Abstract

Historically, political competition between European countries has been cited as having been a stimulus to the innovation process and part of the reason why Europe was the first region of the world to industrialize. Countries that fell behind their rivals in technological and economic progress became more vulnerable to exploitation by their neighbors. This competition between countries provided added incentive to innovate. This paper uses a simple model of conflict between countries to examine the role of country competition on economic growth. The governments of each country are assumed to be threatened politically by innovation and hence face a trade-off between the stability of their regime and 'keeping up' with their rivals. It is shown that "institutional spillovers", such as an increase in the stability of the government in one country, can affect the growth rate in a competing country.

*We thank Oded Galor, Peter Howitt, and the participants of the Brown University Macroeconomic Seminar for their helpful comments and suggestions.
1. Introduction

The political fragmentation of Europe has been seen by many as an important factor in the economic rise of the West. In contrast, the political unity and relative isolation of pre-modern China has been viewed as an impediment to China's industrialization, in spite of its relatively advanced technology. In the words of Diamond (1997), "the real problem in understanding China's loss of political and technological preeminence to Europe is to understand China's chronic unity and Europe's chronic disunity". Why would unity or disunity matter? The answer that we propose is that the political threat of competition from neighboring countries reduces the incentives that political elites may have to block innovation and change. In the case of China, "it lacked the competition or threat of invasion that was critical to western Europe's development" (Parente and Prescott 2000). As a result "China's connectedness eventually became a disadvantage because a decision by one despot could and repeatedly did halt innovation. In contrast, Europe's geographic balkanization resulted in dozens or hundreds of independent, competing statelets and centers of innovation. If one state did not pursue some particular innovation, another did, forcing neighboring states to do likewise or else be conquered or left behind economically" (Diamond 1997). China's failure to industrialize, then, was caused in part by being too successful politically, in terms of unification. On the other hand, "Europe's great good fortune lay in the fall of Rome and the weakness and division that ensued" (Landes 1998). How can we incorporate this idea of competition between countries into the context of economic growth? First, we need some reason why a country in isolation would not choose to innovate and grow as much as possible. We believe that the most reasonable explanation is that the stability of a government may be threatened by innovation and economic change. Motivation for this is provided below. The essence of the model presented in this paper is nicely summarized by North (1981): "In short, the process of growth is inherently destabilizing to a state. ... If, however, growth is destabilizing, so is no growth, when a political-economic unit exists in a world of competing political-economic units". We are unaware of any other formal model that combines 'political losers' from innovation with 'political competition' between countries.

Does this paper help us understand the history of economic growth in the world? We argue that it does. First, as discussed below, we believe that 'political losers' from innovation is an important part of the reason why some countries adopt policies that are bad for growth. Second, if this is true, then the most plausible reason why governments whose stability may be threatened by innovation would nevertheless, at some point in time, block less innovation is that they are threatened by competition from countries that are innovating. The contrasting cases of China and Europe were discussed above. History provides many other examples of political competition between countries motivating economic change. Why did Peter the Great bring in foreign 'experts' into Russia if not in
an attempt to keep up with the West? Without the threat of the innovating West, it seems unlikely that Russia would have promoted innovation on its own. Consider the case of Japan in the 19th century. It is reasonable to suppose that the political elites felt threatened by innovation because they more or less sealed off the country from the rest of the world. Only when U.S. warships appeared on the coast did the political elites decide to encourage, rather than block innovation. It was the direct threat of future conflict with innovating countries that made Japan block less innovation. Consider also the case of the fall of the Soviet empire. Since WWII the Soviet Union and NATO were engaged in the Cold War. Failure to keep up technologically and economically with your rival increased the likelihood of losing any potential conflict. Despite early predictions of "burying capitalism", it became increasingly clear to Soviet leaders that the Communist block was falling further and further behind the West. The threat of future conflict with an innovating West eventually led to attempts to change the Soviet system. As we know, the system was too brittle to admit any substantial change and the Soviet empire collapsed in a remarkably short period of time. Without the threat of political competition from the West, it is doubtful that any attempt would have been made to overhaul the stagnant Soviet system. For Russia, unfortunately, the threat of outside political competition has not yet led to increases in the growth rate of its economy. The predictions of the model presented in this paper should be seen as long run results. Hopefully, once the former Soviet countries have adopted the appropriate institutional structure, their economies will experience sustained growth. Note also that with the implosion of the Soviet empire, much of the threat of direct conflict with the West also disappeared, reducing the role for political competition on growth. Similar arguments could be made for more contemporary examples, notably China.

Acemoglu and Robinson (2000) and Chaudhry and Garner (2001) present models of innovation threatening the political power of the government. A government may then try to block innovation in order to remain in power. This would result in a reduced rate of economic growth. Acemoglu and Robinson (2000) argue that, "Despite the intuitive appeal of the idea, there are relatively few instances where major economic change was blocked by economic losers...A more important reason, however, may be that the introduction of new technology, and economic change more generally, may simultaneously affect the distribution of political power." We believe that any sustained attempts to suppress economic change must have the support of the country’s political elites. In general we can think of three ways in which innovation can politically threaten the current government. First, the nature of the innovation itself could be threatening. Information technologies like printing, satellite dishes, and the Internet could spread information that could induce political instability, especially in repressive regimes that attempt to control the population through ideology, etc. Second, innovations in the private sector could also shift economic power to groups that are unfavorable to the current regime. These groups could use their new economic strength to undermine the government and replace it with one that is more preferable. Third, there may be vested interests that oppose the
adoption of a new innovation. These interests could threaten the stability of the current government if new innovations are adopted. See the papers cited above for a more detailed discussion.

The historical record is full of examples of governments blocking innovations when they feel politically threatened by these innovations. Acemoglu and Robinson (2000) cite the reaction of landed elites in England and Germany with those of Russia and Austria-Hungary in response to industrialization. They note that in England and Germany these landed elites felt more or less secure in their political power and hence did not attempt to block industrialization (i.e. innovation). In Russia and Austria-Hungary, however, the political elites did try to block industrialization as they saw in it a threat to their political power. One of the most dramatic examples of innovation blocking activity by a government occurred in 1433 when, after a series of voyages that brought the Chinese navy to the eastern coast of Africa, the Chinese emperor forbade further voyages, ordered the destruction of ocean-going vessels, and prohibited his subjects from traveling abroad. The primary consideration for this seems to have been that an expansion in maritime activity could result in a shift in political power inside China. See Chaudhry and Garner (2001) for other examples of innovation blocking by governments.

One of Easterly and Levine’s (2000) four stylized facts about economic growth is that economic activity is highly concentrated. On the country level, we observe the clustering of rich and poor nations (see Map 1). Moreno and Trehan (1997) examine the linkage between a country’s location and its growth rate. They find that, ”a country’s growth rate is closely related to that of nearby countries and show that this correlation reflects more than the existence of common shocks. Trade alone does not appear to be responsible for these linkages also.” Although in discussing their results, the authors listed above did not have in mind the political competition between countries that is the subject of this paper, their findings are consistent with our model. A government in a country whose neighbors (and potential competitors) are experiencing economic growth will have less incentive to block innovation than would one whose neighbors are not growing. Location would thus matter for economic growth and we would expect to see some level of clustering with respect to income per capita on the country level.

The model presented in this paper works as follows: There are two countries, country 1 and country 2. The rent-seeking government in each country faces some probability of losing power if an innovation occurs in their country, and on average innovation decreases the expected wealth of the government. Hence, in isolation, each government would have an incentive to block as much innovation as possible in order to stay in power. However both countries face the possibility of ‘conflict’ with the other country in the future. The larger country, in terms of economic strength (where economic strength is thought of as GDP in order to take into account both population size and per capita income), will be able
to expropriate part of the income of the smaller country. This competition will provide an incentive (in most cases, though somewhat surprisingly, not all) for the countries to block less innovation and as a result there will be higher growth. Competition will also be the mechanism through which institutions in one country will affect the growth rate in the other country.

The setup of the paper is as follows: Section 2 presents a simplified version of the Chaudhry and Garner (2001) one country model of growth and innovation with innovation blocking activity\(^1\). Section 3 sets-up the model of political competition between countries and examines the case of two equal countries. Section 4 examines the case of unequal countries competing. Section 5 examines the optimal number of countries for growth. Section 6 discuss alternative mechanisms for competition between countries and extensions of the model. Section 7 concludes.

### 2. The One Country Model

Consider the case of one country in isolation. For presentation and algebraic simplicity there are 2 periods\(^2\). The government of this country captures a certain fraction, \(0 < f < 1\), of the country’s output as rent in period 2. This government faces the possibility of an innovation occurring in the period 2. If an innovation occurs, then the economy becomes more productive and the country’s aggregate income rises. In period 1, the government can influence the probability of an innovation occurring by accessing a costly innovation blocking technology. How could the government make innovation more difficult? The government could introduce a complicated and protracted approval process for any new innovation. These could be concrete obstacles such as the need for government licenses and/or permits, or obstacles such as bureaucratic delays and red-tapism. The government could also use legal mechanisms to protect the current monopolist in the sense of patent rights that are too broadly interpreted; any innovation that even closely resembles the technology of the incumbent monopolist could be blocked. Another interpretation of the government affecting the flow rate of innovation is that it can limit the set of innovations that if discovered can be implemented. For example, the government could prohibit all innovations that use Internet technology. Then the flow rate of innovation would tend to be smaller simply because there are less potential ‘usable’ innovations that researchers could discover. The probability of an innovation occurring is given by \(\lambda(\psi)\) where \(\psi \geq 0\) is the level of innovation blocking activity (IBA).

\(^1\)In Chaudhry and Garner (2001), a general equilibrium model of innovation based growth with a rent-seeking government and innovation blocking is presented. Extending that model to the case of two governments that are political competitors proves to be not particularly tractable. For this reason, and for expositional simplicity, in the present paper we present a simple, 2 period, non-general equilibrium model that is still sufficient for our purposes.

\(^2\)2 periods are all that we require to demonstrate the main results of the paper. Adding additional periods would provide a somewhat richer model, but would involve cumbersome algebraic manipulations.
chosen by the government and $\lambda$ is a function of $\psi$ such that $0 \leq \lambda(\psi) \leq 1$, 
$\lambda(0) = \lambda_0 > 0$, and $\lambda'(\psi) < 0$, $\lambda''(\psi) > 0$, $\lambda'''(\psi) > 0$. The cost of implementing 
IBA level $\psi$ is given by the cost function $\beta c(\psi)$ with $c(0) = 0$, $c'(0) = 0$, and 
$c' \geq 0$, $c'' > 0$, $c''' > 0$. This cost is realized in period 2. The quality of a 
country’s institutions is reflected in the cost of innovation blocking. A country 
with a strong tradition of rule of law would have a relatively high value of $\beta$ 
and a country without such a tradition would have a relatively low value of $\beta$. Let $y$ denote the income of the country if no innovation takes place and let 
$\gamma > 1$ denote the size of the innovation so that the income of the country if the 
innovation occurs is given by $\gamma y$. When an innovation occurs, the government 
may be threatened politically and thus faces probability $\mu$ of retaining power, 
so with probability $1 - \mu$ the government loses power and therefore will collect 
no rents in period 2.

The expected wealth of the government in period 2 is given by:

$$EW(\psi) = \int [(1 - \lambda(\psi))y + \lambda(\psi)\mu\gamma y] - \beta c(\psi)$$

The government’s problem is to maximize expected wealth with respect to 
IBA level $\psi$. It is assumed that $\mu \gamma < 1$ so that the government is ex-ante on 
average hurt by innovation. Given that $c'(0) = 0$ and $\lambda'(\psi) < 0$ the solution to 
the government’s problem will be an interior solution. The first order condition is:

(1) $\lambda'(\psi)f y(\mu\gamma - 1) - \beta c''(\psi) = 0$

The first term of the first order condition represents the marginal benefit 
of blocking innovation and the second term the marginal cost. Note that 
$\frac{\partial^2 EW}{\partial \psi^2} = \lambda''(\psi)f y(\mu\gamma - 1) - \beta c''(\psi) < 0$, so that the second order condition for 
a maximum is satisfied.

This model, then, is applicable to countries in which the government is 
threatened politically by innovation and that has poor enough institutions so 
that blocking is not prohibitively expensive. We believe that historically the set 
of countries that satisfied the two above criteria was quite large and still may 
be so for many developing countries.

Letting $\psi^*(\mu, \gamma, f)$ represent the level of IBA that satisfies the above equation, 
and assuming an interior solution so that $\psi^* > 0$, the following holds:

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3We could have this cost realized in this first period. This would require us to be more 
explicit about government income in the first period and in general would complicate the 
presentation of the model with no qualitative changes. Thus we have the cost be paid in 
period 2.

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A more stable government will block less innovation. The larger the size of the innovation, the less innovation will be blocked. The more the government can extract as rent, the more innovation will be blocked.

The expected growth in this economy is: \( \lambda(\gamma - 1) \).

3. The Two Country Model

There are two countries, country 1 and country 2 with aggregate incomes (without innovation) given by \( y_1 \) and \( y_2 \) respectively and 2 periods in the model. Denote also the fraction of rent collected by the government and the probability of retaining power following innovation in the two countries as \( f_1, f_2, \mu_1, \mu_2 \). We abstract from direct technology spillovers between the two countries. In period 1 both countries choose the level of IBA to be implemented in their respective countries, \( \psi_1 \) and \( \psi_2 \). The function \( \lambda \) and the size of the innovation \( \gamma \) is the same for both countries\(^4\). In period 2 they engage in ‘conflict’ (broadly defined). We could have that the two countries engage in conflict in period 2 only with some probability \( p \). This would complicate the presentation of the results but would produce no qualitative changes. What is important for the model is the potential threat of future conflict. The conflict consists of the larger country expropriating part of the income of the smaller country. Denoting the post-conflict income of country \( i \) as \( y^D_i \), the outcome of this conflict is determined as follows:

If \( y_i \leq y_j \), then:

\[
\begin{align*}
    y^D_i &= [1 - \phi \frac{y_j - y_i}{y_j}] y_i \\
    y^D_j &= y_j + \phi \frac{y_j - y_i}{y_j} y_i
\end{align*}
\]

where \( 0 \leq \phi \leq 1 \) is a parameter that measures the degree of conflict or competition between the 2 countries with \( \phi = 0 \) representing no conflict and \( \phi = 1 \) representing the maximum level of conflict\(^5\).

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\(^4\)If we allow these to differ across countries we would still have similar qualitative results.

\(^5\)Alternatively we could replace the conflict and expropriation of a country’s resources with a conflict over the division of a trade surplus. The total economic strength of a country would help determine its power in trade negotiations. The stronger country would be able to extract more favorable terms of trade from its weaker competitor. This could be an alternative mechanism through which a rent-seeking government whose political power is threatened by innovation would choose to block less innovation in the presence of competition from other countries.
This is a two player, single shot game. A Nash equilibrium will be a pair \((\psi_1^*, \psi_2^*)\) that satisfies simultaneously the following first order conditions:

\[
(2) \quad \frac{\partial EW_1(\psi_1^*, \psi_2^*)}{\partial \psi_1} = 0
\]

\[
(3) \quad \frac{\partial EW_2(\psi_1^*, \psi_2^*)}{\partial \psi_2} = 0
\]

Now there exist five possible cases: (1) \(y_1 = y_2\), the case where the incomes of both countries are the same, (2) \(y_1 < y_2, \gamma y_1 < y_2\), the case where the income of country 1 is less than the income of country 2, and would remain smaller even after it innovates, (3) \(y_1 < y_2, \gamma y_1 > y_2\), the case where the income of country 1 before it innovates is less than the income of country 2, though the post-innovation income of country 1 is larger than that of country 2 if country 2 does not innovate, (4) \(y_1 > y_2, y_1 > \gamma y_2\), the case where the income of country 1 is greater than the income of country 2, and would remain greater even after country 2 innovates, and (5) \(y_1 > y_2, y_1 < \gamma y_2\), the case where the income of country 1 is greater than the income of country 2, though the income of country 1 is smaller than the post-innovation income of country 2.

Let us look at the first case:

**Case I: \(y_1 = y_2\)**

The expected wealth of the government in country 1 is given by:

\[
EW_1 = f_1[(1 - \lambda_1)((1 - \lambda_2)y_1 + \lambda_2(1 - \frac{\gamma y_2 - y_1}{\gamma y_2})y_1) + \\
\mu_1\lambda_1((1 - \lambda_2)(\gamma y_1 + \frac{\gamma y_1 - y_2}{\gamma y_1}y_2) + \lambda_2\gamma y_1)] - \beta_1 c_1(\psi_1)
\]

where \(\lambda_1 = \lambda(\psi_1)\) and \(\lambda_2 = \lambda(\psi_2)\).

The first order condition is:

\[
\frac{\partial EW_1}{\partial \psi_1} = f_1\lambda_1[(\mu_1\gamma - 1)y_1 + \phi((1 - \lambda_2)(\mu_1\frac{\gamma y_1 - y_2}{\gamma y_1}y_2) + \lambda_2\frac{\gamma y_2 - y_1}{\gamma y_2}y_1)] \\
- \beta_1 c'_1(\psi_1) = 0
\]
This condition is the same as the first order condition obtained in the single country case (discussed above), with the addition of the term:

\[
\phi((1 - \lambda_2)(\mu_1 \frac{\gamma y_1 - y_2}{\gamma y_1} + \lambda_2 \frac{\gamma y_2 - y_1}{\gamma y_2})
\]

which is positive. This means that the marginal benefit from blocking innovation is lower in this case, so \(\psi_1^*\), will be less in the two country case. Thus we have the following:

**Proposition 1:** For the case where the initial income is the same in both countries we have that competition between the two countries results in less innovation being blocked in country 1, and thus higher growth in country 1.

Note that the degree to which competition increases growth in country 1 depends positively on \(\phi\), the degree of conflict between the two countries. If \(\phi = 0\) so that there is no conflict in period 2, then country 1 will be unaffected by growth in country 2.

If we assume that \(\lambda_2\) does not depend on \(\psi_1\) then it is easy to see that \(\frac{\partial \psi_1^*}{\partial \lambda_2} < 0\). Thus an increase in the probability of innovation in country 2 will reduce innovation blocking in country 1 and raise growth. An increase in the probability of innovation in country 2 could occur if \(\mu_2\) increases; the government in country 2 would be more stable and block less innovation. Likewise, an increase in \(\beta_2\) or a decrease in \(f_2\) would raise growth in country 1. This type of spillover from country 2 to country 1 is discussed in more detail below.

More generally, in the context of a Nash equilibrium, the following comparative statics can be shown:

**Proposition 2:** For the case of initial income the same in both countries we have:

(i) An increase in the stability of country 1 will reduce the level of innovation blocking and increase growth in country 1:

\[
\frac{\partial \psi_1^*}{\partial \mu_1} < 0
\]
(ii) An increase in the degree of rent-seeking in country 1 will increase the level of innovation blocking and reduce growth in country 1:
\[ \frac{\partial \psi^*_1}{\partial f_1} > 0 \]

(iii) An increase in the degree of political competition between the two countries will reduce the level of innovation blocking and increase growth in country 1:
\[ \frac{\partial \psi^*_1}{\partial \phi} < 0 \]

(iv) An increase in the level of rent-seeking in country 2 will increase the level of innovation blocking and reduce growth in country 1:
\[ \frac{\partial \psi^*_1}{\partial f_2} > 0 \]

(v) An increase in the stability of country 2 will reduce the level of innovation blocking and increase growth in country 1:
\[ \frac{\partial \psi^*_1}{\partial \mu_2} < 0 \]

(vi) An increase in the cost of innovation blocking in country 1 will reduce the level of innovation blocking and increase growth in country 1:
\[ \frac{\partial \psi^*_1}{\partial \beta_1} < 0 \]

(vii) An increase in the cost of innovation blocking in country 2 will reduce the level of innovation blocking and increase growth in country 1:
\[ \frac{\partial \psi^*_1}{\partial \beta_2} < 0 \]

**Proof:** We will illustrate the proof of result (v). The other results follow in a similar fashion.

To find the sign of \( \frac{\partial \psi^*_1}{\partial \mu_2} \) we will use the implicit function theorem (assuming the appropriate regularity conditions). Write equations 1 and 2 as follows:

\[
\begin{align*}
(4) & \quad G_1(\psi^*_1, \psi^*_2) = 0 \\
(5) & \quad G_2(\psi^*_1, \psi^*_2, \mu_2) = 0
\end{align*}
\]
Note that equation 5 implicitly defines $\psi_2^*$ as a function of $\psi_1^*$ and also implicitly defines $\psi_2^*$ as a function of $\mu_2$.

Then by the implicit function theorem:

$$
\frac{\partial \psi_1^*}{\partial \mu_2} = \frac{-\frac{\partial G_1}{\partial \psi_2^*} \left( -\frac{\partial \mu_2}{\partial G_2} \right)}{\frac{\partial G_1}{\partial \psi_1^*} + \frac{\partial G_1}{\partial \psi_2^*} \left( -\frac{\partial \psi_1^*}{\partial G_2} \right)}
$$

where $\frac{\partial G_1}{\partial \psi_1^*} < 0$, $\frac{\partial G_2}{\partial \psi_2^*} < 0$, $\frac{\partial G_1}{\partial \psi_2^*} > 0$, $\frac{\partial G_2}{\partial \psi_1^*} < 0$, $\frac{\partial G_2}{\partial \mu_2} < 0$.

The numerator of the above expression is positive, the first term of the denominator is negative and the second term of the denominator is positive. The sign of the denominator will be negative if:

$$
(6) \quad -\frac{\partial G_1}{\partial \psi_1^*} > -\frac{\partial G_2}{\partial \psi_2^*}
$$

In words, the slope of country 1's reaction function must be greater than the slope of country 2's reaction function. Furthermore, given that $\lambda'''' > 0$ and $\psi'''' > 0$, country 1's reaction function is convex and country 2's reaction function is concave [see graph at end of paper]. This implies that the reaction functions will cross and a Nash equilibrium will exist. Therefore, at the Nash equilibrium it must be the case that condition (6) is satisfied. Also note that $(\psi_1^*, \psi_2^*)$ is a stable Nash equilibrium.

Thus we have shown that $\frac{\partial \psi_1^*}{\partial \mu_2} < 0$. If country 2's regime becomes more stable (in the sense of being threatened less by innovation), then country 1 in equilibrium will block less innovation than before. This is an example of an "institutional spillover". Instability in one country will reduce the growth rate of the other country. Ades and Chua (1993) find that "after holding constant standard determinants of growth including initial GDP per capita, saving rate, and domestic instability, regional instability has strong negative effects on a country’s growth rate". This empirical result is consistent with our model.
Take (iv) above as another example. An increase in the degree of rent-seeking in country 2 lowers the growth rate of country 1 by encouraging more IBA in country 1. Also, (vii) says that an increase in the cost of innovation blocking in country 2 increases the growth rate in country 1 by encouraging less IBA in country 1. We can interpret (iv) and (vii) as an improvement in the institutions in one country will have a spillover effect on growth in the other country through the mechanism of political competition.

Note that it may be in the interests of the governments in both countries to collude in order to reduce the competition between them so that they may both block more innovation and remain in power.\textsuperscript{6} Collusion in this case suffers from the same incentive problem that faces cartels: one government may be tempted to ‘cheat’ if it knows that the other government is sticking to the agreement. One possible way to avoid this problem is to enter into binding treaties that lower the degree of conflict between the two countries. Once the threat of competition from the other country is removed, the governments in both countries can focus on internal stability and innovation blocking.

4. Unequal Countries

There are four cases to consider if the two countries are not of the same size economically prior to any potential conflict. The effects of political competition compared to no political competition (i.e. isolation) are summarized below. A more complete exposition of the four cases follows.

1) Case II: \( y_1 < y_2, \gamma y_1 < y_2 \). Less innovation blocked in country 1. Higher growth in country 1.
2) Case III: \( y_1 < y_2, \gamma y_1 > y_2 \). Less innovation blocked in country 1. Higher growth in country 1.
3) Case IV: \( y_1 > y_2, y_1 > \gamma y_2 \). For high \( \mu_1 \), less innovation blocked in country 1 and higher growth in country 1. For low \( \mu_1 \), more innovation blocked in country 1 and lower growth in country 1.
4) Case V: \( y_1 > y_2, y_1 < \gamma y_2 \). If \( \lambda_2 \) is large or \( \mu_1 \) is high then less innovation is blocked and the growth rate is higher. If \( \lambda_2 \) is small and \( \mu_1 \) is low then more innovation is blocked and the growth rate is smaller.

Mathematical derivation of the results:

Case II: \( y_1 < y_2, \gamma y_1 < y_2 \)

\textsuperscript{6}Whether it would be in the interests of a government to collude with its competitor in order to increase its level of IBA depends on the exact specifications of the parameters in the model. In general, the more threatened by innovation the government is and the more likely its competitor is to innovate, the more incentive it has to collude.
The expected wealth of the government in country 1 is given by:

\[ EW_1 = f_1[(1 - \lambda_1)(1 - \lambda_2)(1 - \phi \frac{y_2 - y_1}{y_2})y_1 + \lambda_2(1 - \phi \frac{\gamma y_2 - y_1}{\gamma y_2})y_1] + \mu_1 \lambda_1((1 - \lambda_2)(1 - \phi \frac{y_2 - \gamma y_1}{y_2})y_1 + \lambda_2\gamma(1 - \phi \frac{y_2 - y_1}{y_2})y_1) - \beta_1 c_1(\psi_1) \]

The first order condition is:

\[ \frac{\partial EW_1}{\partial \psi_1} = f_1\lambda_1'(\mu_1\gamma - 1)y_1 + \phi((1 - \lambda_2)(\frac{y_2 - y_1}{y_2} - \mu_1\frac{\gamma y_2 - y_1}{y_2})y_1 + \\
\lambda_2(\frac{\gamma y_2 - y_1}{\gamma y_2} - \mu_1\frac{\gamma y_2 - y_1}{y_2})y_1) - \beta_1 c_1'(\psi_1) = 0 \]

This condition is the same as the first order condition obtained in the single country case (discussed above), with the addition of the term

\[ \phi((1 - \lambda_2)(\frac{y_2 - y_1}{y_2} - \mu_1\frac{\gamma y_2 - y_1}{y_2}) + \lambda_2(\frac{\gamma y_2 - y_1}{\gamma y_2} - \mu_1\frac{\gamma y_2 - y_1}{y_2})y_1 \]

which is positive. This means that the marginal benefit from blocking innovation is lower in this case, so \( \psi_1^* \), will be less in the two country case. So competition between the two countries results in less innovation being blocked in country 1, and thus a higher growth rate in country 1.

Case III: \( y_1 < y_2, \gamma y_1 > y_2 \)

The expected wealth of the government in country 1 is given by:

\[ EW_1 = f_1[(1 - \lambda_1)(1 - \lambda_2)(1 - \phi \frac{y_2 - y_1}{y_2})y_1 + \lambda_2(1 - \phi \frac{\gamma y_2 - y_1}{\gamma y_2})y_1] + \\
\mu_1 \lambda_1((1 - \lambda_2)(\gamma y_1 + \phi \frac{\gamma y_1 - y_2}{\gamma y_1}y_2) + \lambda_2\gamma(1 - \phi \frac{y_2 - y_1}{y_2})y_1) - \beta_1 c_1(\psi_1) \]
The first order condition is:

\[ \frac{\partial EW_1}{\partial \psi_1} = f_1 \lambda_1^1[(\mu_1 \gamma - 1)y_1 + \phi(1 - \lambda_2)(\frac{y_2 - y_1}{y_2})y_1 + \lambda_2(\frac{\gamma y_2 - y_1}{\gamma y_2} - \mu_1 \gamma \frac{y_2 - y_1}{y_2})y_1 + (1 - \lambda_2)\mu_1 \frac{\gamma y_1 - y_2}{\gamma y_1}y_1] - \beta_1 c_1'(\psi_1) = 0 \]

This condition is the same as the first order condition obtained in the single country case (discussed above), with the addition of the term:

\[ \phi((1 - \lambda_2)(\frac{y_2 - y_1}{y_2})y_1 + \lambda_2(\frac{\gamma y_2 - y_1}{\gamma y_2} - \mu_1 \gamma \frac{y_2 - y_1}{y_2})y_1 + (1 - \lambda_2)\mu_1 \frac{\gamma y_1 - y_2}{\gamma y_1}y_1) \]

which is positive. This means that the marginal benefit from blocking innovation is lower in this case, so \( \psi_1 \), will be less in the two country case. So competition between the two countries results in less innovation being blocked in country 1, and thus a higher growth rate in country 1. Note that less innovation will be blocked in this case than in case II.

Case IV: \( y_1 > y_2, y_1 > \gamma y_2 \)

The expected wealth of the government in country 1 is given by:

\[ EW_1 = f_1[(1 - \lambda_1)((1 - \lambda_2)(y_1 + \phi \frac{y_1 - y_2}{y_1}y_2) + \lambda_2(y_1 + \phi \frac{y_1 - y_2}{y_1})y_1 + (1 - \lambda_2)\mu_1 \frac{\gamma y_1 - y_2}{\gamma y_1}y_1) - \beta_1 c_1(\psi_1) \]

The first order condition is:

\[ \frac{\partial EW_1}{\partial \psi_1} = f_1 \lambda_1^1[(\mu_1 \gamma - 1)y_1 + \phi[(1 - \lambda_2)(\mu_1 \frac{\gamma y_1 - y_2}{\gamma y_1}y_2 - \frac{y_1 - y_2}{y_1}y_2) + \lambda_2\gamma(y_1 + \phi \frac{y_1 - y_2}{y_1}y_1) + (1 - \lambda_2)\mu_1 \frac{\gamma y_1 - y_2}{\gamma y_1}y_1]] - \beta_1 c_1'(\psi_1) = 0 \]
This condition is the same as the first order condition obtained in the single country case (discussed above), with the addition of the term:

\[
\phi[(1 - \lambda_2)(\mu_1 \gamma - \frac{y_1 - y_2}{y_1} y_2 - \frac{y_1 - \gamma y_2}{y_1} y_2) + \lambda_2(\mu_1 \gamma - \frac{y_1 - y_2}{y_1} y_2 - \frac{y_1 - \gamma y_2}{y_1} y_2)]
\]

For high \(\mu_1\) this term will be positive and less innovation will be blocked and growth will be higher. For low \(\mu_1\) the term will be negative and more innovation will be blocked and growth will be lower.

**Case V:** \(y_1 > y_2, y_1 < \gamma y_2\)

\[
EW_1 = f_1((1 - \lambda_1)((1 - \lambda_2)(\gamma y_1 - \frac{y_1 - y_2}{y_1} y_2) + \lambda_2(1 - \frac{\gamma y_2 - y_1}{y_2} y_2)y_1 + \mu_1 \lambda_1((1 - \lambda_2)(\gamma y_1 + \phi \frac{\gamma y_1 - y_2}{\gamma y_2} y_2) + \lambda_2 \gamma (y_1 + \phi \frac{y_1 - y_2}{y_1} y_2)] - \beta_1 c_1(\psi_1)
\]

The first order condition is:

\[
\frac{\partial EW_1}{\partial \psi_1} = f_1 \lambda_1^2((\mu_1 \gamma - 1)y_1 + \phi[(1 - \lambda_2)(\mu_1 \gamma - \frac{y_1 - y_2}{y_1} y_2 - \frac{y_1 - \gamma y_2}{y_1} y_2) + \lambda_2(\mu_1 \gamma - \frac{y_1 - y_2}{y_1} y_2 - \frac{y_1 - \gamma y_2}{y_1} y_2)] - \beta_1 c_1(\psi_1) = 0
\]

This condition is the same as the first order condition obtained in the single country case (discussed above), with the addition of the term:

\[
\phi[(1 - \lambda_2)(\mu_1 \gamma - \frac{y_1 - y_2}{y_1} y_2 - \frac{y_1 - y_2}{y_1} y_2) + \lambda_2(\mu_1 \gamma - \frac{y_1 - y_2}{y_1} y_2 - \frac{y_1 - \gamma y_2}{y_1} y_2)]
\]

The first term is negative if \(\mu_1\) is low and is positive if \(\mu_1\) is high. The second term is positive. If \(\lambda_2\) is small and \(\mu_1\) is low then the first term dominates and
more innovation is blocked than in the single country case and the growth rate is smaller. If $\lambda_2$ is large or $\mu_1$ is high then less innovation is blocked than in the single country case and the growth rate is higher.

Section 5 - to be added
Section 6 - to be added
Conclusion - to be added
References

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Map 1: The Rich and the Poor

The countries in black contain 15% of world population but produce 50% of world GDP. The countries in gray contain 50% of world population but produce 14% of world GDP.

Source: Easterly and Levine (2000)
$R_1$ denotes the reaction function of the government in country 1
$R_2$ denotes the reaction function of the government in country 2

E is a stable Nash equilibrium

Figure 2: