Available online at www.sciencedirect.com
SCIENCE DIRECT®
Research Policy 34 (2005) 1570–1590
research policy
www.elsevier.com/locate/econbase

Technological development and political stability: Patenting in Latin America and the Caribbean

David Matthew Waguespack [a,*], Jóhanna Kristín Birnir [b], Jeff Schroeder [c]

[a] *R.H. Smith School of Business, University of Maryland, College Park, MD 20742, USA*
[b] *University at Buffalo, The State University of New York, Department of Political Science, USA*
[c] *Iowa State University, Department of Political Science, USA*

Received 28 November 2004; received in revised form 12 April 2005; accepted 28 July 2005
Available online 17 October 2005

Abstract

We examine the effect of national political institutions on patent application rates. The expected future value of a patent, like any other form of property, depends at least partially on certainty about the future. In circumstances where policy stability is greatest, and hence political uncertainty least, one should expect more aggressive pursuit of intellectual property rights. We test these ideas using a 27 year panel of Latin American and Caribbean nations, estimating US patent applications and domestic patent applications by local inventors for each observation, and holding other economic and technological inputs to innovation constant. Our principal finding is that political stability matters to patenting. For US patent applications institutional system tenure, regardless of system type, increases patent applications. For domestic patent applications, institutional stability has either a weakly negative or insignificant effect, a result we attribute to generally escalating local patenting standards over time. The type of government influences both US and domestic patent applications rates, with a veto-players institutional coding better predicting marginal patenting rates than regime type.

Keywords: Policy stability; National innovation systems; Patents; Political institutions

Scholars of innovation have an emerging interest in cross-national variation in patenting, both as an indicator of underlying innovative activity and capacity (Griliches, 1990; Furman et al., 2002), and because of the macro level relationship between stocks of technological and scientific knowledge and economic growth (Adams, 1990; Romer, 1990). The link between technological development and growth is of critical policy importance. While national innovation systems encompass a broad range of national attributes, such as educational levels, investment, trade, scientific institutions, industrial clusters, and international linkages, a nation's knowledge stock is one of the few attributes that responds somewhat rapidly to policy

* Corresponding author. Tel.: +1 301 405 9542; fax: +1 301 576 8575.
E-mail addresses: dwaguesp@rhmsith.umd.edu (D.M. Waguespack), jkbirnir@buffalo.edu (J.K. Birnir), jeffs@iastate.edu (J. Schroeder).

0048-7333/$ – see front matter © 2005 Elsevier B.V. All rights reserved.
doi:10.1016/j.respol.2005.07.006

instruments (Nelson, 1993; Steil et al., 2002). Policies that strengthen intellectual property rights (Park and Ginarte, 1997; Lee and Mansfield, 1996), increase trade openness, and decrease governmental crowding out of private enterprise all contribute to increased capital investment, and then to increased growth (Levine and Renelt, 1992).

While scholars of innovation have tended to focus on policy instruments related to national innovation systems, such as comparative intellectual property and trade policies, a more encompassing debate within the comparative political economy (CPE) field concerns the duration of governmental commitment to particular policy positions. Setting aside the question of which policies are conducive to technology development or economic growth, a propensity to abruptly and/or randomly change policies can introduce destructive uncertainty into the economic decision-making of stakeholders (Przeworki et al., 2000). Where policy commitment is weakest, under-investment and poor economic performance are seen to follow. A central question for CPE scholars, therefore, revolves around the issue of which political institutions produce the most credible commitment to policy. Two competing theories come into play on the question of policy stability. The Regime Type theory holds that democratic governments show greater policy stability than authoritarian regimes, where the autocrat has the power to make abrupt changes and the economic interests of the autocrat are not necessarily aligned with the rest of society (North, 1981; North and Weingast, 1989). The Veto Players theory holds that systems with a higher number of independent institutions, regardless of whether democratic or authoritarian, have greater policy stability (Tsebelis, 1995, 2002).

The relevance of the policy commitment debate to cross-national patenting is that a local inventor's perception of the value of inventive activity will theoretically vary with beliefs about political institutions. Firms and inventors seek intellectual property protection when the expected value of the patent exceeds the cost of the patent application and the cost of revealing the invention (Griliches, 1990). Policy instability introduces not just risk of outright expropriation by officialdom, but also complicates expectations about the future expected value of the monopoly grant. For instance, the government may change the conditions under which others may enter the market, or even choose to serve the market itself. Even in the United States, where the expropriation risk is negligible, patents with court tested legal validity have enhanced value relative to those with untested legal claims (Sherry and Teece, 2004). Others have examined how political uncertainty influences long term infrastructure investment decisions (Henisz and Delios, 2001; Henisz and Zelner, 2001). In this paper we explore the relationship between political institutions and patent applications. Political institutions precede policy choices. Our assertion is that, holding other innovative inputs constant, under political institutional structures where abrupt policy changes are less likely, local incipient entrepreneurs face less uncertainty in the short run, and are therefore more likely to seek patents.

We reach this conclusion by examining political institutional structures and patent application rates among a 27 year panel of Latin American and Caribbean countries. Political conditions within Latin America have varied significantly between countries and within countries over time. However, cultural influences that might also affect the individual propensity for patenting are fairly constant within the region. Both US patent applications for foreign residents and domestic applications by residents are evaluated. All other known economic and technological inputs to innovative output are held constant. The principal finding is that institutional system tenure, regardless of system type, increases US patent applications. Institutional stability has an either weakly negative or insignificant effect on domestic patenting, a result that we interpret as being driven by a trend toward strengthening local patenting standards over time. Regime type, democratic or authoritarian, has no unqualified direct marginal effect on patenting behavior after controlling for economic and technological factors. The effect of regime type is mediated by institutional stability, and Democratic regimes initially have lower patent application rates, but over time surpass autocracies. By contrast Veto Player Institutional constraints, at the system level and independent of the regime type and institutional tenure, strongly influence international and local patenting propensities. Not all of the individual hypothesis related Veto Player structures line up as expected, however, suggesting there may be some residual difference between democracies and authoritarian regimes.

In sum, political stability significantly influences patent application rates. Whether that result indicates

that less inventive activity occurs when expectations of policy stability are low, or that firms and inventors are less likely to seek patents for inventions of the same technical quality remains uncertain. With either explanation the technical stock of knowledge the nation might expect is diminished, as are the spillovers to other creative individuals and firms that might have occurred with disclosure.

1. Patents and political institutions

1.1. Patenting propensity

Griliches (1990) posits a knowledge production function, where an observed count of patents is an indicator of unobserved economically useful knowledge. There is a threshold value for new knowledge, such that a patent is applied for on a new invention when the inventor gauges the benefits of patent protection outweigh the costs of applying for the patent and the risks associated with revealing details about the invention. Therefore, only a fraction of new ideas actually result in a patent application and are eventually patented. Assuming that the propensity to apply for a patent remains constant or random for each new unit of economically useful knowledge, a change from time period t to $t+1$ in the number of patents granted to a firm or a region is assumed to result from a change in the underlying level of economically-useful knowledge. Patenting is most commonly examined in the context of the effect of innovative inputs such as research and development expenditures, and mediating factors such as collaboration networks or technological evolution, on innovative outputs (this is a rich field, examples include Ahuja, 2000; Fleming and Sorenson, 2001; Jaffe, 2000).

There are examples where patenting propensity is known to vary systematically for organizations and individuals within the United States. First, the relationship of research and development expenses to patents differs with both firm size and industry. It is unclear whether these differences arrive from statistical quirks or systematic differences in appropriability, so theoretical explanations are elusive (Griliches, 1990). Second, changes in financial incentives to the inventor will influence patenting. For example, the 1980 Bayh-Dole Act granted academic institutions ownership (with limited government "walk-in" rights) of inventions developed with federal research money, and required the institutions to share a portion of licensing revenue with the inventors. The result of Bayh-Dole was a large increase in the quantity, if not the quality, of university assigned patents (Mowery and Ziedonis, 2002). Third, when a patent's legal claims are tested and verified by a court, the patent tends to have higher value relative to those with legally uncertain claims (Sherry and Teece, 2004).

With a few exceptions (Furman and Hayes, 2004), extant empirical research on patenting examines the behavior of firms and individuals located in the United States and a small set of other highly industrialized nations, and pays little attention to political variables that might bear on intellectual property (Taylor, 2004). The omission of political variables is not necessarily surprising given samples taken from highly developed and integrated economies. Intellectual property regimes in the US do change, but these changes occur simultaneously with general changes in investment and technological development, and the variation in US institutions is quite small compared to less developed countries.

1.2. Stability in politics

Our principal question is: do national political conditions also affect an inventors' propensity to patent? National political conditions as defined refer to the aggregate state of national politics. The thought is that given a novel idea, an inventor's decision regarding whether to patent an idea depends on the value placed on future returns from production involving the patented invention. Therefore, the propensity to patent depends on the inventor's evaluation of the stability of future economic conditions, which in turn depend on the stability of political conditions. Stability of political conditions refers to a status quo of the rules of the game and interpretation of these rules within a single institutional setting. We are not arguing that an inventor is speculating about the stability of the regime itself, but rather assessing options within the known structure of the regime lived under. Inventors' evaluations of stable political conditions are associated with economic conditions that will sustain future entrepreneurial endeavors.

The idea that stable political conditions are favorably associated with economic development is not

novel (Huntington, 1968; Przeworki et al., 2000). However, there is little agreement on exactly how stable political conditions promote economic development. Many of the arguments proposed political stability and consequent economic stability is associated with regime type.[1] The contemporary current mostly suggests that democratic regimes are better at promoting economic growth than their authoritarian counterparts because they are subject to institutional constraints that deter arbitrary political changes. This line of reasoning holds that democratic regimes positively, albeit indirectly, affect economic growth through credible commitment to policy.[2] The underlying logic is that while autocratic regimes are theoretically able to promote the same type of policy in the short term, they cannot provide credibility for the longer term due to the lack of institutional constraints on the ruler. The autocrat can at any point arbitrarily decide to change the rules of the game or the interpretation of these rules. For the same reason, it is also possible that the next autocratic ruler rescinds any rights that his predecessor granted. Democracy, on the other hand, provides a more stable institutional environment in the long term. The rules of the game and their interpretation are less likely to change over time within democratic regimes because of institutional constraints that democratic administrations are subject to (North and Weingast, 1989; Olson, 1993; LeBlang, 1996, 1997).

An alternative framework for predicting stable economic conditions that promote patenting as a result of predicted policy stability is Tsebelis' (1995, 2002) theory of Veto Players. The Veto Player argument is based on the assumption that for a policy change to occur, a certain number of political actors have to agree to the change. Therefore, the greater the number of Veto Players, or political actors, in a political system that can prevent the passing of a policy, the less likely that an agreement is reached and the greater the chances for policy stability.

There is a difference between democratic and authoritarian regimes regarding who gets to propose policy (competitive in democratic regimes and non-competitive in authoritarian regimes). However, Tsebelis contends there is not necessarily a difference between these regime types in terms of the number of Veto Players that determine passing of policy. Democratic and authoritarian regimes alike can have many or few Veto Players with similar consequences for expected policy stability.

Our general argument is that, all else equal, inventors are more likely to patent where they have greater expectation of policy stability. Therefore, our first hypothesis is that irrespective of institutional detail:

H1. The longer the tenure of any institutional arrangement the more likely an inventor is to patent.

However, the determinants of policy stability are debatable. Drawing on the two theoretical frameworks above we propose two competing hypotheses. First, according to the policy-stability literature that deals with the relationship between regime type and economic development, we hypothesize that the two broad regime types (democracies and authoritarian regimes) create different incentives for patenting by inventors. More specifically, we argue a democratic regime creates a more favorable environment for patenting. Therefore,

H2. An inventor is more likely to patent in a democratic regime than in an authoritarian regime.

Theoretically, the inventor has less faith in the authoritarian regime's commitment to policy stability than in the democratic regime.

Second, based on the Veto Players argument, we posit that regime type is immaterial to policy stability. We hypothesize that an inventor's propensity to patent increases as the number of Veto Players increases. Therefore,

H3. An inventor's patenting propensity is positively associated with the number of Veto Players in a regime.

As the number of Veto Players increases, an inventor is increasingly likely to believe that the regime will retain stable policies that will support economic prosperity.

[1] For an excellent overview of the competing theories on the subject see Przeworski and Limongi (1993).

[2] The type of policy discussed in this context is most often property rights, but as shown here the argument can easily be generalized to other types of policy.

2. Data and methods

Our analysis data consist of annual observations on 32 Latin American nations from 1973 (or year of independence if later than 1973) to 1999.[3] This gives up to 27 possible observations per country, or 785 total observations when cases with missing economic data are excluded. We use two related dependent variables to get at the question of policy stability and patenting. First is the annual count of patent applications to the United States Patent and Trademark Office by local Latin American inventors. US patent applications data exist for all observations. Second is the annual count of domestic patent applications by residents in Latin American countries reported to the World Intellectual Property Organization (WIPO). Domestic patent applications data exist for 372 of 785 observations. Table 1 reports the name and year range for each country. A panel (or time-series cross-sectional) research design allows for powerful leverage with the explanatory variables. Multiple regression will compare each state to itself in different time periods and with different variables, as well as contemporaneous comparison to similar countries.

2.1. The dependent variable

Table 2 presents coding information and descriptive statistics on all variables, and Table 3 bi-variate correlations. Our first and primary dependent variable is the annual count of patent applications to the United States Patent and Trademark Office by local Latin American inventors. We argue that US patent applications are a good proxy for local patent applications because of the territoriality principle of patent law. Furthermore, we posit that due to limited availability of domestic Latin American patent data, US patent application counts are a much more consistent external benchmark.

According to the principle of territoriality an inventor's patent rights are only protected in the country where the patent was granted (Mills et al., 2002). Therefore, an inventor who applies for and is granted a patent in a Latin American country *does not* have patent protection in any other country, including the United States. International conventions such as the Paris Convention of 1833 and the 1978 Patent Cooperation Treaty oblige signatories to grant applicants domiciled in other nations whatever its patent law accords to its own nationals, and allows a patentee to file one application and have it become a national application in as many countries as he/she designates. However, acceptance or rejection of the patent is at the discretion of the individual member country. Given the proximity of markets and economic opportunities for product development in the United States, Latin American inventors

[3] We exclude Cuba because of missing economic data.

Table 1
Countries and panel entry/exit for US patent applications

Country[a]	Observations	Panel entry	Panel exit
Antigua and Barbuda	18	1982	1999
Argentina	27	1973	1999
Bahamas[b]	11	1977	1987
Barbados	27	1973	1999
Belize	18	1982	1999
Bolivia	27	1973	1999
Brazil	27	1973	1999
Chile	27	1973	1999
Colombia	27	1973	1999
Costa Rica	27	1973	1999
Dominica	21	1979	1999
Dominican Republic	27	1973	1999
Ecuador	27	1973	1999
El Salvador	27	1973	1999
Grenada	23	1977	1999
Guatemala	27	1973	1999
Guyana	27	1973	1999
Haiti	27	1973	1999
Honduras	27	1973	1999
Jamaica	27	1973	1999
Mexico	27	1973	1999
Nicaragua	27	1973	1999
Panama[c]	20	1980	1999
Paraguay	27	1973	1999
Peru	27	1973	1999
St. Kitts and Nevis	16	1984	1999
St. Lucia	20	1980	1999
St. Vincent and the Grenadines	20	1980	1999
Suriname	24	1976	1999
Trinidad and Tobago	27	1973	1999
Uruguay	27	1973	1999
Venezuela	27	1973	1999

[a] Cuba is excluded due to missing economic data for all years.
[b] Investment (Gross Capital Formation) data are missing 1988–1999.
[c] Investment (Gross Capital Formation) data are missing 1973–1979.

Table 2
Descriptive statistics

Variable	Source and coding	Mean	S.D.
US patent applications	US Patent and Trademark Office (USPTO, 2003): number of utility patent applications by year and country of origin	11.25	26.60
WIPO reporting	World Intellectual Property Organization: coded 1 if domestic patent applications for residents reported to WIPO (WIPO, 2004)	0.47	0.50
Domestic patent applications by residents ($N = 372$)	World Intellectual Property Organization (WIPO): Industrial Property Statistics 1883–2000 (WIPO, 2004)	280.17	603.13
Investment	World Bank Development Indicators: natural log of gross capital formation (1995 US $)	21.19	2.12
Development	World Bank Development Indicators: natural log of gross domestic product (1995 US $)* 1,000,000/total population	21.49	0.76
Trade openness	World Bank Development Indicators: natural log of ratio of trade (total imports and exports) to gross domestic product	4.13	0.62
Lagged US patent application	USPTO: natural log of US patent applications by country for prior year	1.22	1.37
Science/engineering publications	Science Citation Index: natural log of number of journal articles by year and country	3.63	2.44
Global treaties	Of GATT, PCT, and the Paris Convention, total number of treaties signed	1.14	0.94
Institutional stability	Natural log of years with current institutional arrangement (based on Veto Players coding)	2.32	0.90
Democracy	Coded 1 when a country is Democratic and 0 when Authoritarian	0.63	0.48
Two-party parliamentary	Democratic single institutional and partisan Veto Player. Coded 1 when a single party is the only institutional and partisan Veto Player	0.22	0.41
Multiparty parliamentary	Democratic single institutional and multiple partisan Veto Players. Coded 1 when the legislature is the only institutional Veto Player but there are more than one partisan Veto Players	0.05	0.22
Presidential democracy	Democratic multiple institutional and partisan Veto Players. Coded 1 when the institutional Veto Players include both president and a legislature and the partisan Veto Players in the legislature are more than one	0.37	0.48
Personal authoritarian	Authoritarian single partisan Veto Player. Coded 1 when the regime is headed by a personal dictator	0.17	0.37
Group authoritarian	Authoritarian multiple partisan Veto Players. Coded 1 when the regime is headed by a military junta or an authoritarian party	0.20	0.40
Elected single chamber	Coded 1 when a legislature is unicameral and 0 when bicameral	0.26	0.44
Appointed second chamber	Coded 1 when the second chamber in the legislature is appointed rather than elected and 0 when the second chamber is elected	0.15	0.36

likely seek patent protection in the United States as well as their home country.

Furthermore, considering US patent applications has the advantage of controlling for issues outside the scope of this study. We consider it reasonable to assume that the US is an important potential venue for Latin American inventors, and that a local inventor filing for patent protection abroad will have likely done so at home. Local filings will also respond to a myriad of strictly local phenomenon, such as changes in patent office administrative procedures that are difficult to control and have no real relationship to underlying inventive activity. In contrast, US patent examination procedures present the same thresholds for novelty and value for each local inventor at each point in time.

Patent applications to the United States Patent and Trademark Office are attributed to a foreign nation when at least one of the inventors or assignees (the corporate entity, if one exists, that owns the intellectual property) is located outside the US Most of the countries studied have domestic patent offices, and report domestic patent applications by residents, but overall these data are of mixed quality.[4] Altogether,

[4] Domestic Patent Data come from the WIPO reports “100 Years of Industrial Property Statistics” and “25 Years of Industrial Property Statistics” (http://wipo.org/ipstats/en/).

Table 3
Bi-variate correlations

		1	2	3	4	5	6	7	8	9	10	11	12	13
1	Investment	1.00												
2	Development	0.36	1.00											
3	Trade openness	−0.66	−0.02	1.00										
4	Science/engineering publications	0.67	0.38	−0.57	1.00									
5	Global treaties	0.35	0.22	−0.23	0.28	1.00								
6	Institutional stability	0.14	0.09	−0.01	0.26	0.09	1.00							
7	Democratic	−0.03	0.12	0.10	0.10	0.08	−0.16	1.00						
8	Two-party parliamentry democracy	−0.45	0.24	0.51	−0.18	−0.01	−0.01	0.40	1.00					
9	Multi-party parliamentry democracy	0.05	−0.25	−0.07	−0.13	0.06	−0.11	0.17	−0.12	1.00				
10	Personal authoritarian	−0.11	−0.17	0.12	−0.18	−0.09	0.14	−0.58	−0.23	−0.10	1.00			
11	Presidential democracy	0.33	0.03	−0.31	0.31	0.06	−0.10	0.58	−0.40	−0.17	−0.34	1.00		
12	Elected single chamber	−0.23	−0.20	0.19	−0.32	−0.19	−0.10	0.45	0.06	0.12	−0.26	0.35	1.00	
13	Appointed second chamber	−0.24	0.21	0.38	0.05	0.09	0.02	0.32	0.80	−0.09	−0.19	−0.32	−0.25	1.00

domestic patent data exists for slightly less than 47.5% of the cases in our panel. Furthermore, for each country some or all years of domestic patent counts are missing. Where domestic data exist, however, there is a bi-variate correlation of 0.75 between the two series. For these reasons and the advantages of US patent data outlined above we use domestic patent data as a robustness check rather than the primary dependent variable of interest.

2.2. The independent variables

The discussion of independent variables outlines only the method and main objectives in coding each variable. For details, such as decisions regarding specific countries see coding appendix.

Hypothesis 1. Institutional stability.

The first hypothesis proposes that increased duration of a regime, irrespective of regime type, positively influences an inventor's propensity to patent. We code this variable as the natural log of the number of years of the current regime or numbers of years since the country entered the panel, whichever is longer. Every time the country undergoes a regime change the count is re-set to one. Most of the countries in the sample experienced a change in regime around the date of panel entry. The two exceptions, Nicaragua's Somoza and Mexico's Partido Revolucionario Institucional, are counted from 1936 to 1929, respectively.

Hypothesis 2. Regime type.

The second hypothesis posits that democracies create positive incentives for patenting. There is little consensus in the literature, however, as to what constitutes a democracy (Huntington, 1991; Diamond and Plattner, 1996). Recently scholars have emphasized transfer of power as an important tangible qualification for democracy (Geddes, 1999; Przeworki et al., 2000; Geddes, 2003). Therefore, we code as democratic procedural democracies where elections are generally deemed free and fair and where transfer of power has occurred. We also examine whether our findings are robust to different coding rules. For further details see coding appendix.

Hypothesis 3. Veto Players.

In any government policy change requires that a certain number of individual or collective actors in government agree to the change. Tsebelis (2002) calls such actors Veto Players, and argues that in democracies there are two types of Veto Players, institutional and partisan. Institutional Veto Players are defined in a countries' constitution and include the president if the system is presidential rather than parliamentary, and one or two chambers depending on whether the legislature is uni- or bi-cameral.[5] By contrast, partisan players are not defined in the constitution but arise from additional institutional structures, primarily the electoral system, that affect the cohesion of collective institutional players. For example, majoritarian electoral systems generally produce a lower number of legislative parties than do proportional systems (Duverger, 1954; Riker, 1986). By definition the president is a cohesive player but each of the legislative houses is more or less cohesive depending on the number of parties in the chamber as determined by the electoral system. For instance, in a unicameral majoritarian two party parliamentary system the ruling party is the only Veto Player. In a unicameral proportional multiparty parliamentary system, however, all government coalition parties constitute separate Veto Players who may act cohesively on certain policy issues and separately on others. In democracies we classify Veto Players according to the institutional criteria and according to the number of partisan players. Thus, the institutional criteria distinguish between presidential and parliamentary systems and uni- or bicameral legislatures under either system type. The partisan criteria further divide presidential and parliamentary systems into two party and multiparty systems. Since all Latin American presidential systems use some variant of proportional representation to elect the legislature, in effect this criteria only distinguishes between parliamentary systems.

Conversely, there are no institutionally mandated or partisan Veto Players in authoritarian regimes in the democratic sense. The number of Veto Players in authoritarian regimes can, however, differ depending on the cohesion of authority within the regime. Tsebelis (2002) points out that due to the lack of transparency, it may be difficult to establish the exact number of players in any particular authoritarian regime. According to the literature, however, there are considerable differences between the numbers of Veto Players in authoritarian regimes in Latin America.[6] We rely on Geddes' (2003) categorization of authoritarian regimes that accounts for whether the authoritarian regime is military, single party, or personalistic. While personal authoritarian regimes are sometimes backed by the military and the personal leader is often a member of the military, the distinguishing feature is that there is only one Veto Player in personal regimes. For our purposes, however, there is more than one Veto Player in both military and single party authoritarian regimes.

The final coding, therefore, includes five Veto Player categories in addition to categories for the type and number of democratic legislative chambers. Roughly ordered according to the expected number of Veto Players (high to low) in each system, the categories are: Presidential Multiparty, Group Authoritarian, Parliamentary Multiparty, Parliamentary Two Party, and Personal Authoritarian. Due to the lack of transparency in authoritarian regimes we do not purport to know whether there is a higher number of Veto Players in Group Authoritarian or Parliamentary Multiparty regimes. We believe that it is even possible that the number of Veto Players in Group Authoritarian regimes rivals that of Presidential Multiparty systems. To the contrary, there is a single Veto Player in both Parliamentary Two Party Regimes and Personal Authoritarian Regimes. Rather than forcing an index of the numbers of Veto Players on these systems, we create five dummy variables accounting for each type and

[5] Others have argued that the judiciary constitutes an additional institutional Veto Player. Tsebelis (2002), however, posits that the appointment procedures of judges ensures that the judiciary is "absorbed" as a Veto Player in that the process eliminates extreme positions and ensures that judicial opinions will be located in the policy space of the aforementioned institutional Veto Players. Consequently, we do not count the judiciary as a separate Veto Player. Similarly, while other actors such as interest groups may have significant policy influence such extra-legislative influence is necessarily represented through one of the Veto Players we code and therefore not accounted for separately.

[6] Remmer (1989) distinguishes between four types on the basis of concentration of authority and fusion of military and government roles. In terms of the Veto Player argument only the concentration of authority axis is relevant because while the legislature and/or the president may be civilians under distinct military regimes, the civilian leaders cannot effectively oppose policy that the military favors. Ultimately, the military is the only Veto Player that matters. Whether that military is unified or dispersed can, however, make a significant difference.

allow the empirical results to aid in distinguishing more clearly between their effects. Three dummy variables account for major differences in legislative structure: Elected Single Chamber, Appointed Second Chamber and Elected Second Chamber. Following the literature, we expect systems with an elected second chamber to have two institutional Veto Players (beyond the president, if a presidential system). With a single elected chamber or an appointed second chamber the legislature represents a single institutional Veto Player.[7]

2.3. Control variables

We also include several important control variables. Investment (Gross capital formation), Development (GDP per capita), and Trade Openness (total imports and exports) are considered fundamental factors in the literature on technology and economic growth (Fagerberg, 1994; Levine and Renelt, 1992; Park and Ginarte, 1997; Schofer et al., 2000). Little empirical work on cross-country variation in patenting exists, but we consider the work on growth generally relevant in that we are attempting to assess a variant of the same phenomenon. The growth literature considers a number of additional variables that we do not include, such as population, and foreign direct investment. These variables all closely track investment, with bi-variate correlations in the 0.95 range, so we have excluded them in multiple analysis to circumvent multicollinearity problems.

The control variable lagged US patent applications, the natural log of patent applications for the prior year, also stems from the growth literature, which uses initial values to benchmark within country growth in cross-sectional models. Theoretically it is a very important variable because while growth patterns in Latin America may be very similar, these states often start from quite different initial positions with respect to intellectual property.

Science and Engineering Publications measures the number of articles published in the Science Citation Index by authors residing in each country (Schofer et al., 2000). Patents are commonly viewed as a measure of technological development, and this measure controls for changes in the local technological base over and above changes in investment or development. To control for any remaining time-related heterogeneity we also include a dummy variable for each year in the panel. US patent applications in general increase in linear fashion over the course of the analysis period, from 37,144 total foreign patent applications in 1973, to 120,362 total foreign patent applications in 1999 (USPTO, 2003). With year dummies included in multiple analysis we can interpret significant results as the marginal effect after having controlled any such time-related trends.

Finally, a common view of international economic organizations is that they contribute to economic development through their function as "linkage organizations." In addition to serving as direct enforcement agencies, entities such as the World Trade Organization (WTO) engage countries in iterated games of prisoner's dilemma that promote a long term economic perspective and decrease a countries incentive to defect on a previously stated position (Alvarez, 2002).[8] The most important international treaties affecting patenting are managed under the World Intellectual Property Organization (WIPO) and the World Trade Organization (WTO). Coding the Legal Globalization variable, we created an ordinal variable that accounts for the major treaties (The Paris Convention, Patent Cooperation Treaty, and General Agreement on Trade and Tariffs) a country is signatory to.

2.4. The statistical methods

Assessing the effect of each variable on the outcome (patent counts), we perform negative binomial regressions (Hausman et al., 1984). Negative binomial estimation is used when the distribution is generated by

[7] For a good overview of the literature relating to the differences between appointed and elected second chambers see Tsebelis and Money (1997). To be clear, much of the literature argues that appointed second chambers are less likely to constitute an additional barrier to policy when compared to single chamber legislatures. Tsebelis and Money (1997), however, find that even appointed second chambers can affect legislation.

[8] Scholars who study the effects of domestic legal institutions on economic development argue that "legal families" diverge in their effects on economic development (La Porta et al., 1999). In Latin America, however, the legal families of Civil law and Common Law are highly correlated with democratic system type. Establishing the relative predictive capabilities of Veto players versus legal Families requires a different sample. Therefore, we do not explore this argument further here but point to it as an exciting venue for further study.

Table 4
WIPO reporting of domestic patenting by Veto Player arrangement

Government type	Cases	Cases with WIPO reported data	% Cases with WIPO reported data
Two-party parliamentary	170	20	11.7
Thereof			
Elected single chamber	53	0	0.0
Appointed second chamber	117	20	17.1
Elected second chamber	0		
Multiparty parliamentary	36	7	19.4
Thereof			
Elected second chamber	18	0	0.0
Appointed second chamber	0		
Elected second chamber	18	7	38.9
Personal authoritarian	130	63	48.5
Group authoritarian	162	93	57.4
Presidential democracy	287	189	65.8
Thereof			
Elected second chamber	132	85	64.4
Appointed second chamber	0		
Elected second chamber	154	103	66.9
Total	785	372	47.4

a poisson-like process, such as non-negative counts of events, but the distribution is too dispersed to use poisson estimation. Poisson is the appropriate form of estimation if the mean and variance of the dependent variable are approximately equal (Hausman et al., 1984). Our data are clearly more dispersed. If the model is robust, negative-binomial coefficients are comparable to those from poisson estimation, but with more stringent significance tests in the form of larger standard errors. A statistically significant alpha estimate indicates over dispersion, and the consequent suitability of the negative binomial distribution. When assessing the relative fit of alternative specifications we perform likelihood ratio tests comparing the log likelihood of the restricted model, where a coefficient is constrained to zero, to the log likelihood in the unrestricted model (Greene, 1993, pp. 379–380).

Domestic patent data exists for less than half of the possible observations in our panel and the reported data are spotty. None of the countries in the panel report domestic patent data 100% of the time. On average countries that do report do so 45% of the time and Antigua, Barbuda, Belize, Dominica, Grenada, St. Kitts and Nevis, St. Vincent, and Suriname never report patent application data to WIPO. More insidiously, the quality of domestic reporting appears to be correlated with one of the main variable of interest in this paper, Veto Player government type. Table 4 shows, for all years in multiple analysis, the rate of reported domestic patenting by Veto Player government type. The Veto Player government types are ordered from lowest expected stability (Parliamentary Two Party) to greatest expected stability (Presidential Democracy). For democratic regimes we also breakout reporting by the number of legislative chambers. Table 4 demonstrates a clear step-wise increase in the quality of domestic patent data as expected stability increases. Consequently, for domestic patent applications we employ a Heckman selection model, first estimating for all cases the probability that any data are reported and recovering a selection hazard index (Heckman, 1976). The selection term is then included as a control variable for estimating domestic patent applications in the subset of cases where the dependent variable is observed.

3. The results

We first consider regression results for US patent applications, and then turn to supplemental results with domestic patent applications. Table 5 presents models

Table 5
Negative binomial estimation of US patent applications by country/year

	(1)	(2)	(3)	(4)	(5)
Investment	0.203 (0.024)**	0.197 (0.024)**	0.197 (0.024)**	0.206 (0.024)**	0.169 (0.025)**
Development	0.042 (0.040)	0.111 (0.043)*	0.111 (0.044)*	0.085 (0.045)+	0.123 (0.044)**
Trade openness	−0.020 (0.047)	−0.115 (0.053)*	−0.116 (0.053)*	−0.099 (0.052)+	−0.064 (0.053)
Lagged US patent applications	0.747 (0.033)**	0.692 (0.036)**	0.692 (0.036)**	0.695 (0.035)**	0.655 (0.037)**
Science/engineering publications	0.139 (0.019)**	0.135 (0.018)**	0.136 (0.019)**	0.138 (0.018)**	0.144 (0.019)**
Global treaties	−0.097 (0.027)**	−0.074 (0.027)**	−0.074 (0.030)*	−0.068 (0.030)*	−0.007 (0.031)
Institutional stability		0.098 (0.025)**	0.098 (0.028)**	0.047 (0.035)	0.135 (0.028)**
Democratic			−0.003 (0.057)	−0.240 (0.120)*	
Institutional stability × democratic				0.092 (0.041)*	
Two-party parliamentary democracy[a]					−1.040 (0.427)*
Multi-party parliamentary democracy[a]					−0.555 (0.245)*
Personal authoritarian[a]					0.039 (0.081)
Presidential democracy[a]					0.121 (0.059)*
Elected single chamber[b]					−0.133 (0.078)+
Appointed second chamber[b]					0.498 (0.437)
Year fixed effects (74–99)	++	++	++	++	++
Constant	−5.647 (0.912)**	−6.737 (0.946)**	−6.740 (0.948)**	−6.312 (0.953)**	−6.616 (0.952)**
Log likelihood	−1461.00	−1453.28	−1453.28	−1450.91	−1428.37
Alpha	0.045 (0.012)**	0.041 (0.011)**	0.041 (0.012)**	0.035 (0.010)**	0.031 (0.009)**
Observations	785	785	785	785	785

Standard errors in parentheses; (+) significant at 10%; (*) significant at 5%; (**) significant at 1%; (++) jointly significant at 1%.

[a] The reference category is “Group Authoritarian”.

[b] The reference category is “Elected Second Chamber”.

for United States Patent and Trademark Office applications by local Latin American inventors.

Model Two builds on the control variable only specification reported in Model One, adding the Institutional Stability variable. As expected this variable is highly statistically significant and positively associated with increased patenting. Furthermore, Institutional Stability remains highly statistically significant in every model even after we account for divergent institutional structures. In Model Three we add the democratic regime variable. According to this model, a change from an autocratic to a democratic regime has no impact on an inventor's inclination to patent. Model Four interacts institutional stability and democratic regime, testing whether the insignificant result on democracy is due to differences in mean regime duration by regime type, and not regime type per se.[9] The interaction terms and main effects are jointly significant. Initially, the negative sign on Democratic indicates that democratic regimes are at a disadvantage. The positive sign on the interaction term, however, indicates that democratic regimes catch up to authoritarian regimes. Manipulating these terms reveals that at 13.6 years of stability ($\exp(2.61) = 13.6$), the two regime types are equivalent, and after that democracies pull away at a declining marginal rate.

In Model Five we replace the Democratic regime variable with the Veto Player categorization. The overall fit of Model Five, as evidenced by likelihood ratio tests, is strongly improved relative to any of the preceding specifications. The Veto Player coding explains patent application rates better than regime type coding. Even so the Veto Player categories do not line up exactly as expected. We argued that the greater the policy stability, the higher the rate of patenting. The Veto Players argument holds that the determinants of policy stability are the numbers of Veto Players in a system. Accordingly, we would expect the regimes with a single Veto Player to be associated with lower rates of patenting than regimes with higher numbers of Veto Players. In our classification, the single Veto Player regimes are Parliamentary Two-Party systems and Personal Authoritarian regimes. Multiple Veto Players, on the other hand are found in the Presidential Multiparty systems, Group Authoritarian systems, and Parliamentary Multiparty systems. Furthermore, in democracies we expect Elected bicameral legislatures to have a higher number of Veto Players than either Elected Single Chamber legislatures or legislatures where the Second Chamber is Appointed.

In Table 5, the findings on Veto Player category are mixed. With respect to US patent applications, as expected Two-Party Parliamentary Democracy had a significant decreasing effect on the number of patent applications and Presidential Democracy a positive significant effect when compared to the reference category of Group Authoritarian Veto Players. The Elected Single Chamber Legislature also has a negative and statistically weakly significant effect when compared to Elected Bicameral Legislatures as expected. The variable accounting for Multi Party Parliamentary systems, where we predicted the number of Veto Players on par with Group Authoritarian regimes, had a negative significant effect on patent applications, and Personal Authoritarian systems were not distinguishable from Group Authoritarian Veto Players. Clearly, while inventors might believe that Presidential Multiparty systems will provide the greatest policy stability, when deciding whether to patent abroad they will find it difficult to determine differences between prospects of policy stability in Personal Authoritarian regimes as opposed to those governed by a Group. This runs contrary to Tsebelis' (2002) untested proposition that divergent numbers of Veto Players in authoritarian regimes may matter. Also unexpectedly the effect of Appointed Second Chambers is not significantly different from that of Elected Bicameral Legislatures.

Furthermore, to verify the difference between the coefficients of the different Parliamentary system type variables, which both are negative, we also performed likelihood ratio tests comparing the log likelihood of Model Five to an unreported restricted specification where the two parliamentary coefficients are constrained to equivalence. Based on this test, the coefficients associated with different Parliamentary systems are not significantly different from each other. Despite the seeming difference in the coefficient, this result is not surprising because only two countries in the sample are ever coded as multiparty parliamentary systems.

The above findings highlight some of the substantive differences that distinguish between regimes with low

[9] In other words, if democratic regimes have on average shorter duration they may not have sufficient time to generate confidence. Our thanks to an anonymous reviewer for suggesting this relationship.

numbers of Veto Players. A regime change as discussed in this paper denotes a change from an authoritarian to a democratic electoral regime or vice versa. There is, however, also a difference between democratic and authoritarian regimes that we have not addressed, in administrative durability within each regime type, which may affect an inventor's propensity to patent. In authoritarian regimes administrative duration is unrestricted. To the contrary, any single administration in a democratic regime has an institutionally mandated upper bound as legislative elections must be held every 6 years, for example. Thus, the Personal Authoritarian regimes classified in our paper (excluding Castro, Somosa and Stroessner) have an average administrative duration of over twelve years, while the maximum duration of any democratic single Veto Player administration is at most half that number. Accordingly, while an inventor in a democratic regime may have every confidence that the regime will endure she also knows that the administration will change hands periodically, which may affect her assessment of future policy stability. This might, for example, explain why Group Authoritarian regimes do better than Multi Party Parliamentary systems with respect to numbers of patents generated despite the fact that both systems have multiple Veto Players.

Second, differences in social polarization between democratic regimes may interact with the number of Veto Players to produce unexpected policy outcomes. For instance, in Presidential Multiparty regimes the high number of Veto Players ensures policy continuity that likely extends beyond any one administration. The number of Veto Players in Two Party Parliamentary regimes, by comparison, is not sufficient to ensure such policy continuity. Downs' (1957) widely accepted argument holds that the plurality electoral structure that produces two party systems is also associated with policy moderation. Tsebelis (1995), however, points out that the theoretical foundations for the direction of this relationship rest on restrictive assumptions and the empirical evidence is incomplete at best. Thus, others have argued that plurality systems are compatible with polarized party systems (Tsebelis, 1995). Theoretically, if a party system is based on cross cutting cleavages, as in many European countries, the systems can make up for the lack of policy stability generated by a lower number of Veto Players through policy proximity in party platforms. The conditions for a polarized party system arise where the system is based on mutually exclusive and even re-enforcing cleavages that promote very divergent policies. Under such conditions, the electorate has a significantly lowered expectation of policy stability, even while holding the number of Veto Players constant. This is precisely the situation in many Parliamentary systems in Latin America, which are all located in Central America and the Caribbean. Generally, Central American and Caribbean polities are thought to be relatively fragmented and fraught with political conflict over cleavages such as class, business, race, ethnicity, and even divergent colonial legacies. Adding the oil crisis of the 1970's and the general economic decline of the 1980's to the mix, it is hardly surprising that democratic politics in the then recently independent Caribbean were less stable than politics of authoritarian regimes in the region.[10]

Moving on to the control variables, every model in Table 5 demonstrates that Investment, Lagged Patenting level, and local Science and Engineering Publications are as important to national innovative outputs in Latin America as they are in the United States. The 26 dummy variables for Year, with the reference category 1973, are jointly significant in all specifications. For parsimony, the year dummy coefficients are not reported. The remaining control variables, Development and Trade Openness, both lose significance in the first specification and Trade in the final specification. A likely explanation is that Development is contingent on stability (Przeworki et al., 2000) and thus inclusion of any measure thereof. The negative sign on the Trade variable is, however, puzzling. Our supposition is that with increasing global integration, and the expectation that the rule of law will govern these relations, defensive international patenting is less of a concern. Similarly, Global Treaties loses significance in the final specification and the negative sign on global treaties may seem surprising at first glance. Our explanation is that international treaties such as the Patent Cooperation Treaty[11] provide international search reports and optional preliminary international examination reports that effectively establish the international patentability of the invention prior to application in the United States

[10] For a good discussion of causes of political fragmentation in Caribbean politics, including economics, see for instance Payne and Sutton (1993).

[11] The United States became signatory to the PCT in 1978.

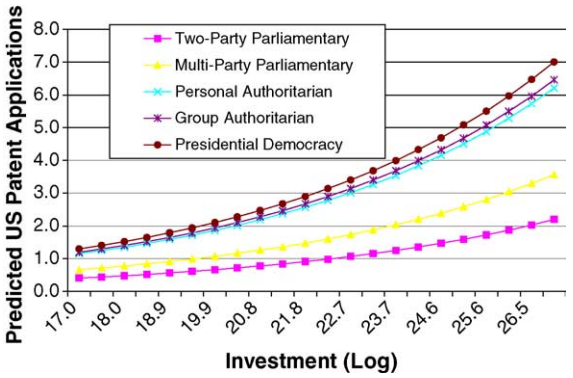

Fig. 1. Predicted US Patent Application Counts for five Veto-Player Government Types at different levels of Investment. This graph is based on the coefficients in specification 5 from Table 5. For each line the value of the other Veto-Player types is set to zero, investment varies over its range in the data, and all other variable are set to their mean.

(WIPO, 2004). Finally, before turning to the variables of interest, we note that in likelihood ratio tests the fit of each successive model, with the exception of Models Two and Three, improves at the 1% level of significance.

Fig. 1 shows the substantive difference between US patenting rates depending on number of principal Veto Players in a regime, at varying levels of investment, and with average values of other economic and institutional control variables (using the prgen procedure from Long and Freese (2001)). The level of investment is expressed as the natural log of millions of dollars and ranges from the lowest investment figure (17) to the highest (27) in the data. As the figure shows there is a substantively significant difference in rates of patents depending on number of Veto Players, and this difference increases as investment increases. In countries where levels of investment are low, the average number of US patents that inventors file increases roughly half a patent when we go from Two Party Parliamentary Regimes with the lowest rates of patenting to an Authoritarian Regime and another half if the regime type changes to Presidential Multiparty, which is the regime type with the greatest rates of patenting. Many of the smaller countries, where investment is lowest, may only produce a single patent every few years. An increase of one patent per year as a result of changing regime type is, therefore, substantively significant. At higher levels of investment in the larger countries the differences between rates of patenting under different regime types are more pronounced.

3.1. Domestic patent data

Table 6 presents supplemental regressions using the annual count of Domestic Patent Applications for Residents in Latin American by country and year. Even though there is a 0.75 bi-variate correlation between US patent applications and domestic patent applications, there are several limitations with this analysis that bear noting. First, and as noted above, domestic patent data are frequently missing. The results for domestic application regressions include a selection term to control for any relationship between the probability that any data are reported and the actual value reported. Second, there are undoubtedly many purely local changes in patent regimes, such as modifications in local patent legislation, that are not captured in these models. With US patents, by contrast, every inventor faces the same legal requirements at the same time. Third, the gaps in domestic reporting preclude using lagged values of the dependent variable as an independent variable. We test models without the lagged dependent variable, and then use the value for lagged US patent applications as a robustness check in a final specification. Finally, high missing data counts for Two-Party Parliamentary and Multi-Party Parliamentary necessitated collapsing these two types into a single category.

Turning to the results, the non-selection hazard term is significant in all specifications. This term is recovered from a first stage probit where all explanatory variables except global treaties, which is excluded for identification purposes, are regressed on a dummy variable for WIPO domestic patenting reporting. Only when data are reported to WIPO do we have an observation on the number of domestic patent applications by residents. A significant selection term indicates that, absent the inclusion of this variable, sample selection bias is a problem for the other coefficient estimates. With respect to the other control variables, every model in Table 6 demonstrates that Investment, and local Science and Engineering Publications are as important to national innovative outputs as they are to patenting in the United States. The unreported 26 dummy variables for Year, with the reference cate-

Table 6
Negative binomial estimation of domestic patent applications for residents by country/year

	(6)	(7)	(8)	(9)	(10)	(11)
Investment	0.516 (0.052)**	0.550 (0.053)**	0.550 (0.053)**	0.577 (0.055)**	0.417 (0.042)**	0.309 (0.051)**
Development	−0.202 (0.105)+	−0.234 (0.103)*	−0.245 (0.103)*	−0.286 (0.105)**	−0.285 (0.085)**	−0.202 (0.084)*
Trade openness	−0.973 (0.147)**	−0.884 (0.156)**	−0.882 (0.153)**	−0.865 (0.151)**	−0.489 (0.118)**	−0.447 (0.118)**
Science/engineering publications	0.509 (0.073)**	0.529 (0.072)**	0.533 (0.071)**	0.538 (0.071)**	0.709 (0.077)**	0.603 (0.083)**
Global treaties	0.018 (0.052)	0.008 (0.051)	0.020 (0.056)	0.025 (0.055)	0.140 (0.050)**	0.134 (0.049)**
Non-selection hazard	1.131 (0.576)*	1.240 (0.571)*	1.255 (0.563)*	1.339 (0.560)*	1.828 (0.596)**	1.332 (0.599)*
Institutional stability		−0.082 (0.041)*	−0.079 (0.043)+	−0.174 (0.066)**	−0.033 (0.039)	−0.070 (0.040)+
Democratic			0.026 (0.100)	−0.359 (0.223)		
Institutional stability × democratic				0.152 (0.078)+		
Parliamentary democracy[a]					−1.555 (0.328)**	−1.625 (0.318)**
Personal authoritarian[a]					−1.393 (0.488)**	−0.976 (0.492)*
Presidential democracy[a]					−0.514 (0.113)**	−0.500 (0.110)**
Elected single chamber[b]					0.274 (0.114)*	0.207 (0.112)+
Appointed second chamber[b]					0.284 (0.169)+	0.226 (0.164)
Lagged US patent applications						0.187 (0.055)**
Year fixed effects (1974–1999)	++	++	++	++	++	++
Constant	−3.195 (1.787)+	−3.598 (1.793)*	−3.460 (1.797)+	−3.144 (1.809)+	−3.247 (1.545)*	0.221 (1.526)
Log likelihood	−1812.03	−1808.65	−1808.31	−1806.44	−1755.93	−1748.27
Alpha	0.401	0.400	0.395	0.395	0.288	0.272
	(0.032)**	(0.032)**	(0.032)**	(0.032)**	(0.025)**	(0.023)**
Observations	372	372	372	372	372	372

Standard errors in parentheses; (+) significant at 10%; (*) significant at 5%; (**) significant at 1%; (++) jointly significant at 1%.

[a] The reference category is “Group Authoritarian”.

[b] The reference category is “Elected Two Chambers”.

gory 1973, are jointly significant in all specifications. Of the remaining control variables, Development is only significant in a one tailed test until we control for Institutional stability in the Seventh Model. Here, however, Development is inversely related to patenting. There are many possible explanations for this. Possibly local patenting regimes have become increasingly stringent over time as development has increased. Similarly, as development increases patenting abroad may take on increasing significance relative to local patenting. Trade openness is significantly and negatively related to local patenting in every specification, probably for the same reasons. Global Treaties is only significant in the Ninth and Tenth Models where we control for Veto Player variables. A likely explanation is that certain Veto System types are more likely than others to be members of Global Treaties with consequences at home. Model Eleven is a robustness check that includes lagged US patent applications rather than lagged domestic patent applications because of the loss of cases associated with the latter in an already limited panel.

With respect to independent variables of interest, Institutional Stability is negatively related to Domestic Patent Applications but this variable is only significant in Models Seven to Nine before we account for any of the regime or Veto Player variables, and weakly significant in models Eight and Eleven. Our supposition is that the inverse relationship between Institutional Stability and numbers of patents over time results from convergence on international standards as more countries become members to international patenting organizations. This convergence makes the domestic patent application process increasingly stringent, and also opens up foreign venues for patent applications such as the US Once we account for divergence in domestic political institutions that effect the likelihood of such international integration, which presumably require persistent policy efforts, the negative effect of Institutional Stability decreases.

Model Eight adds the variable accounting for Democratic Regimes. As with US patent application this variable is not statistically significant. Model Nine adds an interaction between democratic and institutional stability. As with US patent application counts, in this specification democracies are initially at a disadvantage but eventually catch up.

In the Tenth Model we substitute the regime variable with the Veto Player variables. As with US patent applications, the Veto Player specification shows a dramatically improved overall fit relative to any preceding specification. With reference to Group Authoritarian, Personal Authoritarian regimes have a highly significant negative effect and Presidential Democracies a highly significant positive effect as expected. The negative and highly significant effect of an Appointed Second Chamber is also what we would have expected. The highly significant negative effect of Parliamentary Democracy when compared to Group Authoritarian systems is unexpected. While this variable contains both multi party and two party systems, most of the two party systems drop out of the panel due to lack of data and the bulk of the remaining cases (20 out of 27) represent two multi party countries that we expect to be on par with Group Authoritarian systems. We take this as an indication that the size of the negative coefficient is likely increased by inclusion of Two Party parliamentary systems but the sign is consistent with that in Table 5, pointing to unexpected differences between Group Authoritarian and Multi Party Parliamentary systems. Finally, the weakly significant positive effect of the Elected Single Chamber is unexpected and contrary to our findings in Table 5. The likely reason for this finding is that Costa Rica, an unusually stable Latin American country, is unicameral, and a number of the less stable unicameral countries, such as Dominica, St. Kitts, St. Vincent, and Suriname are not included in this panel because of non reporting of data. Lastly, in the Eleventh Model where we add the Lagged US patent applications the signs of the Veto Player variables remain the same but Presidential Democracy becomes weakly significant and the Elected Single Chamber looses significance.

The results using domestic patenting data largely confirm the results using US patent data. These results also cast doubt on a rival interpretation associated with the use of US patent data as opposed to domestic patent data. A possible rival is that the true relationship between domestic Latin American patent applications and US patent applications is negative, rather than US patent applications approximating Latin American patent applications. In that case, we would expect Latin American inventors to “flee” policy instability with subsequent increases in US rates of patenting. Unless,

however, Latin American inventors are fleeing democratic presidential systems, our results disconfirm this interpretation.

4. Conclusions and directions for future research

National political conditions influence patent application rates. We posited that, all else equal, one should expect inventors to consider national policy stability as an indicator of economic prospects when deciding whether to engage in inventive activity or seek patents. Our results support this argument and show more specifically that policy stability and consequent rates of patent applications increase roughly in line with predictions of the Veto Players argument. The higher the number of Veto Players in a system the greater the policy stability expected by an inventor and the more likely she is to seek a patent for her invention.

Scholars studying national innovation systems have given considerable attention to knowledge stocks. These results suggest that there is a fundamental relationship between political institutions and technology development. The exact nature of this relationship, what occurs between expectations regarding policy stability and the ultimate *granting* of intellectual property, remains unknown. We see several promising venues for exploration. One possibility is that the quality of intellectual property rights (IPR) within each nation is in itself a product of governmental system type. While we demonstrate an effect from political institutions that precede IPR, the policy implications will depend partially on whether IPR policies still exert an independent influence on patenting propensities. For instance, patent laws that converge on international standards may eventually overcome local stability concerns by conferring the expectation that international parties will by and large respect the intellectual property, even if that is not the case at home. A related policy issue concerns the role that governments play in developing local cluster of expertise via direct government funding. Although hindered by low policy stability expectations, governments with few Veto Players may also be able to more effectively target these national initiatives. Within higher Veto Player systems, by contrast, much of the government largesse will necessarily go to building coalitions across independent players (i.e. "pork-barrel" projects) and not necessarily the targeted program. Conversely, corruption is obviously also a higher probability outcome when there are fewer independent institutions.

In terms of scholarly work, another issue concerns the substance of patents that emerge under different institutional structures. Social network scholars have noted that cohesive relationships are often an effective extra-legal mechanism for preventing opportunistic behavior (Coleman, 1988). This would imply that local inventive clusters may, in part, rise from the need of local firms to establish more secure intellectual property if only by engaging in more effective monitoring of potential rivals. Most known technology clusters exist in relatively stable industrialized nations, but even these nations vary on legal tradition (La Porta et al., 1999). Different "legal families" have different patenting principles, even for such seemingly fundamental concepts as invention novelty or priority, that strongly influence international citation patterns (Waguespack and Birnir, 2005). Moreover, as more politically volatile nations such as Romania, India, and Taiwan become increasingly important innovation outsourcing locales, protection of intellectual property in these nations will become a growing concern for multinational firms. A related question concerns that nature of invention disclosure. Under less stable regimes firms may hedge by revealing less information in patent applications, or by predominantly disclosing incremental innovations as opposed to more revolutionary discoveries.

These speculations, of course, also beg the question of whether increased patent application rates lead to an increase in patent grants. Consider the unexpected finding that Personal Authoritarian regimes in Latin America have marginal patent application rates approximately equal to those from parliamentary democracies. It is possible that this is simply a by-product of cronyism, with Personal Authoritarian regimes disproportionately pursuing trivial IPR at the whim of a dictator. Finally, migration patterns and international knowledge flow may be another consequence of policy stability. Creative individuals, when deciding whether to engage in inventive activity and patenting in a given locale, also often have the option of seeking another venue. Little is known about the inventive activity of these immigrants in developed nations such as the United States, or their future repatriation patterns.

Acknowledgements

We would like to thank Jeff Frieden, Barbara Geddes, Olav Sorenson, George Tsebelis, and two anonymous reviewers at Research Policy for useful suggestions and comments.

Appendix A. Coding

A.1. The independent variables

Hypothesis 1. Regime type.

When coding the regime variable we only code countries that are independent because theoretically an inventor's incentives for patenting are quite different in colonies than in independent countries.

A.1.1. Democratic regimes

We code regimes as democratic if elections are generally considered free and fair and if transfer of power has taken place. Transfer of power refers to government changing hands, for instance, when a military cedes control of government to civilian politicians. In many Caribbean cases the same party that won the first elections after independence also dominated politics prior to independence. Thus, we did not code countries as democratic until a transfer of power had taken place from a party that dominated politics prior to independence or prior to democratization and immediately thereafter to a different party. Furthermore, democratic periods are counted even when they are followed by insurrection after a single election, and insurrections that lasted less than three years are not considered a "break" in democratic politics.[12] To ensure that our coding did not bias our results we also ran the analysis with an alternate coding that does not require a transfer of power.[13]

Since our variable is coded on a yearly basis the endpoint convention we use is to code democratic the last year in the period classified by Geddes (2003) as authoritarian, if the first democratic election takes place in that year.[14] The endpoint convention at the beginning of an authoritarian period is the same in that a country is coded as democratic in the year of authoritarian breakdown if the last democratic election took place that year.[15]

Hypothesis 2. Veto Players.

In classifying Latin American presidential systems we start with the minimal definition of a presidential system that the head of state be elected separately from the legislature (Shugart and Carey, 1992).[16] Furthermore, we try to stay true to the spirit of the Veto Players argument in that this head of state has the ability to exert an influence on the legislative process, distinct from the legislature. Consequently, while Bolivia is a presidential system in that voters cast two votes, both

[12] We did not count Fujimori's auto-coup in 1992 as a democratic interruption because it was preceded and followed by democratic elections within 3 years. For the same reason we did not count the insurrection of 1990 in Suriname.

[13] The alternative coding is based on Jones (1995). In addition to not requiring transfer of power Jones does not include competitive elections that are followed soon thereafter by insurrections. In this version we coded Argentina in 1960–1965 and 1973–1975 as military, Ecuador 1960–1962 as personal and 1966–1971 as military, Honduras 1960–1962 as military, Panama 1960–1968 as authoritarian party and Suriname 1987–1990 as military. Using Jones our substantive conclusions remain similar, the Veto Player theory is a more informative predictor of patenting rates than regime theory. The Democratic regime variable did come in highly significant when we used Jones. However, the Veto Player variables also lined up with the same signs as the Veto Player variables when we used the alternative coding. Furthermore, the presidential regime variable was highly statistically significant using Jones whereas two party parliamentary variable lost significance. We interpret this to mean that the reason the Democratic regime variable came in significant using Jones is that it acted as a proxy for presidential systems. However, using the Veto Player variables allows us to distinguish between presidential and parliamentary systems.

[14] Therefore, Argentina in 1973 and 1983, Chile in 1989, Dominican Republic in 1978, Ecuador in 1979, El Salvador in 1984, Guatemala in 1966 and 1985, Honduras in 1981, Nicaragua in 1990, Panama in 1989, Paraguay in 1993, Peru in 1980, and Uruguay in 1984 are coded as democratic because elections took place in those years.

[15] Therefore, Guatemala in 1970, Panama in 1968, and Dominican Republic in 1966 are coded democratic because the last democratic election took place the same year as the authoritarian breakdown.

[16] Another popular criteria of presidential systems, that the survival of the head of state be independent from the legislature is violated in the case of Chile, Ecuador, and Peru where the legislatures have the power to censure. However, censure of the president is usually used as an extreme measure and does, therefore, not eliminate the legislative Veto influence of the president. Consequently, we do not use this criteria for classification of presidential systems.

Table 7
Authoritarian periods/countries not coded by Geddes

Country	Personalistic	Military/single party
Antigua and Barbuda		1981
The Bahamas	1973–1991	
Belize	1981–1983	
Bolivia	1970	1978–1982
Colombia		Arranged party government 1960–1978
Dominican Republic		1962–1965
Grenada	1974–1983	
Guatemala		1960–1962 and 1967–1969
Guyana	1966–1991	
Haiti		1987–1990
Peru	1960–1967	
St. Vincent and the Grenadines		1979–1983
Suriname	1981–1986	
Trinidad and Tobago	1962–1985	

votes must be for the same party, and the leader of the majority party becomes president. In case of plurality the legislature chooses the president from among the three top party candidates. Therefore, the legislative function of Bolivian presidents is more like that of prime ministers and in terms of Veto Players we classify the country on par with a parliamentary system. To the contrary, we classify Venezuela as a presidential systems despite the fact that president does not have any of the more conventional powers that bear directly on legislation.[17] Nevertheless, the president in Venezuela does control the formation and dissolution of cabinets without the need for confirmation or investiture by the legislature, thereby, indirectly affecting legislation in the capacity of a Veto Player that is distinct from the legislature.[18]

The second institutional criterion distinguishes between the number of houses in the legislature with the idea that two chambers constitutes a higher number of Veto Players than a single chamber. We distinguish both independently elected and appointed upper chambers from unicameral legislatures to let the regression determine whether the expectation of ineffective appointed upper chambers is accurate.

In terms of the partisan criteria, most Latin American democratic presidential systems elect their legislatures under rules of simple proportional representation.[19] The exceptions are Bolivia, Ecuador, Mexico, and Venezuela. The current electoral systems in Bolivia, Mexico and Venezuela are mixed.[20] While a large portion of the legislature is elected in single member districts another portion is elected in multimember districts. The composition of the legislature is, however, multiparty. Since 1998 Ecuador uses a system of unlimited vote.[21] While this system is not a conventional PR system the resultant composition of the legislature is multiparty. Therefore, Bolivia, Ecuador, Mexico, and Venezuela are all classified as multiparty systems when democratic. Finally, with the exception of Suriname all democratic parliamentary regimes in Latin America are two party systems.

A.1.2. Veto players in authoritarian regimes

We rely primarily on Geddes' (2003) cataloging of authoritarian regimes. Geddes does not classify all Latin American Countries, authoritarian interventions of less than three years, or transitional periods. Table 7

[17] According to Shugart and Carey (1992) these are package or partial veto, decree powers, budgetary powers, the ability to introduce legislation in specific issue areas to the legislature, and referenda powers (p. 150).

[18] Ministers can be dismissed and censured by the legislature but this requires a 2/3 vote (Mainwaring and Shugart, 1997).

[19] Some like Ecuador, El Salvador, Nicaragua, Guatemala and Suriname use a two tiered system but the rule is essentially proportional in both tiers.

[20] The electoral systems in Bolivia prior to 1994 and in Venezuela prior to 1993 were PR.

[21] For Further discussion see Mejia Acosta and Katz (2001).

lists the countries and years left unclassified by Geddes, and shows our coding of these regimes. In determining whether these countries are authoritarian we apply the transfer of power rule. Therefore, a regime is considered authoritarian if the dominant party has never lost control of the executive, even when international observers considered elections free and fair. In determining whether the countries are personalistic or military/party governments we code regimes only as personalistic if there is clearly a single identifiable leader.[22] Accordingly the remaining countries are classified as shown in Table 7.

References

Adams, J.D., 1990. Fundamental stocks of knowledge and productivity growth. Journal of Political Economy 98 (4), 673–702.

Ahuja, G., 2000. Collaboration networks, structural holes, and innovation: a longitudinal study. Administrative Science Quarterly 45 (3), 425–455.

Alvarez, J.E., 2002. The WTO as linkage machine (in symposium: the boundaries of the WTO). American Journal of International Law 96 (1), 146–158.

Coleman, J.S., 1988. Social capital in the creation of human capital. American Journal of Sociology 94, S95–S120.

Diamond, L., Plattner, M. (Eds.), 1996. The Global Resurgence of Democracy. John Hopkins University Press, Baltimore.

Downs, A., 1957. An Economic Theory of Democracy. Harper Collins Publishers, New York, NY.

Duverger, M., 1954. Political Parties, Their Organization and Activity in the Modern State. Wiley Methuen, London, New York.

Fagerberg, J., 1994. Technology and International Differences in Growth-Rates. Journal of Economic Literature 32 (3), 1147–1175.

Fleming, L., Sorenson, O., 2001. Technology as a complex adaptive system: evidence from patent data. Research Policy 30 (7), 1019–1039.

Furman, J.L., Porter, M.E., Stern, S., 2002. The determinants of national innovative capacity. Research Policy 31 (6), 899–933.

Furman, J.L., Hayes, R., 2004. Catching up or standing still? National innovative productivity among 'follower' countries, 1978–1999. Research Policy 33 (9), 1329–1354.

Geddes, B., 1999. What do we know about democratization after twenty years? Annual Review of Political Science 2, 115–144.

Geddes, B., 2003. Paradigms and Sand Castles: Theory Building and Research Design in Comparative Politics. University of Michigan Press, Ann Arbor.

[22] Geddes (2003) outlines a detailed coding scheme for determining whether the authoritarian regime is single party, military or a personalistic regime. For purposes of the veto player argument we do not distinguish between party and military regimes. Thus, we did not verify some of the detail required for the three way classification.

Griliches, Z., 1990. Patent statistics as economic indicators – a survey. Journal of Economic Literature 28 (4), 1661–1707.

Greene, W.H., 1993. Econometric Analysis, second ed. Prentice Hall, Englewood Cliffs, NJ.

Hausman, J., Hall, B.H., Grilliches, Z., 1984. Econometric-models for count data with an application to the patents R and D relationship. Econometrica 52 (4), 909–938.

Heckman, J.J., 1976. Sample selection bias as a specification error. Econometrica 47, 153–161.

Henisz, W.J., Delios, A., 2001. Uncertainty, imitation, and plant location: Japanese multinational corporations, 1990–1996. Administrative Science Quarterly 46 (3), 443–475.

Henisz, W.J., Zelner, B.A., 2001. The institutional environment for telecommunications investment. Journal of Economics and Management Strategy 10 (1), 123–147.

Huntington, S.P., 1968. Political Order in Changing Societies. Yale University Press, New Haven and London.

Huntington, S.P., 1991. The Third Wave: Democratization in the late Twentieth Century. University of Oklahoma Press, Norman.

Jaffe, A.B., 2000. The US patent system in transition: policy innovation and the innovation process. Research Policy 29 (4–5), 531–557.

Jones, M., 1995. A guide to the electoral systems of the Americas. Electoral Studies 14 (1), 5–21.

La Porta, R., Lopez-de-Silanes, F., Shleifer, A., Vishny, R.W., 1999. The quality of government. The Journal of Law, Economics, and Organization 15 (1), 222–279.

LeBlang, D.A., 1996. Property rights, democracy and economic growth. Political Research Quarterly 49 (1), 5–26.

LeBlang, D.A., 1997. Political democracy and economic growth: pooled cross-sectional and time-series evidence. British Journal of Political Science 27 (3), 453–466.

Lee, J.Y., Mansfield, E., 1996. Intellectual property protection and US foreign direct investment. Review of Economics and Statistics 78 (2), 181–186.

Levine, R., Renelt, D., 1992. A sensitivity analysis of cross-country growth regressions. American Economic Review 82 (4), 942–963.

Long, J.S., Freese, J., 2001. Regression Models for Categorical Dependent Variables Using Stata. Stata Press, Texas.

Mainwaring, S., Shugart, M.S., 1997. Presidentialism and Democracy in Latin America. Cambridge University Press, New York.

Mejia Acosta, A., Katz, A., 2001. Ecuador: the search for democratic governance. http://www.aceproject.org/main/english/es/esy_ec.htm (access date 12 October 2003).

Mills III, J.G., et al., 2002. Patent Law Fundamentals, second ed. Thomson West, New York.

Mowery, D.C., Ziedonis, A.A., 2002. Academic patent quality and quantity before and after the Bayh-Dole act in the United States. Research Policy 31 (3), 399–418.

Nelson, R.R. (Ed.), 1993. National Innovation Systems: A Comparative Analysis. Oxford University Press, New York.

North, D.C., 1981. Structure and Change in Economic History. Norton, New York.

North, D.C., Weingast, B., 1989. Constitutions and commitment: the evolution of institutions governing the public choice in

seventeenth-century England. Journal of Economic History 49, 803–832.
Olson, M., 1993. Dictatorship, democracy, and development. American Political Science Review 87, 567–576.
Park, W.G., Ginarte, J.C., 1997. Intellectual property rights and economic growth. Contemporary Economic Policy 15 (3), 51–61.
Payne, A., Sutton, P. (Eds.), 1993. Modern Caribbean Politics. John Hopkins University Press, Baltimore.
Przeworki, A., et al., 2000. Democracy and Development: Political Institutions and Well-Being in the World 1950–1990. Cambridge University Press, Cambridge.
Przeworski, A., Limongi, F., 1993. Political regimes and economic growth. The Journal of Economic Perspectives 7 (3), 51–69.
Remmer, K., 1989. Military Rule in Latin America Boston. Unwin Hyman.
Riker, W.H., 1986. Duverger's law revisited. In: Lijphart, A., Grofman, B. (eds.), Electoral Laws, Their Political, Consequences. Agathon Press, New York, NY.
Romer, P.M., 1990. Endogenous technological-change. Journal of Political Economy 98 (5), S71–S102.
Schofer, E., Ramirez, F.O., Meyer, J.W., 2000. The effects of science on national economic development, 1970–1990. American Sociological Review 65 (6), 866–887.
Sherry, E.F., Teece, D.J., 2004. Royalties, evolving patent rights, and the value of innovation. Research Policy 33 (2), 179–191.
Shugart, M.S., Carey, J.M., 1992. Presidents and Assemblies: Constitutional Design and Electoral Dynamics. Cambridge University Press, Cambridge England; New York.
Steil, B., Victor, D.G., Nelson, R.R. (Eds.), 2002. Technological Innovation and Economic Performance. Princeton University Press, Princeton, New Jersey.
Taylor, M.Z., 2004. Empirical evidence against varieties of capitalism's theory of technological innovation. International Organization 58 (3), 601–631.
Tsebelis, G., 1995. Decision making in political systems: Veto Players in presidentialism, parliamentarism, multicameralism and multipartyism. British Journal of Political Science 25 (3), 289–325.
Tsebelis, G., 2002. Veto Players: How Political Institutions Work. Princeton University Press, Princeton, New Jersey.
Tsebelis, G., Money, J., 1997. Bicameralism. Cambridge University Press, Cambridge England; New York.
USPTO, U.S. Patent and Trademark Office, 2003. Number of Utility Patent Applications Filed in the United States, By Country of Origin, Calendar Years 1965 to Present. http://www.uspto.gov/web/offices/ac/ido/oeip/taf/appl_yr.htm.
Waguespack, D.M., Birnir, J.K., 2005. Foreignness and the diffusion of ideas. Journal of Engineering and Technology Management 22 (1–2), 31–50.
WIPO, World Intellectual Property Organization, 2004. Industrial Property Statistics. http://www.wipo.int/ipstats/en/statistics/patents/index.html.