**Towards an International Relations Theory of National Innovation Rates**

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By Mark Zachary Taylor

**Appendix: Methods & Data**

Country Selection: In the first test, in order to get a representative sample of countries, I began with the universe of all states for which data is available. Since very poor countries do not possess the wealth to sustain the necessary investments in national S&T capabilities, I therefore selected for analysis those nations with a GDP per capita greater than $1500, or roughly 50% or greater of overall world GDP per capita during the 1960s.[[1]](#footnote-1) Also, since innovative societies require a large enough population to allow some of its members to specialize in S&T, fourteen very small states (defined as those with populations under 1 million) were dropped.[[2]](#footnote-2) A review of the remaining 42 states revealed that they represent the full spectrum of geographic regions, cultures, sizes, industry concentrations, levels of development, security concerns, and S&T capabilities and performance. Thus these states constitute a representative sample, with considerable variation in both the dependent and independent variables.

Dependent variable: The dependent variable is the national innovation rate, measured here using technology patents per capita, weighted by forward citations (to control for minor vs. major innovations) for total patents granted to applicants (by country) between 1970-2005. Patents are useful measures because they are acquired throughout the innovation process, not just at the act of invention. Even the diffusion of new technology can require patents as technologies are adapted to new environments. Most importantly, the current consensus holds that patent measures are useful because they have been shown to provide a representative measure. At the national level, citations-weighted patents per capita have been found to correlate highly with other measures which we generally associate with aggregate innovation rates, including S&T research publications, GDP growth, manufacturing growth, exports of capital goods, R&D spending, capital formation, Nobel Prize winners, etc.[[3]](#footnote-3) Perhaps a simple litmus test of the appropriateness of patents is that one cannot find a technologically innovative country which is not relatively well represented by its aggregate patent data; even the Soviet Union during its period of isolation from the West regularly patented at a rate roughly representative of its overall relative technological prowess. In sum, patents have problems as empirical measures, especially at the micro-level, but when aggregated at the national level and used in large time periods, they appear to provide a statistically representative sample of a nation’s innovation rate. Certainly patents have flaws as innovation measures. However, the current consensus holds that these flaws are most apparent when patents are used as a measure of micro-level innovation (e.g. to compare the innovativeness of individual firms or specific industries in a given month or year). Patent data are a far more accurate measure of innovation when used in the aggregate as is done in this test (e.g. as a measure of national levels of innovation across long periods of time). Interested scholars can find the debate over patents and other innovation measures more fully reviewed elsewhere.[[4]](#footnote-4) Finally, technological output and the capacity to produce it are two different phenomena, Patents directly measure the former, and thereby provide an indirect measure of the latter.

Independent Variable: The independent variable is the relative balance (domestic v. external) of each nation’s security concerns. All countries confront a combination of domestic tensions and external threats (where external threats include challenges to economic and/or military security). The theory of technological change tested here is not concerned with the absolute or total level of domestic tensions or external threats. Rather, the theory posits that where external threats outweigh domestic tensions, countries should innovate relatively more than those countries with the reverse situation.

While there are no established measures for such a “relative threat balance” variable, we can as a first cut look at a combination of observables as proxies. Specifically, countries with severe domestic tensions often suffer frequent strikes, protests, and high levels of economic inequality. In extreme cases, governments may even use force to redistribute wealth away from, or severely regulate, innovative activity in order to ameliorate status-quo interests and deaden the gale of creative destruction. Conversely, countries with considerable external threat are often characterized by histories of frequent international conflict and a heavy reliance on imports for basic economic inputs.

Therefore, for a *prima facie* empirical test, I look at the relative balance of these conditions (summarized in Table 1). Countries which experience relatively: more labor strikes, greater economic inequality, less reliance on imports of food and energy, and fewer years of external conflict are judged to have *relatively* greater domestic tensions than external threats. Conversely, nations are judged to have relatively greater external threats than domestic tensions if they have *relatively*: fewer labor strikes, less economic inequality, higher reliance on imports of food and energy, more years of external conflict. Finally, countries which have suffered recent a civil war or a military dictatorship which actively redistributes wealth away from S&T sectors and entrepreneurs (and towards status-quo actors, labor, welfare, agriculture, or natural resource sectors) is considered to have a *relatively* greater concern with domestic tensions.[[5]](#footnote-5) Certainly while pro-S&T military dictatorships exist, I make no empirical assignments for them in this test.[[6]](#footnote-6) This is because a military dictatorship which is pro-S&T in its initial years may become a staunch defender of status-quo interests, as industry innovators evolve into established players tied to the regime, and both subsequently attempt to prevent the creative destruction that might spell their replacement.[[7]](#footnote-7) Therefore its overall effect on national innovation rate is indeterminate and likely dependent on the time frame analyzed. To arrive at overall rankings, nations are ranked relative to one another in each category (strikes, inequality, etc.). For each category, nations above the average are assigned +1, nations below the average are assigned -1. These scores are then summed across categories for a rough approximation of overall relative balance of security concerns.

Data Sources: Innovation data is derived from The National Bureau of Economic Research’s “Patent Dataset”. National strike data is taken from the International Labor Organization’s *Yearbook of Labour Statistics*. Economic inequality data comes from the University of Texas Inequality Project.[[8]](#footnote-8) Energy and food import dependency data is taken from the World Bank Development Indicators (energy imports as percentage of total energy used, agricultural land as percent of total land area). Conflict data comes from the Correlates of War (external conflict duration) and the University of Texas Political Regime Dataset[[9]](#footnote-9) (years civil war). Regime data comes from the University of Texas Political Regime Dataset (years military dictatorship).[[10]](#footnote-10)

1. World GDP per capita equaled $3300 in 1970. [↑](#footnote-ref-1)
2. The population constraint eliminated the following small states: Bahamas, Belize, Fiji, French Polynesia, Gabon, Iceland, Kuwait, Luxembourg, Malta, New Caledonia, Oman, Seychelles, St. Vincent and the Grenadines, Trinidad and Tobago, [↑](#footnote-ref-2)
3. Amsden, Alice H. and Mona Mourshed. 1997. “Scientific Publications, Patents and Technological Capabilities in Late-Industrializing Countries" *Technology Analysis and Strategic Management* 9(3). [↑](#footnote-ref-3)
4. “Legacy and New Databases for Linking Innovation to Impact.” Lynne G. Zucker and Michael R. Darby in *The Handbook of the Science of Science Policy*. (Stanford University Press, forthcoming 2011); Greenhalgh and Rogers (2010); “Measuring Innovation” by Keith Smith, Chapter 6 in Jan Fagerberg, David C. Mowery, and Richard R. Nelson (eds.). *The Oxford Handbook of Innovation*. Oxford University Press 2004; Eliezer Geisler, “The Metrics of Technology Evaluation: Where We Stand And Where We Should Go From Here” *International Journal of Technology Management* (2002), 24(4): 341-374. [↑](#footnote-ref-4)
5. This describes the countries of Argentina, Brazil, Chile, Greece, El Salvador, Panama, Peru, Spain, Turkey, Uruguay,. [↑](#footnote-ref-5)
6. South Korea and Taiwan arguably fit this description. [↑](#footnote-ref-6)
7. Acemoglu and Robinson. 2005. APSR [↑](#footnote-ref-7)
8. Galbraith, James K. 2009. Inequality, Unemployment and Growth: New Measures for Old Controversies. *Journal of Economic Inequality*. 7:189-206 [↑](#footnote-ref-8)
9. http://utip.gov.utexas.edu/data.html [↑](#footnote-ref-9)
10. Ibid. [↑](#footnote-ref-10)