities for the rest. Second, because buyouts are publicly financed, they may engender domestic conflict over the desired extent of tax financing, and such conflict will be influential if the government cares not simply about total welfare but about the welfare of politically important groups. In contrast, financing innovation through market sales of subsequent private goods (via patent power) circumscribes the global externality as well as the extent of dependence on public financing.

Our analysis demonstrate how these global and domestic distributional concerns may constrain the pursuit of buyouts, potentially to the detriment of the innovating country's and the world's welfare. We also elaborate on the interaction between the two aspects, especially that domestic politics can interfere with the otherwise optimal and feasible solution of a buyout internationally financed through transfers.

In light of these findings, buyouts of globally useful innovations may be understood as *publicly financed goods with global externalities*, and hence acutely difficult to institute. At the same time, from a policy perspective, an appreciation of the political economy difficulties of instituting buyouts can facilitate an assessment of the possibilities for alleviating these constraints. Our exploration of transfer-financed buyouts goes in this vein. In-depth exploration of other mechanisms is beyond the scope of this article, but here we briefly refer to possibilities for (i) sovereign initiative arising from strategic concerns and (ii) non-governmental initiative in the form of collaborative and/or philanthropic funding.

On the sovereign front, while transfers help to offset negative externalities from free riding, a distinct possibility (unmodelled) is that *positive* externalities from welfare in the less wealthy countries may improve the desirability of buyouts, even in the absence of transfers. For example, governments of innovating countries may be interested in providing aid to less advanced economies, as this may result in positive externalities to them from political stabilization or other strategically motivated objectives (Olivie and Perez, 2020). If buyouts can be linked to such objectives, thereby viewed as one channel for aid, then concerns about loss of profits globally would be reduced to the extent that they form part of the strategic resource transfer embedded in aid.

Similarly, for certain technologies with positive externalities it might be in rich countries' interest to facilitate their widespread use globally, even if doing so comes at a cost. This might be the case for health technologies that limit the spread of contagious diseases (such as vaccines or HIV antiretroviral therapy) and for climate technologies that help to reduce greenhouse gas emissions. For example, the debate over innovation financing and global access to technology took on renewed importance during COVID-19 not only because of the magnitude of human suffering, but also because of the externalities of innoculating against cross-border contagious disease, with the latter demonstrably boosting public support in the West for globally accessible vaccination (Klumpp et al., 2022).

However, while the presence of positive externalities from resource transfer for buyouts can help offset negative externalities associated with free riding, it would not necessarily alleviate domestic distributional concerns. Continuing with the above examples, justifying buyouts as aid would be subject to the same domestic conflict over how much foreign aid, which is tax-financed, is desirable, and there may also be considerable disagreement over how much to invest abroad in technologies that generate positive spillovers domestically. As shown in our analysis, these concerns stem primarily from the structure of domestic politics in the innovating countries themselves. One possible implication is that in more equal societies, and in those where political representation is *not* primarily driven by a small group of the wealthy electorate, publicly financed innovation regimes are less likely to be contentious, with positive repercussions for the rest of the world.

With respect to non-governmental initiatives, our analysis has policy implications for efforts to collaborate internationally on innovation financing, and which feature into the agenda of recent initiatives such as the Health Impact Fund (Banerjee et al., 2010) and Advanced Market Commitment (Kremer et al., 2020, 2022). These initiatives have largely focused on incentivizing innovation of drugs which cater to poor populations with limited purchasing power (e.g. neglected diseases), through advancing a design in which companies are compensated by the fund if they sell the end-products at competitive (cost) prices to the target population. Therefore, as opposed to a system like buyouts which supplants patents generally, they aim to *complement* patent financing in areas where monopoly power is an insufficient incentive due to limited market demand.

Despite the more limited scope of these initiatives (relative to buyouts), our political economy lens can shed light on their challenges and prospects. For example, the Health Impact Fund, which relies in its design on voluntary financing by wealthy states for the fund and which initially suggested a budget of 6 billion USD (later revised downward), has yet to gain traction to be implemented or even piloted. Our analysis can help explain the hesitancy of potential financiers, particularly since in this case the size of the global externality vis-a-vis domestic benefit is, by design, large. The Advanced Market Commitment initiative instead relies on philanthropic private donors and has been more successful, as evidenced by its key success to this date in pneumococcal drugs, funded by the Gates Foundation. Congruent with our framework, this is precisely because some degree of 'altruism' neutralizes the extent of international and domestic distributional conflict in the way. On the other hand, the limited aim and size of this project likely reflects limitations to altruistic funding, at least relative to the magnitude of social surplus which could motivate comprehensive non-patent systems such as buyouts.

In the renewed discourse after the COVID-19 pandemic on the consequences of patented technologies, potential toll on the global South, and alternative systems of incentivizing innovation, political economy and distributional considerations took center stage. Resistance by innovating countries to the placement of vaccine innovations in the public domain was often understood in terms of international profit loss concerns (APHA, 2022), with some evidence supporting this view in the press (Furlong et al., 2022), and with heterogeneity within countries about the desired extent of public financing for global accessibility (Clarke et al., 2021). The framework presented here, although general and not engaging with the specifics of particular innovations, emphasizes precisely these issues. We believe it can help to shed light on the primacy of political economy concerns in the choice (and consequences) of patent regimes versus other innovation regimes more generally, and to facilitate future research on feasible policy spaces in response.

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