Relationship Between the Strength of Intellectual Property Rights and Innovation

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ABSTRACT

FRANK C JONES: Relationship Between the Strength of Intellectual Property Rights and Innovation
(Under the direction of Robert Jenkins)

This paper discusses the relationship between the strength of intellectual property rights and innovation. It is commonly held that increasing the strength of intellectual property rights will lead to increased innovation. However, this relationship cannot be infinite in nature, instead this paper explores the possibility of a parabolic or logarithmic relationship between these variables. The findings of this study are inconclusive with regard to this relationship, but there is strong evidence the Hofstede Cultural Dimensions cannot be used in place of country indicators when measuring their impact on innovation (GII) or the strength of intellectual property rights (IPR). Additionally, concrete finding in this area were hindered by lacking time series data for innovation and the strength of intellectual property rights. As these terms become better defined and studied, further study of this relationship should be possible with new data.

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ABBREVIATIONS

GII The Global innovation Index (GII) created by INSEAD. This index measures the inputs and outputs of the innovation process and considers the tangible as well as intangible assets that are involved in the innovation process.

IDV Individualism vs Collectivism, One of the Hofstede Cultural Dimensions which measures the propensity for a culture to be more individualistic or collectivist. Ranked on a scale of 1 (most collectivist) to 100 (most individualistic).

IPR The primary independent variable of interest, taken from International Property Rights Index (IPRI). Specifically, a single component of this index, rankings for the Intellectual Property Rights Score.

IVR Indulgence vs Restraint, One of the Hofstede Cultural Dimensions which measures the propensity for a culture to be more indulgent or restrained. Ranked on a scale of 1 (most restrained) to 100 (most indulgent).

LTO Long-term Orientation vs Short-term Orientation, One of the Hofstede Cultural Dimensions which measures the propensity for a culture to be more long-term oriented or short-term orientated. Ranked on a scale of 1 (most short-term orientated) to 100 (most long-term orientated).

MAS Masculinity vs Femininity, One of the Hofstede Cultural Dimensions which measures the propensity for a culture to be more masculine or feminine. Ranked on a scale of 1 (most feminine) to 100 (most masculine).

PDI Power Distance Index, One of the Hofstede Cultural Dimensions which measures the propensity for a culture to be more or less accepting of differences in power distribution. Ranked on a scale of 1 (least accepting of differences in power distribution) to 100 (most accepting of differences in power distribution).

UAI Uncertainty Avoidance Index, One of the Hofstede Cultural Dimensions which measures the propensity for a culture to be more likely to avoid uncertainty. Ranked on a scale of 1 (least likely to avoid uncertainty) to 100 (most likely to avoid uncertainty).

Introduction

Since its beginning in the United Kingdom during the eighteenth century, intellectual property rights protections have been consistently expanding. This is not to say they were more restricted prior to the passage of the Statute of Anne. On the contrary, full monopolistic rights over the publication and distribution of various works of art and literature were granted by the monarchy. This was the reason the Statute of Ann was created as a way to restrict these rights and allow artistic works to pass into the public domain. However, the restrictions which were put in place by the Statute of Anne in the UK, and later exported around the world, have been under constant attack by various rights holders seeking to strengthen the protection of their intellectual property rights. One of the strongest justifications given for this strengthening of intellectual property rights is the correlation with increased innovation. However, it is my hunch that strengthening intellectual property rights protections will only increase innovation to a certain extent. Once some threshold is reached, in terms of intellectual property rights protections, there will be a precipitous decline in innovation as access to the marketplace is disrupted. For this reason, I propose a parabolic relationship between strengthening intellectual property rights protections and innovation. However, the data and analysis from this study neither confirms nor rejects this possibility. Another model which would allow for property rights to increase to some extent before having little impact on innovation would be a logarithmic model. The data and analysis from this study also does not confirm nor reject the possibility of a logarithmic function.

While exploring this data I tested the hypothesis that country indicators could be substituted by the Hofsted Cultural Dimensions. The results show this is completely untrue and country indicators are significantly better indicators of both innovation and intellectual property rights protections than the Hofstede Cultural Dimensions.

Theory

It is my assertion that strengthening intellectual property rights protections will lead to greater innovation in some cases while reducing innovation in others. The reason for this is that strong intellectual property rights protections are needed to ensure that large-scale innovators will profit from their investment. Without intellectual property rights protections, it would be easier to copy the work of others rather than create innovative products. However, if intellectual property rights protections are too strong, the barriers to entry in the marketplace will discourage innovation. For this reason, when intellectual property rights protections are too strong there will be a decline in innovation. Of course it must be noted that some innovation will occur regardless of the strength of intellectual property rights protections. This is because some people will innovate regardless of profit (hobbyists) or legal implications (pirates).

Implications of Using Indexes and Ranked Variables

Although using an index can generate noise in a data set, it also helps to approximate variables which cannot be measured directly. This is the reason why the Organization for Economic and Community Development (OECD) and the United States Department of Commerce (DOC) have such complicated and multifaceted definitions of innovation as shown below. Researches of innovation have commonly used indexes to approximate the values of each facet of their definition of innovation and to create ranked comparisons between observations.

> - In OECD's Oslo Manual, which provides guidelines for collecting and interpreting innovation data, innovation is defined as the implementation of products or production and delivery processes with new or significantly improved characteristics. The third edition of the Oslo Manual extends the definition to include new organizational methods in business practices, workplace organization, or external relations (OECD 2005).
> - DOC defines innovation as the design, development, and implementation of new or altered products, services, processes, organizational structures, and business models to create value for the customer and financial returns for the firm practicing innovation (DOC 2008).
>
> (Rose, S., Shipp, S., Lal, B., & Stone, A. (2009) p.2)

As the authors of "Frameworks for Measuring Innovation: Initial Approaches" point out, innovation is made up of tangible and intangible inputs. The tangible inputs, such as "information and communications technology infrastructure, production materials, production machinery, and facilities" (Rose, S., Shipp, S., Lal, B., & Stone, A. (2009) p.3) are more easily measured. On the other hand, the intangible inputs, such as "patents, databases, R&D progress, organizational processes, and the knowledge & skills of the labor force" (Rose, S., Shipp, S., Lal, B., & Stone, A. (2009) p.3) require individual indexes to approximate their value. These individual indexes are then weighted against one another and compiled into a composite index with the tangible inputs to create an innovation index. For this reason, a composite index is the best way to account for all the inputs of innovation and produce a quantitative figure for comparison between observations.

Using a more specific industry index to measure innovation may provide a more precise measure of innovation within a specific industry. However, the lack of an industry specific index for the strength of intellectual property rights protection means this data cannot be used in this study. Additionally, an index used to measure innovation within one industry cannot necessarily be used to measure innovation in another industry. For example, innovation in science and technology is heavily determined by patent applications and holdings. Whereas the banking and fashion industries rely very little on patents as a measure of innovation. There is at least one organization, Britain's National Endowment for Science Technology and the Arts (NESTA), which is working to develop an index to assess the state of innovation within specific industries. (Beck, E. (2008) p.1) Their index is designed for modern service based industries, which rely heavily on intangible inputs, rather than the old standard which focused on tangible inputs of industrial economies. Unfortunately, they just launched a pilot version in November of 2009 and there is not nearly enough data to use this index in my study today. Measuring innovation and the strength of intellectual property rights protections are both very new topics of study, as such, they are both lacking in data sources. Those indexes which measure innovation within a specific industry tend to do so within a specific country as well. I have yet to find any industry specific index which is international in scope and different indexes within different countries are not comparable due to differences in model specification for each index.

This lack of available data for measuring innovation across countries has required me to use a ranked variable for the measure of innovation in this study. This means that comparisons cannot be made between years in the panel since the results are relative to the rank of one country compared to the others in the study for a given year. Additionally, my dependent variable is not capable of taking on all possible values because it is ranked. This is because there can only be one country in first place, one in second, one in third, and so on. For this reason, the results are relative to the other countries in the study. For example, a one unit increase in the strength of intellectual property rights protections will result in some increase or decrease in innovation relative to the other countries in the study.

Definitions

This section will explain why it's hard to define these terms, who is working on them, and outline the current progress in defining innovation and intellectual property rights protections.

Defining Innovation

The topic of innovation is a very hot buzz word right now and there is no clear definition of this term, let alone a consensus on how it should be measured. There are several interesting projects currently working to develop better measurements of innovation, one of which proposes a custom index of innovation within each industry sector of interest. Although this may provide more accurate measures of innovation for the individual sectors, it does not provide for comparison between sectors.

The OECD has updated and adapted its definition of innovation over the years from one restricted in scope to apply only to technological innovation to now include service industry innovations. The OECD defined innovation in 2005 as:

> *"An innovation is the implementation of a new or significantly improved product (good or service), a new process, a new marketing method, or a new organizational method in business practices, workplace organization, or external relations."*
>
> (OECD/EC, 2005, also known as the Oslo Manual 2005)

Then in 2010, the OECD updated their definition in include:

> *"consideration being given to extending the methodology to public sector innovation and social innovation so as to correspond to the reality of innovation today"*
>
> (OECD, 2010)

Similarly, the United Nations conference on Trade and Development (UNCTAD) defined innovation in 2007 as:

> *"Innovation also occurs when a firm introduces a product or process to a country for the first time. It occurs when other firms imitate this pioneering firm. Moreover, it occurs when the initial or follower firms make minor improvements and adaptations to improve a product or production process, leading to productivity improvements. In short, innovation occurs through 'creative imitation'."*
>
> (UNCTAD, 2007, p. 6)

The working definition of innovation used in this paper is:

> *Innovation is the capacity and practice of expanding and developing resources and ideas within a specific field or region of interest. This can include the creation of a new product, streamlining a process, or the application of a new or existing conceptual model in a different way.*

This definition combines the updated definitions and recommendations of the OECD, the US DOC, and the UNCTAD into a single concise statement which addresses all areas of innovation. The inputs of the innovation process make up the capacity for innovation, while the practice of innovation deals with the outputs of the process. Innovation includes improving or expanding on the resources already available in addition to developing future resources. However, innovation doesn't only deal with tangible resources. The innovation process also requires some assessment of intangible resources in the form of intellectual property, education, skills, or other manifestations of ideas. Further, innovation is specific to a particular field or region. That is to say that a product or process may not be particularly novel, rather its application to a particular area may be the innovation. These ideas are further explained by the examples in the second part of the definition used by this paper.

It is particularly important to note the differences in innovation between industries as well as the methods used to protect such innovations. Within the fields of science and technology, patents tend to be the legal record used to secure ownership of an idea or process. However, the business world protects its innovative processes through the creation of private access databases, non-compete agreements, and other forms of safeguards against corporate espionage. Similarly, the fashion industry continually develops new trends and innovative designs in order to stay one step ahead of imitators and producers of knock off merchandise.

This study is looking to compare innovation between countries and therefore needs an index which forms a composite of multiple industries for comparison among several countries. The most appropriate index currently available is the Global innovation Index (GII) created by INSEAD. This index measures the inputs and outputs of the innovation process and considers the tangible as well as intangible assets that are involved in the innovation process. This index expands and builds upon the recommendations laid out in “Frameworks for Measuring Innovation: Initial Approaches” (Rose, S., Shipp, S., Lal, B., & Stone, A. (2009)).

Defining Intellectual Property Rights Protections

Intellectual property rights were created in the UK through the passage of the Statute of Anne in 1710. However, the concept of intellectual property and, more specifically, copyright has changed over the years.

> “In the last three hundred years, we have come to apply the concept of "copyright" ever more broadly. But in 1710, it wasn't so much a concept as it was a very particular right. The copyright was born as a very specific set of restrictions: It forbade others from re- printing a book. In 1710, the "copy-right" was a right to use a particular machine to replicate a particular work. It did not go beyond that very narrow right. It did not control any more generally how a work could be used. Today the right includes a large collection of restrictions on the freedom of others: It grants the author the exclusive right to copy, the exclusive right to distribute, the exclusive right to perform, and so on.” (Lessig, p83)

These rights were granted to ensure that individuals (people or corporations) who create new products or ideas should be permitted to benefit from those creations. This conception of intellectual property rights presumes that one individual has played a sufficient role in the creation of a product or idea such that they should be granted control over the use of that property. Legal guidelines are then setup to ensure some level of control over that property for some time allowing the rights holder to profit from their work. The strength of these intellectual property rights protections is then determined by the restrictiveness of these laws and the term of their application.

Strengthening of Intellectual Property Rights

Two of the more well known applications of past intellectual property rights law in the United States involves Walt Disney, Mickey Mouse, and the fairy tales of the Brothers Grimm. When speaking of these innovations in entertainment which were created by Walt Disney, Dr. Lessig states,

> "Sometimes this borrowing was slight. Sometimes it was significant. Think about the fairy tales of the Brothers Grimm. If you're as oblivious as I was, you're likely to think that these tales are happy, sweet stories, appropriate for any child at bedtime. In fact, the Grimm fairy tales are, well, for us, grim. It is a rare and perhaps overly ambitious parent who would dare to read these bloody, moralistic stories to his or her child, at bedtime or anytime." (Lessig, p24)

You see, Mickey Mouse was based on Steamboat Willie, as most people are aware. However, most people do not know that Steamboat Willie was created as a parody of the silent film "Steamboat Bill, Jr" which debuted first. "Steamboat Willie is a direct cartoon parody of Steamboat Bill, and both are built upon a common song as a source." (Lessig, p24) Furthermore, the invention of synchronized sound with silent films was originally created for the performance of "The Jazz Singer" and copied by Walt Disney. "Disney was always parroting the feature-length mainstream films of his day." (Lessig, p24)

Today, international intellectual property rights laws have created a scenario in which, it is easier for competing telecommunication companies to buy patents and use them to keep competitors out of the market place, rather than develop superior technologies. This has lead to a vicious cycle of lawsuits between the largest companies in the information technology and telecommunications industries.

> “One problem with nuclear attacks, even those of the metaphoric variety, is that the targets may retaliate with nukes of their own. That is precisely what has happened. For every Apple allegation, a rival has countered that Apple is not as uniquely innovative as Jobs liked to boast. To the contrary, Samsung, Motorola, and others insist that some of Apple’s most valuable patents—such as those protecting the minimalist design of the iPhone and iPad—were never valid in the first place.” (Barrett, p2)

Each side claims their intellectual property rights were violated when a competitor develops a product with similar characteristics to their own. Walt Disney would have never gotten away with developing the Mickey Mouse character which was so closely related to Steamboat Bill. Furthermore, rewriting the Grimm fairy tales while still using the same characters and titles would have never been allowed under today's intellectual property rights protections. This is due, in part, to the difference between the formal rights granted under current intellectual property rights law and the functional rights which can actually be exercised by innovators. Although a particular use of intellectual property may be strictly legal, there is still a swarm of lawyers at the ready to bring a lawsuit against anyone using the intellectual property owned by a major corporation for any reason they take offense to. This creates a schism between the formal rights laid out in the law and the functional rights exercised by the people.

To highlight a future application of strengthening intellectual property rights protections, I'd like to introduce the topic of patenting DNA. “In a closely watched case, a federal appeals court ruled on [July 29, 2011] that genes can be patented, overturning a lower court decision that had shocked the biotechnology industry.” (Pollack, p1) The argument was that DNA which is isolated from the body is “markedly different” from that which is inside the chromosomes in the body. This is the legal loophole being used to avoid complications with patenting human life.

> “Critics say it is unethical to patent something that is part of the human body or the natural world. Some also say that the cost of testing might be reduced if companies did not hold testing monopolies because of their patents. Myriad, which holds the patents on the genes called BRCA1 and BRCA2 with the University of Utah Research Foundation, charges more than $3,000 for its breast cancer risk test.” (Pollack, p2)

We are rapidly entering a world of biotechnologies and the decisions we make regarding the application of intellectual property rights protections in these areas can have long reaching ramifications. As one of the judges in this case put it,

> “Judicial restraint is particularly important here because an entire industry developed in the decades since the Patent Office first granted patents to isolated DNA,” Judge Moore wrote. “Disturbing the biotechnology industry’s settled expectations now risks impeding, not promoting, innovation.” (Pollack, p3)

We already allow biotechnology companies to hold patents on specific genes when they are removed from the body and the process used for testing those genes. This means that patients may be barred access to care, not because the facilities are not available, but due to a dispute over the ownership of the method used to diagnose and treat the patient.

The constant expansion of intellectual property rights protections, lengthening of term limits for patents, and the monopolistic control granted to patent holders causes a reduction in the number of participants in the marketplace. This is due to the restrictions imposed by the law in the form of reductions in formal rights and limitations placed on functional rights. As intellectual property rights are strengthened, fewer and fewer people are granted access to the raw materials of innovation, intellectual property found in the public domain and fair use.

Data and Methods

Data for innovation and the strength of intellectual property rights protections has been hard to come by and a review of the literature shows why. Both of these terms are extremely hard to define and even more complicated to measure. A working definition for innovation could be the propensity for generating new and profitable products or ideas. While a working definition for the strength of intellectual property rights protections could be the ability to secure and defend profits for the originators of innovative products or ideas. I have settled on the Global Innovation Index (GII) and the International Property Rights Index (IPRI) to measure each of these variables as they are the most frequently cited data sources used by other scholars studying innovation and property rights. This is combined with the Hofstede Cultural Dimensions Index to control for cultural differences in the conception of intellectual property and innovation.

After combining these data sets and removing countries and years for which data is not provided by all three of these indexes, I am left with a complete time series panel of eight variables for fifty-six countries over three years. Each of these variables, with the exception of GII, appear to be normally distributed around the mean which is required for ordinary least squared regression (OLS). Other assumptions of OLS include correct specification, exogeneity, absence of multicollinearity, homoscedasticity, and nonautocorrelation. For a summary of the tests performed for each of these assumptions, see Appendix 2. Since I am dealing with time series data, autocorrelation is expected.

	GII	IPR	PDI	IDV	MAS	UAI	LTO	IVR
Min.	-124.00	2.10	11.00	12.00	5.00	8.00	13.00	0.00
1st Qu.	-58.00	5.00	40.00	27.00	38.00	50.00	32.00	29.00
Median	-35.00	6.10	63.00	48.00	50.00	70.00	39.00	48.00
Mean	-39.95	6.30	57.95	48.33	49.29	66.80	49.46	47.20
3rd Qu.	-16.00	7.90	70.00	69.00	64.00	86.00	62.00	65.00
Max.	-1.00	8.70	104.00	91.00	110.00	112.00	88.00	100.00

Illustration 1: Distribution of the Variables

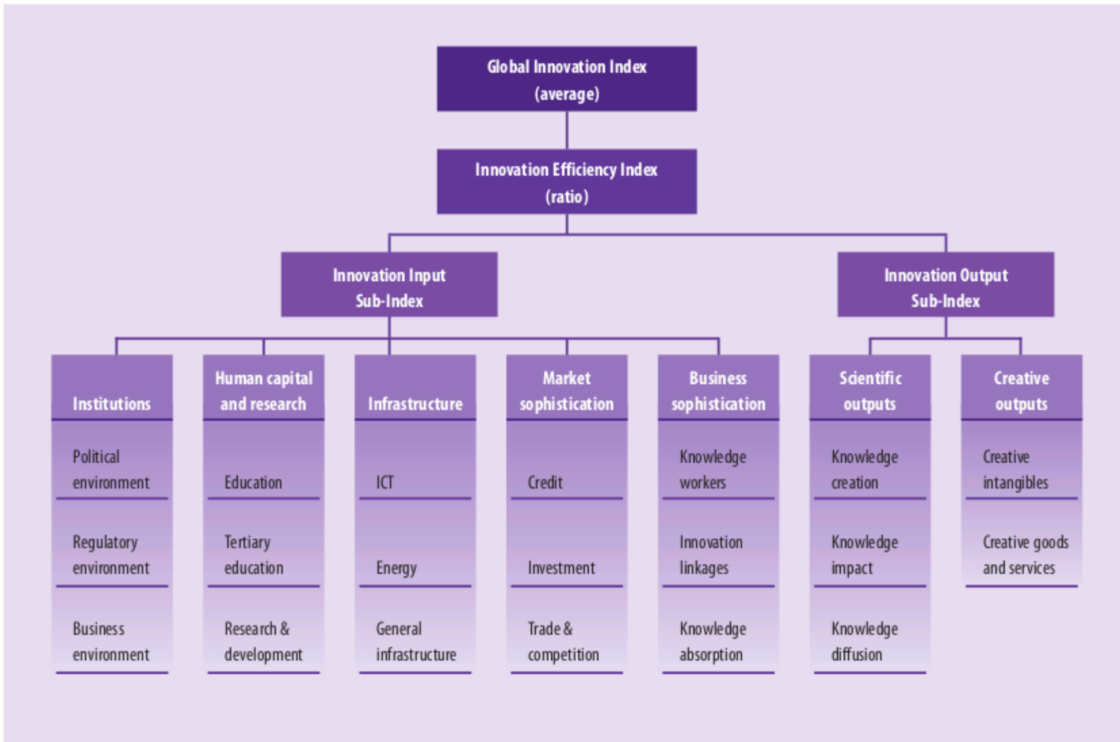
In exploring the question of a linear, parabolic, or logarithemic relationship between the strength of intellectual property rights protections and innovation I used OLS as well as random-effects models. This allowed me to calculate beta estimates and t-scores for IPR, IPR^2, and log(IPR).

Global Innovation Index

The dependent variable for this study is taken from the Global Innovation Index (GII) and is comprised of eighty variables which are combined to create the index. These variables include general statistics, surveys, and other indexes. Due to changes in the model specification from 2010 to 2011, this variable is a ranked index. Using the actual index scores would have been preferred, however the changes have resulted in the inability to compare the scores from 2009 & 2010 with those of 2011. Therefore, the scale is from 1 to the number of countries scored in a given year. Additionally, since this is a rank indicator, I had to invert the scores in order to calculate the proper slope in the models[1].

The global innovation index is comprised of two sub-indexes for innovation inputs and innovation outputs. Each of those sub indexes are built from a collection of other indicators, some of which are indexes themselves. Each pillar in a sub-index has a score calculated from its constituent variables using a weighted average. The value of each sub-index is calculated using a simple average of it's pillars. These sub-index values are then used to calculate the global innovation index using a simple average of the two sub-indexes. Additionally, an innovation efficiency index is calculated based on the ratio between the innovation input sub-index and the innovation output sub-index. (Global Innovation Index 2011, p.8)

1 Given a ranked scale of 1 – 100, increasing down the scale actually decreases innovation. The simplest way to solve this is to invert the scale to be -1 – -100 in order to calculate the appropriate slope.



(Global Innovation Index 2011, p.8)
Illustration 2: Global Innovation Index

International Property Rights Index

The primary independent variable of interest is taken from International Property Rights Index (IPRI). Specifically, I used a single component of this index, rankings for the Intellectual Property Rights Score. “The IPR component evaluates the protection of intellectual property. In addition to an opinion-based measure of the protection of IP, it assesses protection of two major forms of intellectual property rights (patents and copyrights) from de jure and de facto perspectives, respectively.” (International Property Rights Index: 2011 Report) These are scored on a scale of 0 through 10 and then combined to create the Intellectual Property Rights component score.

Hofstede Cultural Dimensions

The remaining independent variables were taken from the Hofstede Cultural Dimensions Index. I am using this index to control for confounding variables which are caused by cultural differences that lead to variance in the conception of innovation, existence of intellectual property as an individual good, and the perceived utility of protecting such property. These variables include Power Distance Index (PDI), Individualism vs Collectivism (IDV), Masculinity vs Femininity (MAS), Uncertainty Avoidance Index (UAI), Long-term Orientation vs Short-term Orientation (LTO), and Indulgence vs Restraint (IVR). Each of these is scored on a scale of 1 – 100.

In order to test the ability of the Hofstede Cultural Dimensions good indicators of the strength of intellectual property rights, in addition to innovation, I used OLS and random-effects models. Specifically, models A through D and 10 through 14 address these questions directly. This will be demonstrated if the models using the Hofstede Cultural Dimensions are statistically significantly different from those using the country indicators, while also providing greater explanations for the variance in the dependent variable as evidenced by larger values for R-squared.

The question of the ability to use Hofstede Cultural Dimensions as better indicators of innovation than comparison with other countries was tested using OLS. For this question, models A through D are used. Model A uses only intellectual property rights protections (IPR) as its independent variable. Models B and C add to this first model by including the Hofstede Cultural Dimensions and country indicators, respectively. Model C, then includes both the Hofstede Cultural Dimensions and country indicators in addition to IPR as its independent variables. This allows me to compare the models and determine which provides the best fit as well as calculate an F-statistic to determine if there is any statistically significant difference between the models.

Hypotheses and Research Questions

Based on the theory I've outlined I expect to find a parabolic relationship between the strength of intellectual property rights protections and innovation. Additionally, I expect to find a positive relationship between individualism and the strength of intellectual property rights protections as well as innovation. Also, I suspect there will be stronger intellectual property rights protections in countries with high scores on the Power Distance Index (PDI), Uncertainty Avoidance Index (UAI), Long-term Orientation vs Short-term Orientation (LTO), and Indulgence vs Restraint (IVR). Lastly, I expect knowing the Hofstede Cultural Dimensions of a country is at least as significant in determining the level of innovation within that country than comparing the country to others. That is, my hypothesis suggests the Hofstede Cultural Dimensions will at least as statistically significant as country indicators when predicting innovation and intellectual property rights protections.

1. Are the Hofstede Cultural Dimensions an adequate substitute for country indicators for innovation?
2. Is the relationship between the strength of intellectual property rights protections and innovation linear, parabolic, or logarithmic?
3. Are the Hofstede Cultural Dimensions an adequate substitute for country indicators for the strength of intellectual property rights?

Country vs Hofstede

Model	Equation
A	$GII=\beta_0+\beta_1*IPR+\varepsilon$
B	$GII=\beta_0+\beta_1*IPR+\beta_2*PDI+\beta_3*IDV+\beta_4*MAS+\beta_5*UAI+\beta_6*LTO+\beta_7+IVR+\varepsilon$
C	$GII=\beta_0+\beta_1*IPR+\beta_{2-58}*Country_{1-56}+\varepsilon$
D	$GII=\beta_0+\beta_1*IPR+\beta_2*PDI+\beta_3*IDV+\beta_4*MAS+\beta_5*UAI+\beta_6*LTO+\beta_7+IVR+\beta_{8-64}*Country_{1-56}+\varepsilon$

Table 1: Equations for Models A - D

	Model A	Model B	Model C	Model D
R-squared	0.7836	0.8652	0.9575	0.9575
Adj. R-squared	0.7822	0.8587	0.932	0.932
F-statistic	546.8	132.9	37.55	37.55
df	1 & 151	7 & 145	57 & 95	57 & 95
P-value	2.20E-016	2.20E-016	2.20E-016	2.20E-016

Table 2: Country vs Hofstede Models

	AvB	AvC	AvD	BvD	CvD
F-statistic	14.625091	6.942158	6.942158	4.127511	na
df	6 & 145	56 & 95	56 & 95	50 & 95	na
CritVal	2.1616	1.4668	1.4668	1.4837	na

Table 3: Country vs Hofstede F-Tests

ANOVA	AvB	BvC	CvD
F-statistic	30.3975	4.1275	na
P-value	2.20E-016	1.45E-009	na

Table 4: Country vs Hofstede ANOVA

Table 2 shows that, although Model B does improve upon Model A by adding the Hofstede Cultural Dimensions to the model, Model C and Model D account for much more of the variance in innovation (GII) through the inclusion of the country indicators.

One indicator of this is the higher R-squared values for Model C and Model D when compared with Model B.

The calculated F-statistics in Table 3 further confirm that the models which include the country indicators account for a statistically significantly larger portion of the variance in GII. Comparing Model A with Model B shows a marked improvement by including the Hofstede Cultural Dimensions over the model relying only on the Intellectual Property Rights Index (IPR) data. This is also true of the comparison between Model A and Model C, which expands on the IPR data by including the country indicators. Furthermore, Model D, which includes both the country indicators and the Hofstede Cultural Dimensions, shows a marked improvement over Model A. In each case we reject the null hypothesis that the two models are equal in favor of the alternative hypothesis that the second model provides a better fit. This leads us to compare Model B, which includes the IPR data and the Hofstede Cultural Dimensions, with Model D, which expands upon the IPR data with the country indicators and the Hofstede Cultural Dimensions. This test shows that the model including the country indicators in addition to the Hofstede Cultural Dimensions is statistically significantly superior to the model lacking the country indicators. We now have evidence that the country indicators can explain more of the variance in GII, but we still need to test if the Hofstede Cultural Dimensions add anything to this analysis. For this reason, we compare Model C, the one using the IPR data and country indicators, with Model D, the one including the IPR data in addition to the country indicators and the Hofstede Cultural Dimensions. Since the R-squared, Adjusted R-squared, F-statistic, degrees of freedom, and P-value for Model C is identical to that of Model D, these models are identical with regard to the F-test. This shows that the Hofstede Cultural Dimensions account for no part of the variance in GII which is not already explained by the country indicators. This is due to multicollinearity between the Hofstede Cultural Dimensions and the country variables.

This is further tested using Analysis of Variance (ANOVA) in Table 4. First, we see the comparison between Model A and Model B which shows that Model B is statistically significantly different from Model A. Looking back at the R-squared values from Table 2, we can conclude that Model B is superior to Model A with regard to explaining the variance in innovation (GII). Next, we have the comparison between Model B and Model C. This shows they are statistically significantly different, and another glance to Table 2 confirms that Model C provides the better fit when compared with Model B. Lastly, we look at Model C and Model D only to find they are identical with regard to ANOVA. Since the difference between these models is the inclusion of the Hofstede Cultural Dimensions in Model D and their exclusion in Model C, we can conclude the Hofstede Cultural Dimensions provide no additional explanation for the variance in GII which is not already covered by the country indicators. We can now answer my first research question and claim the Hofstede Cultural Dimensions are not an adequate substitute for country indicators for innovation. This is why the other models of GII used in this paper make use of the country indicators over the Hofstede Cultural Dimmensions.

OLS Models

Model	Equation
1	$GII=\beta_0+\beta_1*IPR+\beta_{2-58}*Country_{1-56}+\varepsilon$
2	$GII=\beta_0+\beta_1*IPR+\beta_2*IPR^2+\beta_{3-59}*Country_{1-56}+\varepsilon$
3	$GII=\beta_0+\beta_1*\log(IPR)+\beta_{2-58}*Country_{1-56}+\varepsilon$
4	$GII=\beta_0+\beta_1*IPR+\varepsilon$ Random Effects (Between Effects)
5	$GII=\beta_0+\beta_1*IPR+\beta_2*IPR^2+\varepsilon$ Random Effects (Between Effects)
6	$GII=\beta_0+\beta_1*\log(IPR)+\varepsilon$ Random Effects (Between Effects)
7	$GII=\beta_0+\beta_1*IPR+\varepsilon$ Fixed Effects (Within Effects)
8	$GII=\beta_0+\beta_1*IPR+\beta_2*IPR^2+\varepsilon$ Fixed Effects (Within Effects)
9	$GII=\beta_0+\beta_1*IPR+\varepsilon$ Fixed Effects (Within Effects)
10	$IPR=\beta_0+\beta_1*IDV+\varepsilon$
11	$IPR=\beta_0+\beta_1*PDI+\beta_2*IDV+\beta_3*LTO+\beta_4*IVR+\varepsilon$
12	$IPR=\beta_0+\beta_{1-56}*Country_{1-56}+\varepsilon$
13	$IPR=\beta_0+\beta_1*PDI+\beta_2*IDV+\beta_3*MAS+\beta_4*UAI+\beta_5*LTO+\beta_6*IVR+\varepsilon$
14	$IPR=\beta_0+\beta_1*PDI+\beta_2*IDV+\beta_3*MAS+\beta_4*UAI+\beta_5*LTO+\beta_6*IVR+\beta_{7-63}*Country_{1-56}+\varepsilon$

Table 5: Equations for Models 1 - 14

ANOVA	13
F-statist	45.334
P-value	20E-016

Table 6.

F-Tests	Fstat	dfNum	dfDen	CritVal
1v2	1.5968674	1	94	3.9423033
1v3	Inf	0	95	NA
4v5	3.7317661	1	150	3.9042019
4v6	-Inf	0	151	NA
7v8	2.5481927	1	150	3.9042019
7v9	Inf	0	151	NA
10v11	17.5312	3	148	2.6657292
10v13	11.711926	5	146	2.2761691
11v13	2.463089	2	146	3.0580504
12v14	Inf	0	96	NA
13v14	45.334037	50	96	1.4823887

Table 7: Models 1 - 14 F-Tests

Model	Coefficients	Estimate	Std. Error	T-value	Significance Level	P-value	95% CI	
1	IPR	10.4251	3.2421	3.216	**	99.94%	10.167463	10.682737
2	IPR	24.9026	11.9038	2.092	*	98.18%	23.956653	25.848547
2	I(IPR^2)	-1.2311	0.9742	-1.264		89.69%	-1.3085158	-1.1536842
3	log(IPR)	57.8105	15.9343	3.628	***	99.99%	56.544265	59.076735

Table 8: Models 1 - 3 Variables of Interest

Coefficients	Estimate	Std. Error	T-value	Significance Level	P-value	95% CI	
(Intercept)	-137.88438	6.04328	-22.816	***	100.00%	-138.36462	-137.40414
IPR	15.52174	0.94948	16.348	***	100.00%	15.446289	15.597191

Signif. Codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
Total Sum of Squares: 28769
Residual Sum of Squares: 9233.5
R-Squared : 0.67906
Adj. R-Squared : 0.67018
F-statistic: 319.482 on 1 and 151 DF, p-value: < 2.22e-16

Table 9: Model 4

Coefficients	Estimate	Std. Error	T-value	Significance Level	P-value	95% CI	
(Intercept)	-169.41553	18.54913	-9.1333	***	100.00%	-170.88955	-167.94151
IPR	26.96314	6.442	4.1855	***	100.00%	26.45122	27.47506
I(IPR^2)	-0.95363	0.53134	-1.7948	.	96.37%	-0.9958535	-0.9114065

Signif. Codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
Total Sum of Squares: 28963
Residual Sum of Squares: 9069.7
R-Squared : 0.68685
Adj. R-Squared : 0.67338
F-statistic: 164.502 on 2 and 150 DF, p-value: < 2.22e-16

Table 10: Model 5

Coefficients	Estimate	Std. Error	T-value	Significance Level	P-value	95% CI	
(Intercept)	-194.6182	9.4406	-20.615	***	100.00%	-195.36841	-193.86799
log(IPR)	85.822	5.2578	16.323	***	100.00%	85.404184	86.239816

Signif. Codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
Total Sum of Squares: 28070
Residual Sum of Squares: 9026.8
R-Squared : 0.67842
Adj. R-Squared : 0.66955
F-statistic: 318.56 on 1 and 151 DF, p-value: < 2.22e-16

Table 11: Model 6

Coefficients	Estimate	Std. Error	T-value	Significance Level	P-value	95% CI	
IPR	10.4251	3.2421	3.2155	**	99.93%	10.167463	10.682737

Signif. Codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
Total Sum of Squares: 6208
Residual Sum of Squares: 5598.7
R-Squared : 0.098155
Adj. R-Squared : 0.060946
F-statistic: 10.3396 on 1 and 95 DF, p-value: 0.00178

Table 12: Model 7

Coefficients	Estimate	Std. Error	T-value	Significance Level	P-value	95% CI	
IPR	24.90258	11.90383	2.092	*	98.18%	23.95663	25.84853
I(IPR^2)	-1.23109	0.97421	-1.2637		89.68%	-1.3085066	-1.1536734
Signif. Codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 Total Sum of Squares: 6208 Residual Sum of Squares: 5505.1 R-Squared : 0.11322 Adj. R-Squared : 0.06956 F-statistic: 6.00072 on 2 and 94 DF, p-value: 0.0035266							

Table 13: Model 8

Coefficients	Estimate	Std. Error	T-value	Significance Level	P-value	95% CI	
log(IPR)	57.81	15.934	3.628	***	99.99%	56.543789	59.076211
Signif. Codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 Total Sum of Squares: 6208 Residual Sum of Squares: 5452.5 R-Squared : 0.12169 Adj. R-Squared : 0.075561 F-statistic: 13.1627 on 1 and 95 DF, p-value: 0.00046198							

Table 14: Model 9

Models 1 – 3, shown in table 8 (complete OLS models shown in Appendix 1), define the standard OLS model for a linear, parabolic, and logarithmic relationship between the strength of intellectual property right protections (IPR) and innovation (GII).

Model 1 suggests a one unit increase in IPR, on average, is associated with a 10.4251 unit increase in GII rank. This is a linear relationship and only valid within the range of the model which includes values of IPR from 2.1 – 8.7.

Model 2 is a little more difficult to explain since it is modeling a parabolic relationship. As such, the expected change in GII based on a one unit increase in IPR is not constant. This is caused by the non-constant slope of a parabola. For this reason, model 2 is best represented in a chart showing the slope of the line within various intervals of IPR.

IPR	Average	Slope
2 – 8	5	93.7355
9 – 15	12	121.5528
16 – 25	20.5	-6.866475

Table 15: Model 2 Slope of IPR

Within the range of IPR values between 2 – 8, the average here being 5, we expect to find a slope of 93.7355. That is, within this range, a one unit increase in IPR, on average, is associated with a 93.7355 unit increase in GII rank. The first range in table 15, 2 – 8, was selected to match the range within the data set used for this model. The next two ranges, 9 – 15 and 16 – 25, show the apex and negative slope of the parabola. Between IPR values of 9 – 15, the average being 12, we expect to find a one unit change in IPR to be, on average, associated with a 121.5528 unit increase in GII rank. However, the other side of the parabola lies within the range of IPR values of 16 – 25. Within this third range, a one unit increase in IPR would be, on average, associated with a 6.866475 decline in GII rank. The first range is based on the date used to calculate the model and is the only one supported by that data. The second and third ranges are predictions based on the model and are included for illustrative purposes.

Model 3 is the logarithmic model which can easily be interpreted using a trick of dividing the beta estimate by 100 (Studenmund, 2001). Therefore, model 3 holds that a 1% increase in IPR, on average, is associated with a 0.578% increase in GII rank.

Models 4 – 6 are used to test the random effects, sometimes referred to as between effects, of there models. These models are used to explore the result of differences in IPR scores between different states.

Model 4, the linear model, shows evidence that a one unit increase in IPR, on average, is associated with a 15.52174 unit increase in GII rank. Just a before, this is a linear relationship and only valid within the range of the model which includes values of IPR from 2.1 – 8.7. That is, for a given year and the set of countries used in the model, we can expect a one unit change in IPR between countries to be associated with a 15.52174 unit increase in GII rank.

Model 5, being the parabolic model, is associated with different change in GII depending on the value of IPR. This is best represented in the table below.

IPR	Average	Slope
2 – 8	5	110.97495
9 – 24	16.5	185.2660425
25 – 35	30	-49.3728

Table 16: Model 5 Slope of IPR

Within the first range of values, 2 – 8 (those used in the data set), we can expect a one unit increase in IPR to be associated with a 110.97495 unit increase in GII rank. Here too, we are modeling the difference between countries during a given year in the data set. The second range, 9 – 24, is predictive of extending the data and reaching the apex of the parabola. Within this second range we can expect a one unit increase in IPR to be associated with a 185.2660425 unit increase in GII rank, on average. Range three, 25 – 35, is associated with a 49.3728 unit decrease in GII rank, on average, for each one unit increase in IPR.

Model 6, the logarithmic model of the random effects in this data set, is best explained after dividing the beta estimate by 100, as noted above. This model claims a

1% increase in IPR is, on average, associated with a 0.858% increase in GII rank.

Models 7 – 9 test the fixed effects, also referred to as the within effects, of this data set. These models calculate the result of changes within the various countries in the data set over the years included.

Model 7 claims a one unit increase in IPR, on average, is associated with a 10.4251 unit increase in GII rank. This being a fixed effects model, this means that a one unit increase in IPR within a given country in the data set, on average, is associated with a 10.4251 unit increase in GII rank for that same country during the years of this study.

Model 8, the fixed effects parabolic model, here too, is best represented in a table.

IPR	Average	Slope
2 – 8	5	93.73565
9 – 24	16.5	75.7283175
25 – 35	30	-360.9036

Table 17: Model 8 Slope of IPR

We can see that for the first range, 2 – 8, a one unit increase in IPR is, on average, associated with a 93.73565 unit increase in GII rank within the same country over the years of this study. The second range, 9 – 24, claims a one unit increase in IPR is, on average, associated with a 75.7283 unit increase in GII rank within the same country over the years of this study. Lastly, the third range, 25 – 35, shows the negative slope of the parabola. In this range, a one unit increase in IPR is associated, on average, with a 360.90 unit decrease in GII rank within the same country over the years of this study.

Model 9 is the logarithmic model of the fixed effects for this data set. It claims a 1% increase in IPR, on average, is associated with a 0.578% increase in GII rank.

Ordinary Least Squares Regression Results

As the results show (listed in the Models section above), my primary research question was not disproved by the results of this analysis. However, it was also not definitively shown to be true. It seems that there may be a linear, parabolic, or logarithmic relationship between the strength of intellectual property rights protections and innovation. As I had hoped, the model specifying a parabolic relationship does produce a smaller sum of squared errors which results in a larger R-squared. Additionally, the logarithmic function provides an even better visual fit. This means that a parabolic or logarithmic distribution visually appear to provide a better fit with the data, but neither are statistically significantly different from the linear model. This is shown in the first six F-Tests in table 7 on page 22. None of those tests reach the critical value which would be required for statistically significant differences between the linear, parabolic, and logarithmic models. Unfortunately, the visual differences, as shown in the graphs below (Illustration 3), are minimal and not statistically significant.

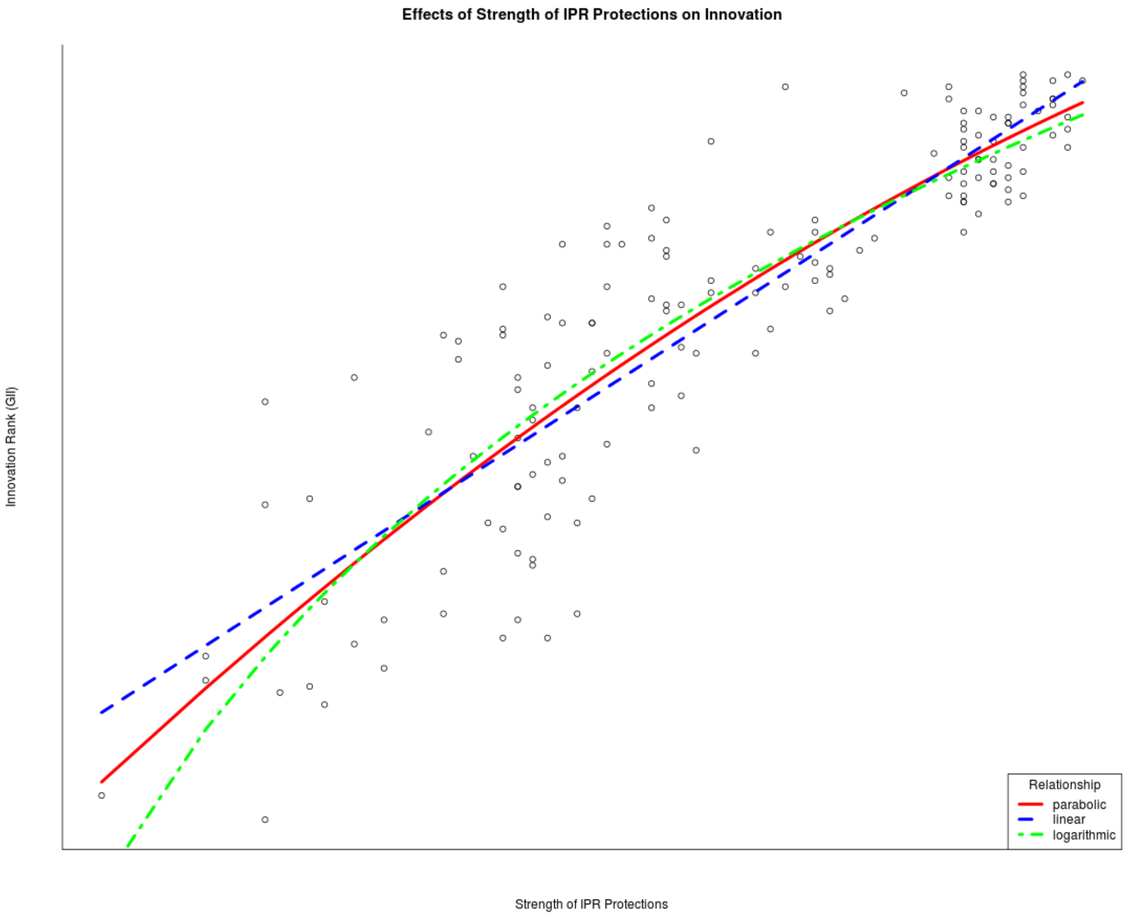


Illustration 3: Effects of Strength of IPR Protections on Innovation - Linear, Logarithmic, or Parabolic

Conclusions

After carefully considering the literature on the topic of intellectual property rights protections and innovation, as well as the data from this paper, I have found no support for accepting or rejecting my theorized parabolic relationship between intellectual property rights and innovation. The models do not show any statistically significant difference between a linear, parabolic, or logarithmic explanation of the data. However, regardless of the shape of the relationship, there is a correlation between the strength of intellectual property rights (IPR) and innovation (GII). Additionally, further study of this topic using additional data as it becomes available may result in support for a linear, parabolic, or logarithmic relationship. Additional data will be available for the Global Innovation Index each year and, thanks to the new methodology used for this index, it will be comparable to last year's scores. This means data will be available to conduct this study without the limitations of a ranked indicator being used as the dependent variable.

This study has also shown that the Hofstede Cultural Dimensions are not a fitting substitute to country indicators with regard to innovation (GII) or intellectual property rights protections (IPR). Several models showed that, not only were the country indicators capable of explaining more of the variance in GII, the Hofstede Cultural Dimensions didn't add anything to the models beyond what was already covered by the country indicators.

Appendix 1 – Model Summaries

```
[1] "Model A"

Call:
lm(formula = GII ~ IPR, data = data)

Residuals:
    Min      1Q  Median      3Q     Max
-35.054  -7.726  -0.720   6.588  33.946

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) -139.4614     4.3984  -31.71   <2e-16 ***
IPR           15.7860     0.6751   23.38   <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 13.74 on 151 degrees of freedom
Multiple R-squared: 0.7836,  Adjusted R-squared: 0.7822
F-statistic: 546.8 on 1 and 151 DF,  p-value: < 2.2e-16

[1] "Model B"

Call:
lm(formula = GII ~ IPR + PDI + IDV + MAS + UAI + LTO + IVR, data = data)

Residuals:
    Min      1Q  Median      3Q     Max
-33.200  -7.739  -0.190   6.084  32.221
```

```
Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -1.289e+02  8.285e+00 -15.554  < 2e-16 ***
IPR          1.500e+01  9.422e-01  15.918  < 2e-16 ***
PDI          4.471e-02  6.345e-02   0.705    0.482
IDV         -4.149e-03  6.463e-02  -0.064    0.949
MAS         -1.923e-01  4.427e-02  -4.345 2.60e-05 ***
UAI         -1.743e-01  3.987e-02  -4.373 2.33e-05 ***
LTO          2.845e-01  5.552e-02   5.124 9.39e-07 ***
IVR         -2.035e-02  5.575e-02  -0.365    0.716
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 11.07 on 145 degrees of freedom
Multiple R-squared: 0.8652,  Adjusted R-squared: 0.8587
F-statistic: 132.9 on 7 and 145 DF,  p-value: < 2.2e-16

[1] "Model C"

Call:
lm(formula = GII ~ IPR + Country, data = data)

Residuals:
    Min      1Q  Median      3Q     Max
-20.9150  -3.0567   0.3758   2.6667  20.9150

Coefficients:
                  Estimate Std. Error t value Pr(>|t|)
(Intercept)        -117.0617    16.6348  -7.037 3.03e-10 ***
IPR                  10.4251     3.2421   3.216 0.001780 **
CountryAustralia     12.9801    12.4751   1.040 0.300756
```

CountryAustria	13.5901	12.8350	1.059	0.292362	
CountryBangladesh	-16.9798	10.9306	-1.553	0.123649	
CountryBelgium	12.9518	12.6545	1.023	0.308674	
CountryBrazil	3.7875	7.8461	0.483	0.630406	
CountryBulgaria	7.8512	7.0992	1.106	0.271550	
CountryCanada	23.3276	12.3858	1.883	0.062704	.
CountryChile	17.6245	7.5705	2.328	0.022032	*
CountryChina	28.9362	7.6922	3.762	0.000292	***
CountryColombia	-17.2055	7.1810	-2.396	0.018536	*
CountryCroatia	24.0850	7.7041	3.126	0.002349	**
CountryCzech Republic	18.5611	9.1543	2.028	0.045404	*
CountryDenmark	22.4626	13.6602	1.644	0.103403	
CountryEl Salvador	-17.2237	7.9608	-2.164	0.033006	*
CountryEstonia	31.3337	7.4539	4.204	5.94e-05	***
CountryFinland	20.1009	13.8462	1.452	0.149871	
CountryFrance	13.0085	12.2969	1.058	0.292799	
CountryGermany	20.1859	13.2910	1.519	0.132142	
CountryGreece	-0.1697	7.9893	-0.021	0.983099	
CountryHong Kong	39.8377	9.4382	4.221	5.57e-05	***
CountryHungary	11.2136	9.2242	1.216	0.227123	
CountryIndia	8.8087	7.1582	1.231	0.221518	
CountryIndonesia	-5.9686	8.6808	-0.688	0.493402	
CountryIran	-17.5537	9.9994	-1.755	0.082403	.
CountryIreland	17.3843	12.0319	1.445	0.151790	
CountryItaly	10.1144	9.7331	1.039	0.301360	
CountryJapan	17.2284	13.0166	1.324	0.188822	
CountryLatvia	29.1063	7.7195	3.771	0.000283	***
CountryLithuania	17.6528	7.4914	2.356	0.020507	*
CountryLuxembourg	16.6326	12.5647	1.324	0.188758	
CountryMalaysia	27.9012	7.7444	3.603	0.000503	***
CountryMexico	-4.7021	7.0131	-0.670	0.504185	

CountryMorocco	-24.7163	7.0181	-3.522	0.000661	***
CountryNetherlands	21.1859	13.2910	1.594	0.114256	
CountryNew Zealand	17.3560	12.2082	1.422	0.158399	
CountryNorway	21.7460	11.8569	1.834	0.069778	.
CountryPakistan	-22.9049	8.9183	-2.568	0.011778	*
CountryPeru	-10.1387	8.1564	-1.243	0.216917	
CountryPhilippines	-17.0000	7.6768	-2.214	0.029188	*
CountryPoland	4.1070	8.2057	0.501	0.617879	
CountryPortugal	8.4194	9.8843	0.852	0.396470	
CountryRomania	4.1137	7.2053	0.571	0.569399	
CountryRussia	7.0213	7.6785	0.914	0.362820	
CountrySerbia	7.7864	9.7421	0.799	0.426136	
CountrySingapore	28.6610	12.3858	2.314	0.022823	*
CountrySlovakia	15.0503	8.4387	1.783	0.077699	.
CountrySlovenia	27.6670	7.4539	3.712	0.000347	***
CountrySpain	12.6960	10.1938	1.245	0.216021	
CountrySweden	29.2426	12.9257	2.262	0.025954	*
CountrySwitzerland	27.5760	12.9257	2.133	0.035467	*
CountryThailand	17.1913	7.8142	2.200	0.030231	*
CountryTurkey	3.9362	7.0248	0.560	0.576569	
CountryUnited States	22.1151	13.7531	1.608	0.111152	
CountryUruguay	-0.7304	7.0248	-0.104	0.917405	
CountryVenezuela	-30.8624	9.0875	-3.396	0.000999	***
CountryVietnam	18.0101	8.6064	2.093	0.039046	*

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 7.677 on 95 degrees of freedom

Multiple R-squared: 0.9575, Adjusted R-squared: 0.932

F-statistic: 37.55 on 57 and 95 DF, p-value: < 2.2e-16

```
[1] "Model D"

Call:
lm(formula = GII ~ IPR + PDI + IDV + MAS + UAI + LTO + IVR +
    Country, data = data)

Residuals:
     Min       1Q   Median       3Q      Max
-20.9150  -3.0567   0.3758   2.6667  20.9150

Coefficients: (6 not defined because of singularities)
                   Estimate Std. Error t value Pr(>|t|)
(Intercept)          101.7823   128.5679   0.792  0.43053
IPR                   10.4251     3.2421   3.216  0.00178 **
PDI                   -5.4885     4.5788  -1.199  0.23363
IDV                   -1.4346     1.4495  -0.990  0.32484
MAS                   -4.0899     3.1612  -1.294  0.19888
UAI                   -0.2643     0.1286  -2.055  0.04259 *
LTO                    3.8487     3.4244   1.124  0.26388
IVR                    4.6915     4.3379   1.082  0.28221
CountryAustralia      -30.1229    20.5028  -1.469  0.14508
CountryAustria       -250.8662   228.4237  -1.098  0.27487
CountryBangladesh     198.0312   191.6338   1.033  0.30405
CountryBelgium        -78.8582    82.0361  -0.961  0.33886
CountryBrazil          -7.4849    11.9460  -0.627  0.53245
CountryBulgaria        61.6756    56.7469   1.087  0.27985
CountryCanada         -98.9134    86.3847  -1.145  0.25507
CountryChile         -123.5314   119.2425  -1.036  0.30285
CountryChina          108.2922    77.7537   1.393  0.16694
CountryColombia        -6.1987    11.7805  -0.526  0.59999
CountryCroatia         59.9384    38.1357   1.572  0.11934
```

CountryCzech Republic	42.9847	33.9387	1.267	0.20842	
CountryDenmark	-383.0215	306.8759	-1.248	0.21505	
CountryEl Salvador	-152.6445	128.6443	-1.187	0.23836	
CountryEstonia	-134.0007	113.5628	-1.180	0.24096	
CountryFinland	-218.9794	178.5281	-1.227	0.22301	
CountryFrance	0.1722	12.4997	0.014	0.98904	
CountryGermany	-130.4369	121.1558	-1.077	0.28438	
CountryGreece	15.4649	14.1913	1.090	0.27858	
CountryHong Kong	156.3380	121.5316	1.286	0.20143	
CountryHungary	172.5251	142.4688	1.211	0.22891	
CountryIndia	202.7823	184.0341	1.102	0.27330	
CountryIndonesia	7.3005	19.6708	0.371	0.71136	
CountryIran	90.6712	110.7080	0.819	0.41483	
CountryIreland	-57.3154	47.4945	-1.207	0.23051	
CountryItaly	105.3197	92.9281	1.133	0.25992	
CountryJapan	37.8771	36.8530	1.028	0.30666	
CountryLatvia	-120.9145	91.2248	-1.325	0.18820	
CountryLithuania	-180.3714	138.9677	-1.298	0.19745	
CountryLuxembourg	-182.6433	161.4679	-1.131	0.26084	
CountryMalaysia	205.9608	158.5059	1.299	0.19696	
CountryMexico	20.4933	8.1553	2.513	0.01366	*
CountryMorocco	270.1931	268.7007	1.006	0.31718	
CountryNetherlands	-379.9472	316.1539	-1.202	0.23244	
CountryNew Zealand	-196.1157	166.7763	-1.176	0.24257	
CountryNorway	-274.7709	216.9523	-1.267	0.20843	
CountryPakistan	110.7617	131.4578	0.843	0.40159	
CountryPeru	27.9788	34.9760	0.800	0.42574	
CountryPhilippines	298.4079	276.2360	1.080	0.28276	
CountryPoland	248.5834	213.9217	1.162	0.24813	
CountryPortugal	65.7759	58.8553	1.118	0.26656	
CountryRomania	223.8727	193.8885	1.155	0.25113	

```
CountryRussia         121.3262   102.5116   1.184  0.23955
CountrySerbia         165.5051   135.2921   1.223  0.22424
CountrySingapore      -49.8274    51.2238  -0.973  0.33315
CountrySlovakia       477.2624   385.1749   1.239  0.21837
CountrySlovenia       -75.5702    80.7158  -0.936  0.35152
CountrySpain          -16.7987    17.8785  -0.940  0.34980
CountrySweden        -459.4055   383.1508  -1.199  0.23350
CountrySwitzerland   -199.9310   192.0795  -1.041  0.30057
CountryThailand            NA         NA      NA       NA
CountryTurkey              NA         NA      NA       NA
CountryUnited States       NA         NA      NA       NA
CountryUruguay             NA         NA      NA       NA
CountryVenezuela           NA         NA      NA       NA
CountryVietnam             NA         NA      NA       NA
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 7.677 on 95 degrees of freedom
Multiple R-squared: 0.9575,  Adjusted R-squared: 0.932
F-statistic: 37.55 on 57 and 95 DF,  p-value: < 2.2e-16

[1] "Model 1"

Call:
lm(formula = GII ~ IPR + Country, data = data)

Residuals:
    Min       1Q   Median       3Q      Max
-20.9150  -3.0567   0.3758   2.6667  20.9150

Coefficients:
```

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	-117.0617	16.6348	-7.037	3.03e-10	***
IPR	10.4251	3.2421	3.216	0.001780	**
CountryAustralia	12.9801	12.4751	1.040	0.300756	
CountryAustria	13.5901	12.8350	1.059	0.292362	
CountryBangladesh	-16.9798	10.9306	-1.553	0.123649	
CountryBelgium	12.9518	12.6545	1.023	0.308674	
CountryBrazil	3.7875	7.8461	0.483	0.630406	
CountryBulgaria	7.8512	7.0992	1.106	0.271550	
CountryCanada	23.3276	12.3858	1.883	0.062704	.
CountryChile	17.6245	7.5705	2.328	0.022032	*
CountryChina	28.9362	7.6922	3.762	0.000292	***
CountryColombia	-17.2055	7.1810	-2.396	0.018536	*
CountryCroatia	24.0850	7.7041	3.126	0.002349	**
CountryCzech Republic	18.5611	9.1543	2.028	0.045404	*
CountryDenmark	22.4626	13.6602	1.644	0.103403	
CountryEl Salvador	-17.2237	7.9608	-2.164	0.033006	*
CountryEstonia	31.3337	7.4539	4.204	5.94e-05	***
CountryFinland	20.1009	13.8462	1.452	0.149871	
CountryFrance	13.0085	12.2969	1.058	0.292799	
CountryGermany	20.1859	13.2910	1.519	0.132142	
CountryGreece	-0.1697	7.9893	-0.021	0.983099	
CountryHong Kong	39.8377	9.4382	4.221	5.57e-05	***
CountryHungary	11.2136	9.2242	1.216	0.227123	
CountryIndia	8.8087	7.1582	1.231	0.221518	
CountryIndonesia	-5.9686	8.6808	-0.688	0.493402	
CountryIran	-17.5537	9.9994	-1.755	0.082403	.
CountryIreland	17.3843	12.0319	1.445	0.151790	
CountryItaly	10.1144	9.7331	1.039	0.301360	
CountryJapan	17.2284	13.0166	1.324	0.188822	
CountryLatvia	29.1063	7.7195	3.771	0.000283	***

CountryLithuania	17.6528	7.4914	2.356	0.020507	*
CountryLuxembourg	16.6326	12.5647	1.324	0.188758	
CountryMalaysia	27.9012	7.7444	3.603	0.000503	***
CountryMexico	-4.7021	7.0131	-0.670	0.504185	
CountryMorocco	-24.7163	7.0181	-3.522	0.000661	***
CountryNetherlands	21.1859	13.2910	1.594	0.114256	
CountryNew Zealand	17.3560	12.2082	1.422	0.158399	
CountryNorway	21.7460	11.8569	1.834	0.069778	.
CountryPakistan	-22.9049	8.9183	-2.568	0.011778	*
CountryPeru	-10.1387	8.1564	-1.243	0.216917	
CountryPhilippines	-17.0000	7.6768	-2.214	0.029188	*
CountryPoland	4.1070	8.2057	0.501	0.617879	
CountryPortugal	8.4194	9.8843	0.852	0.396470	
CountryRomania	4.1137	7.2053	0.571	0.569399	
CountryRussia	7.0213	7.6785	0.914	0.362820	
CountrySerbia	7.7864	9.7421	0.799	0.426136	
CountrySingapore	28.6610	12.3858	2.314	0.022823	*
CountrySlovakia	15.0503	8.4387	1.783	0.077699	.
CountrySlovenia	27.6670	7.4539	3.712	0.000347	***
CountrySpain	12.6960	10.1938	1.245	0.216021	
CountrySweden	29.2426	12.9257	2.262	0.025954	*
CountrySwitzerland	27.5760	12.9257	2.133	0.035467	*
CountryThailand	17.1913	7.8142	2.200	0.030231	*
CountryTurkey	3.9362	7.0248	0.560	0.576569	
CountryUnited States	22.1151	13.7531	1.608	0.111152	
CountryUruguay	-0.7304	7.0248	-0.104	0.917405	
CountryVenezuela	-30.8624	9.0875	-3.396	0.000999	***
CountryVietnam	18.0101	8.6064	2.093	0.039046	*

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

```
Residual standard error: 7.677 on 95 degrees of freedom
Multiple R-squared: 0.9575,  Adjusted R-squared: 0.932
F-statistic: 37.55 on 57 and 95 DF,  p-value: < 2.2e-16

[1] "Model 2"

Call:
lm(formula = GII ~ IPR + I(IPR^2) + Country, data = data)

Residuals:
    Min      1Q  Median      3Q     Max
-19.916  -2.962   0.000   2.650  19.916

Coefficients:
                      Estimate Std. Error t value Pr(>|t|)
(Intercept)          -158.2916    36.5994  -4.325 3.80e-05 ***
IPR                    24.9026    11.9038   2.092 0.039136 *
I(IPR^2)               -1.2311     0.9742  -1.264 0.209473
CountryAustralia       17.3742    12.9131   1.345 0.181710
CountryAustria         18.7048    13.4198   1.394 0.166659
CountryBangladesh      -3.6793    15.1497  -0.243 0.808639
CountryBelgium         17.6938    13.1612   1.344 0.182058
CountryBrazil           2.8273     7.8584   0.360 0.719822
CountryBulgaria         7.1114     7.1012   1.001 0.319188
CountryCanada          27.5354    12.7882   2.153 0.033864 *
CountryChile           16.3939     7.6094   2.154 0.033763 *
CountryChina           28.6051     7.6726   3.728 0.000329 ***
CountryColombia       -18.1685     7.1990  -2.524 0.013288 *
CountryCroatia         24.6415     7.6927   3.203 0.001856 **
CountryCzech Republic  18.0249     9.1355   1.973 0.051427 .
CountryDenmark         29.3853    14.6781   2.002 0.048169 *
```

CountryEl Salvador	-15.0336	8.1229	-1.851	0.067344	.
CountryEstonia	30.0940	7.4951	4.015	0.000119	***
CountryFinland	27.4373	14.9741	1.832	0.070071	.
CountryFrance	17.0463	12.6680	1.346	0.181664	
CountryGermany	26.3470	14.1180	1.866	0.065132	.
CountryGreece	-1.4717	8.0307	-0.183	0.854993	
CountryHong Kong	39.8991	9.4088	4.241	5.21e-05	***
CountryHungary	10.7406	9.2030	1.167	0.246130	
CountryIndia	7.9220	7.1702	1.105	0.272048	
CountryIndonesia	-0.7059	9.6037	-0.073	0.941566	
CountryIran	-13.5613	10.4568	-1.297	0.197844	
CountryIreland	20.9125	12.3149	1.698	0.092790	.
CountryItaly	10.1659	9.7027	1.048	0.297448	
CountryJapan	22.7157	13.6832	1.660	0.100224	
CountryLatvia	29.8387	7.7171	3.867	0.000203	***
CountryLithuania	16.5092	7.5226	2.195	0.030655	*
CountryLuxembourg	21.2212	13.0411	1.627	0.107031	
CountryMalaysia	26.5704	7.7917	3.410	0.000958	***
CountryMexico	-4.9298	6.9935	-0.705	0.482607	
CountryMorocco	-25.0039	6.9999	-3.572	0.000561	***
CountryNetherlands	27.3060	14.1068	1.936	0.055915	.
CountryNew Zealand	21.2157	12.5475	1.691	0.094182	.
CountryNorway	24.9590	12.0902	2.064	0.041734	*
CountryPakistan	-16.9416	10.0652	-1.683	0.095656	.
CountryPeru	-6.9244	8.5195	-0.813	0.418405	
CountryPhilippines	-17.0246	7.6528	-2.225	0.028500	*
CountryPoland	3.0085	8.2261	0.366	0.715387	
CountryPortugal	8.6301	9.8548	0.876	0.383412	
CountryRomania	3.2713	7.2137	0.453	0.651247	
CountryRussia	7.1727	7.6554	0.937	0.351191	
CountrySerbia	16.7129	12.0089	1.392	0.167296	

```
CountrySingapore       32.9179    12.7984   2.572 0.011677 *
CountrySlovakia        13.9584     8.4565   1.651 0.102155
CountrySlovenia        26.4520     7.4926   3.530 0.000645 ***
CountrySpain           13.3319    10.1743   1.310 0.193272
CountrySweden          34.6420    13.5753   2.552 0.012328 *
CountrySwitzerland     32.8933    13.5550   2.427 0.017145 *
CountryThailand        18.5664     7.8654   2.361 0.020316 *
CountryTurkey           3.5641     7.0090   0.508 0.612297
CountryUnited States   29.2405    14.8243   1.972 0.051495 .
CountryUruguay         -1.0862     7.0085  -0.155 0.877166
CountryVenezuela      -24.2885    10.4466  -2.325 0.022223 *
CountryVietnam         22.8260     9.3878   2.431 0.016934 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 7.653 on 94 degrees of freedom
Multiple R-squared: 0.9582,  Adjusted R-squared: 0.9324
F-statistic: 37.16 on 58 and 94 DF,  p-value: < 2.2e-16

[1] "Model 3"

Call:
lm(formula = GII ~ log(IPR) + Country, data = data)

Residuals:
    Min      1Q  Median      3Q     Max
-19.950  -2.861   0.000   2.664  19.950

Coefficients:
                      Estimate Std. Error t value Pr(>|t|)
(Intercept)          -157.7539    25.7165  -6.134 1.96e-08 ***
```

log(IPR)	57.8105	15.9343	3.628	0.000462	***
CountryAustralia	16.9736	10.6102	1.600	0.112975	
CountryAustria	18.0188	10.8111	1.667	0.098868	.
CountryBangladesh	-1.9534	13.3878	-0.146	0.884302	
CountryBelgium	17.1585	10.7112	1.602	0.112494	
CountryBrazil	3.3228	7.7359	0.430	0.668506	
CountryBulgaria	7.4652	7.0047	1.066	0.289241	
CountryCanada	27.2100	10.5608	2.577	0.011520	*
CountryChile	17.1883	7.4092	2.320	0.022490	*
CountryChina	28.7578	7.5912	3.788	0.000266	***
CountryColombia	-17.6839	7.0811	-2.497	0.014233	*
CountryCroatia	24.4369	7.6057	3.213	0.001794	**
CountryCzech Republic	19.0991	8.5763	2.227	0.028312	*
CountryDenmark	27.9357	11.2584	2.481	0.014847	*
CountryEl Salvador	-15.6435	7.9184	-1.976	0.051102	.
CountryEstonia	30.8309	7.3170	4.214	5.72e-05	***
CountryFinland	25.8102	11.3585	2.272	0.025321	*
CountryFrance	16.7857	10.5104	1.597	0.113574	
CountryGermany	25.2087	11.0552	2.280	0.024828	*
CountryGreece	-0.4805	7.7447	-0.062	0.950662	
CountryHong Kong	40.7797	8.7398	4.666	1.01e-05	***
CountryHungary	11.8093	8.6238	1.369	0.174107	
CountryIndia	8.3704	7.0589	1.186	0.238663	
CountryIndonesia	-1.4385	8.9903	-0.160	0.873219	
CountryIran	-14.4232	10.0572	-1.434	0.154822	
CountryIreland	20.8463	10.3603	2.012	0.047037	*
CountryItaly	11.1557	8.9617	1.245	0.216260	
CountryJapan	21.8793	10.9116	2.005	0.047794	*
CountryLatvia	29.5865	7.6236	3.881	0.000192	***
CountryLithuania	17.2434	7.3402	2.349	0.020886	*
CountryLuxembourg	20.7400	10.6591	1.946	0.054639	.

CountryMalaysia	27.4724	7.5543	3.637	0.000449	***
CountryMexico	-4.8432	6.9215	-0.700	0.485798	
CountryMorocco	-24.8835	6.9264	-3.593	0.000521	***
CountryNetherlands	26.1950	11.0581	2.369	0.019867	*
CountryNew Zealand	21.0251	10.4608	2.010	0.047279	*
CountryNorway	25.0071	10.2593	2.438	0.016649	*
CountryPakistan	-17.7825	9.3237	-1.907	0.059512	.
CountryPeru	-7.5980	8.2019	-0.926	0.356605	
CountryPhilippines	-17.0246	7.5760	-2.247	0.026942	*
CountryPoland	4.0028	7.8969	0.507	0.613410	
CountryPortugal	9.5932	9.0611	1.059	0.292411	
CountryRomania	3.7577	7.0947	0.530	0.597594	
CountryRussia	7.1216	7.5779	0.940	0.349707	
CountrySerbia	16.3713	10.7894	1.517	0.132498	
CountrySingapore	32.5612	10.5571	3.084	0.002672	**
CountrySlovakia	15.0319	8.0766	1.861	0.065813	.
CountrySlovenia	27.1820	7.3154	3.716	0.000342	***
CountrySpain	14.1856	9.2552	1.533	0.128668	
CountrySweden	33.8172	10.8539	3.116	0.002427	**
CountrySwitzerland	32.1215	10.8600	2.958	0.003910	**
CountryThailand	18.1165	7.7325	2.343	0.021220	*
CountryTurkey	3.7192	6.9333	0.536	0.592918	
CountryUnited States	27.7049	11.3087	2.450	0.016122	*
CountryUruguay	-0.9324	6.9330	-0.134	0.893306	
CountryVenezuela	-25.0787	9.6050	-2.611	0.010492	*
CountryVietnam	21.9539	8.8297	2.486	0.014651	*

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 7.576 on 95 degrees of freedom

Multiple R-squared: 0.9586, Adjusted R-squared: 0.9338

F-statistic: 38.6 on 57 and 95 DF, p-value: < 2.2e-16

```
[1] "Model 4"
Oneway (individual) effect Random Effect Model
   (Swamy-Arora's transformation)

Call:
plm(formula = GII ~ IPR, data = data, model = "random", index = "Country")

Unbalanced Panel: n=57, T=1-3, N=153

Effects:
                  var std.dev share
idiosyncratic  58.933   7.677 0.308
individual    132.170  11.497 0.692
theta  :
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.4447  0.6403  0.6403  0.6249  0.6403  0.6403

Residuals :
    Min.  1st Qu.   Median     Mean  3rd Qu.     Max.
-21.2000  -3.9800   0.4770   0.0207   3.9500  25.6000

Coefficients :
              Estimate Std. Error t-value  Pr(>|t|)
(Intercept) -137.88438    6.04328 -22.816 < 2.2e-16 ***
IPR           15.52174    0.94948  16.348 < 2.2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Total Sum of Squares:    28769
```

```
Residual Sum of Squares: 9233.5
R-Squared      :  0.67906
      Adj. R-Squared :  0.67018
F-statistic: 319.482 on 1 and 151 DF, p-value: < 2.22e-16
[1] "Model 5"
Oneway (individual) effect Random Effect Model
   (Swamy-Arora's transformation)

Call:
plm(formula = GII ~ IPR + I(IPR^2), data = data, model = "random",
    index = "Country")

Unbalanced Panel: n=57, T=1-3, N=153

Effects:
                  var std.dev share
idiosyncratic  58.565   7.653 0.311
individual    129.967  11.400 0.689
theta  :
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.4427  0.6386  0.6386  0.6232  0.6386  0.6386

Residuals :
    Min.  1st Qu.   Median     Mean  3rd Qu.     Max.
-21.8000  -3.8100   0.4640  -0.0023   4.0000  27.0000

Coefficients :
              Estimate Std. Error t-value  Pr(>|t|)
(Intercept) -169.41553   18.54913 -9.1333 4.250e-16 ***
IPR           26.96314    6.44200  4.1855 4.829e-05 ***
I(IPR^2)      -0.95363    0.53134 -1.7948   0.07471 .
```

```
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Total Sum of Squares:    28963
Residual Sum of Squares: 9069.7
R-Squared      :  0.68685
      Adj. R-Squared :  0.67338
F-statistic: 164.502 on 2 and 150 DF, p-value: < 2.22e-16
[1] "Model 6"
Oneway (individual) effect Random Effect Model
   (Swamy-Arora's transformation)

Call:
plm(formula = GII ~ log(IPR), data = data, model = "random",
    index = "Country")

Unbalanced Panel: n=57, T=1-3, N=153

Effects:
                  var std.dev share
idiosyncratic  57.395   7.576   0.3
individual    133.797  11.567   0.7
theta  :
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.4521  0.6463  0.6463  0.6311  0.6463  0.6463

Residuals :
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
-23.200  -3.700   0.808   0.002   4.260  26.700

Coefficients :
```

```
            Estimate Std. Error t-value  Pr(>|t|)
(Intercept) -194.6182     9.4406 -20.615 < 2.2e-16 ***
log(IPR)      85.8220     5.2578  16.323 < 2.2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Total Sum of Squares:    28070
Residual Sum of Squares: 9026.8
R-Squared      :  0.67842
      Adj. R-Squared :  0.66955
F-statistic: 318.56 on 1 and 151 DF, p-value: < 2.22e-16
[1] "Model 7"
Oneway (individual) effect Within Model

Call:
plm(formula = GII ~ IPR, data = data, model = "within", index = "Country")

Unbalanced Panel: n=57, T=1-3, N=153

Residuals :
   Min. 1st Qu.  Median 3rd Qu.    Max.
-20.900  -3.060   0.376   2.670  20.900

Coefficients :
    Estimate Std. Error t-value Pr(>|t|)
IPR  10.4251     3.2421  3.2155  0.00178 **
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Total Sum of Squares:    6208
Residual Sum of Squares: 5598.7
```

```
R-Squared      :  0.098155
      Adj. R-Squared :  0.060946
F-statistic: 10.3396 on 1 and 95 DF, p-value: 0.00178
[1] "Model 8"
Oneway (individual) effect Within Model

Call:
plm(formula = GII ~ IPR + I(IPR^2), data = data, model = "within",
    index = "Country")

Unbalanced Panel: n=57, T=1-3, N=153

Residuals :
   Min. 1st Qu.  Median 3rd Qu.    Max.
 -19.90   -2.96    0.00    2.65   19.90

Coefficients :
         Estimate Std. Error t-value Pr(>|t|)
IPR      24.90258   11.90383  2.0920  0.03914 *
I(IPR^2) -1.23109    0.97421 -1.2637  0.20947
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Total Sum of Squares:    6208
Residual Sum of Squares: 5505.1
R-Squared      :  0.11322
      Adj. R-Squared :  0.06956
F-statistic: 6.00072 on 2 and 94 DF, p-value: 0.0035266
[1] "Model 9"
Oneway (individual) effect Within Model
```

```
Call:
plm(formula = GII ~ log(IPR), data = data, model = "within",
    index = "Country")

Unbalanced Panel: n=57, T=1-3, N=153

Residuals :
   Min. 1st Qu.  Median 3rd Qu.    Max.
 -20.00   -2.86    0.00    2.66   20.00

Coefficients :
         Estimate Std. Error t-value Pr(>|t|)
log(IPR)   57.810     15.934   3.628 0.000462 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Total Sum of Squares:    6208
Residual Sum of Squares: 5452.5
R-Squared      :  0.12169
      Adj. R-Squared :  0.075561
F-statistic: 13.1627 on 1 and 95 DF, p-value: 0.00046198
[1] "Model 10"

Call:
lm(formula = IPR ~ IDV, data = data)

Residuals:
    Min      1Q  Median      3Q     Max
-3.0493 -0.8053 -0.0069  0.7548  3.4931

Coefficients:
```

```
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 3.749919   0.214877   17.45   <2e-16 ***
IDV         0.052849   0.004023   13.14   <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1.132 on 151 degrees of freedom
Multiple R-squared: 0.5333,  Adjusted R-squared: 0.5302
F-statistic: 172.5 on 1 and 151 DF,  p-value: < 2.2e-16

[1] "Model 11"

Call:
lm(formula = IPR ~ PDI + IDV + LTO + IVR, data = data)

Residuals:
     Min       1Q   Median       3Q      Max
-2.49167 -0.51740 -0.00753  0.45558  2.76477

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  3.103231   0.619752   5.007 1.55e-06 ***
PDI         -0.015116   0.005212  -2.900   0.0043 **
IDV          0.036020   0.004863   7.406 9.13e-12 ***
LTO          0.023273   0.004526   5.142 8.46e-07 ***
IVR          0.025098   0.004474   5.609 9.70e-08 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.9817 on 148 degrees of freedom
Multiple R-squared: 0.6557,  Adjusted R-squared: 0.6464
```

F-statistic: 70.45 on 4 and 148 DF, p-value: < 2.2e-16

[1] "Model 12"

Call:
lm(formula = IPR ~ Country, data = data)

Residuals:

```
     Min       1Q   Median       3Q      Max 
-0.60000 -0.10000 -0.03333  0.13333  0.70000 
```

Coefficients:

```
                      Estimate Std. Error t value Pr(>|t|)    
(Intercept)          4.850e+00  1.709e-01  28.382  < 2e-16 ***
CountryAustralia     3.183e+00  2.206e-01  14.430  < 2e-16 ***
CountryAustria       3.317e+00  2.206e-01  15.034  < 2e-16 ***
CountryBangladesh   -2.400e+00  2.417e-01  -9.931  < 2e-16 ***
CountryBelgium       3.250e+00  2.206e-01  14.732  < 2e-16 ***
CountryBrazil        5.000e-01  2.417e-01   2.069 0.041237 *  
CountryBulgaria      3.500e-01  2.206e-01   1.587 0.115913    
CountryCanada        3.150e+00  2.206e-01  14.279  < 2e-16 ***
CountryChile         8.833e-01  2.206e-01   4.004 0.000123 ***
CountryChina         1.500e-01  2.417e-01   0.621 0.536275    
CountryColombia      4.833e-01  2.206e-01   2.191 0.030880 *  
CountryCroatia      -2.000e-01  2.417e-01  -0.828 0.409957    
CountryCzech Republic  1.817e+00  2.206e-01   8.235 9.03e-13 ***
CountryDenmark       3.617e+00  2.206e-01  16.394  < 2e-16 ***
CountryEl Salvador  -6.500e-01  2.417e-01  -2.690 0.008435 ** 
CountryEstonia       7.833e-01  2.206e-01   3.551 0.000597 ***
CountryFinland       3.683e+00  2.206e-01  16.696  < 2e-16 ***
CountryFrance        3.117e+00  2.206e-01  14.127  < 2e-16 ***
```

CountryGermany	3.483e+00	2.206e-01	15.790	< 2e-16	***
CountryGreece	1.183e+00	2.206e-01	5.364	5.62e-07	***
CountryHong Kong	1.950e+00	2.206e-01	8.839	4.63e-14	***
CountryHungary	1.850e+00	2.206e-01	8.386	4.31e-13	***
CountryIndia	4.500e-01	2.206e-01	2.040	0.044118	*
CountryIndonesia	-1.250e+00	2.417e-01	-5.172	1.26e-06	***
CountryIran	-1.050e+00	2.960e-01	-3.548	0.000604	***
CountryIreland	3.017e+00	2.206e-01	13.674	< 2e-16	***
CountryItaly	2.083e+00	2.206e-01	9.443	2.33e-15	***
CountryJapan	3.383e+00	2.206e-01	15.336	< 2e-16	***
CountryLatvia	-2.500e-01	2.417e-01	-1.034	0.303509	
CountryLithuania	8.167e-01	2.206e-01	3.702	0.000357	***
CountryLuxembourg	3.217e+00	2.206e-01	14.581	< 2e-16	***
CountryMalaysia	1.017e+00	2.206e-01	4.608	1.25e-05	***
CountryMexico	8.333e-02	2.206e-01	0.378	0.706458	
CountryMorocco	1.167e-01	2.206e-01	0.529	0.598140	
CountryNetherlands	3.483e+00	2.206e-01	15.790	< 2e-16	***
CountryNew Zealand	3.083e+00	2.206e-01	13.976	< 2e-16	***
CountryNorway	2.950e+00	2.206e-01	13.372	< 2e-16	***
CountryPakistan	-1.400e+00	2.417e-01	-5.793	8.74e-08	***
CountryPeru	-8.500e-01	2.417e-01	-3.517	0.000668	***
CountryPhilippines	-1.439e-14	2.417e-01	0.000	1.000000	
CountryPoland	1.317e+00	2.206e-01	5.968	4.02e-08	***
CountryPortugal	2.150e+00	2.206e-01	9.746	5.23e-16	***
CountryRomania	5.167e-01	2.206e-01	2.342	0.021248	*
CountryRussia	-5.000e-02	2.417e-01	-0.207	0.836529	
CountrySerbia	-1.850e+00	2.417e-01	-7.655	1.51e-11	***
CountrySingapore	3.150e+00	2.206e-01	14.279	< 2e-16	***
CountrySlovakia	1.450e+00	2.206e-01	6.573	2.56e-09	***
CountrySlovenia	7.833e-01	2.206e-01	3.551	0.000597	***
CountrySpain	2.283e+00	2.206e-01	10.350	< 2e-16	***

```
CountrySweden         3.350e+00  2.206e-01  15.185  < 2e-16 ***
CountrySwitzerland    3.350e+00  2.206e-01  15.185  < 2e-16 ***
CountryThailand      -4.500e-01  2.417e-01  -1.862 0.065652 .
CountryTurkey         1.500e-01  2.206e-01   0.680 0.498184
CountryUnited States  3.650e+00  2.206e-01  16.545  < 2e-16 ***
CountryUruguay        1.500e-01  2.206e-01   0.680 0.498184
CountryVenezuela     -1.500e+00  2.417e-01  -6.207 1.37e-08 ***
CountryVietnam       -1.200e+00  2.417e-01  -4.966 2.97e-06 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.2417 on 96 degrees of freedom
Multiple R-squared: 0.9865,  Adjusted R-squared: 0.9786
F-statistic: 124.9 on 56 and 96 DF,  p-value: < 2.2e-16

[1] "Model 13"

Call:
lm(formula = IPR ~ PDI + IDV + MAS + UAI + LTO + IVR, data = data)

Residuals:
    Min       1Q   Median       3Q      Max
-2.32724 -0.55929  0.06527  0.48636  2.65392

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  3.595251   0.664175   5.413 2.48e-07 ***
PDI         -0.016185   0.005411  -2.991  0.00326 **
IDV          0.034268   0.004918   6.968 1.02e-10 ***
MAS          0.004587   0.003870   1.185  0.23786
UAI         -0.006731   0.003457  -1.947  0.05347 .
```

```
LTO          0.022001   0.004524   4.863 2.96e-06 ***
IVR          0.023849   0.004481   5.322 3.79e-07 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.9722 on 146 degrees of freedom
Multiple R-squared: 0.6669,  Adjusted R-squared: 0.6532
F-statistic: 48.72 on 6 and 146 DF,  p-value: < 2.2e-16

[1] "Model 14"

Call:
lm(formula = IPR ~ PDI + IDV + MAS + UAI + LTO + IVR + Country,
   data = data)

Residuals:
     Min       1Q   Median       3Q      Max
-0.60000 -0.10000 -0.03333  0.13333  0.70000

Coefficients: (6 not defined because of singularities)
                    Estimate Std. Error t value Pr(>|t|)
(Intercept)          10.148364   3.912559   2.594 0.010978 *
PDI                  -0.283162   0.141214  -2.005 0.047758 *
IDV                  -0.016810   0.045598  -0.369 0.713203
MAS                  -0.278933   0.095356  -2.925 0.004296 **
UAI                  -0.003468   0.004032  -0.860 0.391932
LTO                   0.233126   0.105141   2.217 0.028964 *
IVR                   0.332351   0.132278   2.513 0.013655 *
CountryAustralia     -1.709135   0.621412  -2.750 0.007114 **
CountryAustria      -10.589629   7.109125  -1.490 0.139612
CountryBangladesh    13.236166   5.879457   2.251 0.026650 *
```

CountryBelgium	-5.054146	2.530465	-1.997	0.048621	*
CountryBrazil	-0.556439	0.371749	-1.497	0.137722	
CountryBulgaria	5.425974	1.698395	3.195	0.001894	**
CountryCanada	-6.081724	2.647615	-2.297	0.023788	*
CountryChile	-7.907638	3.665984	-2.157	0.033500	*
CountryChina	8.095926	2.304012	3.514	0.000676	***
CountryColombia	1.888698	0.316819	5.961	4.14e-08	***
CountryCroatia	2.672980	1.169109	2.286	0.024432	*
CountryCzech Republic	3.832237	0.994226	3.854	0.000210	***
CountryDenmark	-22.222156	9.390488	-2.366	0.019968	*
CountryEl Salvador	-9.698761	3.926902	-2.470	0.015283	*
CountryEstonia	-8.037916	3.479575	-2.310	0.023029	*
CountryFinland	-11.557624	5.494906	-2.103	0.038051	*
CountryFrance	-0.080678	0.393408	-0.205	0.837948	
CountryGermany	-4.786680	3.782585	-1.265	0.208772	
CountryGreece	2.642346	0.356161	7.419	4.72e-11	***
CountryHong Kong	12.455917	3.608441	3.452	0.000829	***
CountryHungary	11.928080	4.316549	2.763	0.006859	**
CountryIndia	12.990318	5.639675	2.303	0.023415	*
CountryIndonesia	1.687768	0.594798	2.838	0.005547	**
CountryIran	6.405119	3.423243	1.871	0.064381	.
CountryIreland	-1.285521	1.489365	-0.863	0.390215	
CountryItaly	7.814728	2.814563	2.777	0.006606	**
CountryJapan	6.492733	0.952261	6.818	8.16e-10	***
CountryLatvia	-9.589993	2.699826	-3.552	0.000594	***
CountryLithuania	-10.489179	4.241714	-2.473	0.015162	*
CountryLuxembourg	-9.088996	4.997671	-1.819	0.072083	.
CountryMalaysia	11.173462	4.857727	2.300	0.023606	*
CountryMexico	-0.076976	0.256611	-0.300	0.764848	
CountryMorocco	18.859568	8.236819	2.290	0.024231	*
CountryNetherlands	-23.840575	9.650551	-2.470	0.015261	*

CountryNew Zealand	-10.928957	5.130283	-2.130	0.035704	*
CountryNorway	-16.444341	6.620261	-2.484	0.014727	*
CountryPakistan	11.643917	3.964002	2.937	0.004144	**
CountryPeru	3.143519	1.053269	2.985	0.003602	**
CountryPhilippines	19.607868	8.462546	2.317	0.022628	*
CountryPoland	15.959100	6.534337	2.442	0.016422	*
CountryPortugal	6.657137	1.723695	3.862	0.000204	***
CountryRomania	14.464824	5.922407	2.442	0.016420	*
CountryRussia	6.482005	3.158541	2.052	0.042871	*
CountrySerbia	8.508527	4.169545	2.041	0.044033	*
CountrySingapore	0.485060	1.611773	0.301	0.764105	
CountrySlovakia	30.077439	11.730345	2.564	0.011896	*
CountrySlovenia	-5.727831	2.472781	-2.316	0.022666	*
CountrySpain	0.182385	0.562510	0.324	0.746466	
CountrySweden	-28.760685	11.699008	-2.458	0.015748	*
CountrySwitzerland	-10.637886	5.948417	-1.788	0.076873	.
CountryThailand	NA	NA	NA	NA	
CountryTurkey	NA	NA	NA	NA	
CountryUnited States	NA	NA	NA	NA	
CountryUruguay	NA	NA	NA	NA	
CountryVenezuela	NA	NA	NA	NA	
CountryVietnam	NA	NA	NA	NA	

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.2417 on 96 degrees of freedom

Multiple R-squared: 0.9865, Adjusted R-squared: 0.9786

F-statistic: 124.9 on 56 and 96 DF, p-value: < 2.2e-16

Appendix 2 – Test of Assumptions

Normality

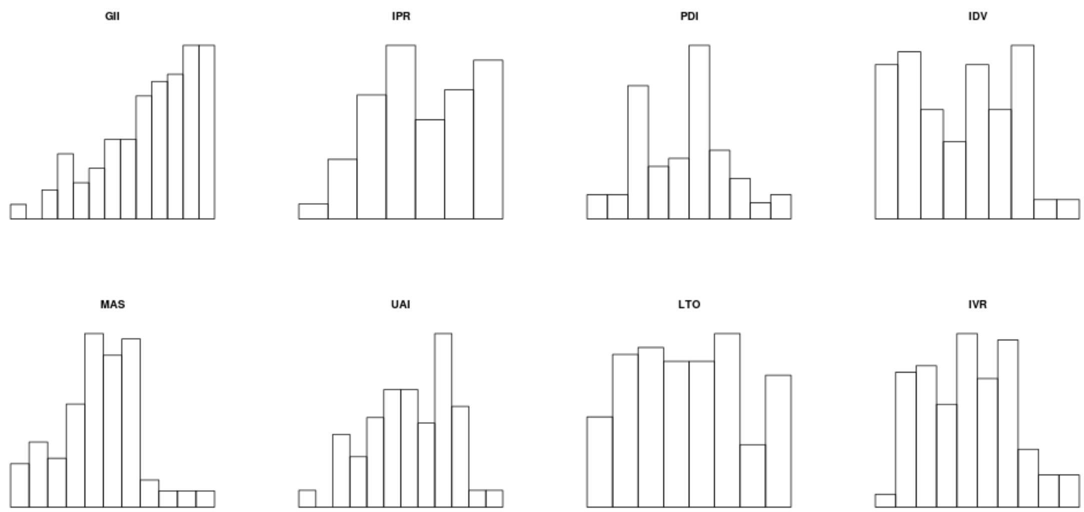


Illustration 4: Distribution of the Variables

Correct specification

I am attempting to learn structural equation modeling as a way to provide support for correct model specification. However, I'm open to other suggestions for proving a model specification to be correct.

Exogeneity

One Sample t-test

data: modelA$residuals

t = 0, df = 152, p-value = 1

alternative hypothesis: true mean is not equal to 0

95 percent confidence interval:

-2.187497 2.187497

sample estimates:

```
  mean of x 
1.104781e-16 


        One Sample t-test

data:  modelB$residuals
t = 0, df = 152, p-value = 1
alternative hypothesis: true mean is not equal to 0
95 percent confidence interval:
 -1.726578  1.726578
sample estimates:
  mean of x 
2.739276e-17 


        One Sample t-test

data:  modelC$residuals
t = 0, df = 152, p-value = 1
alternative hypothesis: true mean is not equal to 0
95 percent confidence interval:
 -0.9693798  0.9693798
sample estimates:
  mean of x 
3.083386e-17 


        One Sample t-test

data:  modelD$residuals
t = 0, df = 152, p-value = 1
```

```
alternative hypothesis: true mean is not equal to 0
95 percent confidence interval:
 -0.9693798  0.9693798
sample estimates:
   mean of x
5.919602e-17


        One Sample t-test

data:  model1$residuals
t = 0, df = 152, p-value = 1
alternative hypothesis: true mean is not equal to 0
95 percent confidence interval:
 -0.9693798  0.9693798
sample estimates:
   mean of x
3.083386e-17


        One Sample t-test

data:  model2$residuals
t = 0, df = 152, p-value = 1
alternative hypothesis: true mean is not equal to 0
95 percent confidence interval:
 -0.9612493  0.9612493
sample estimates:
   mean of x
3.278401e-17
```

One Sample t-test

data: model3$residuals
t = 0, df = 152, p-value = 1
alternative hypothesis: true mean is not equal to 0
95 percent confidence interval:
 -0.9566455 0.9566455
sample estimates:
   mean of x
7.564755e-17

One Sample t-test

data: model4$residuals
t = 0.0329, df = 152, p-value = 0.9738
alternative hypothesis: true mean is not equal to 0
95 percent confidence interval:
 -1.224195 1.265597
sample estimates:
 mean of x
0.02070084

One Sample t-test

data: model5$residuals
t = -0.0037, df = 152, p-value = 0.997
alternative hypothesis: true mean is not equal to 0
95 percent confidence interval:
 -1.236136 1.231491
sample estimates:

```
  mean of x 
-0.002322427 


        One Sample t-test

data:  model6$residuals
t = 0.0032, df = 152, p-value = 0.9974
alternative hypothesis: true mean is not equal to 0
95 percent confidence interval:
 -1.228881  1.232892
sample estimates:
  mean of x 
0.002005224 


        One Sample t-test

data:  model7$residuals
t = 0, df = 152, p-value = 1
alternative hypothesis: true mean is not equal to 0
95 percent confidence interval:
 -0.9693798  0.9693798
sample estimates:
    mean of x 
-6.693992e-16 


        One Sample t-test

data:  model8$residuals
t = 0, df = 152, p-value = 1
```

alternative hypothesis: true mean is not equal to 0
95 percent confidence interval:
 -0.9612493 0.9612493
sample estimates:
    mean of x
-6.631802e-16

One Sample t-test

data: model9$residuals
t = 0, df = 152, p-value = 1
alternative hypothesis: true mean is not equal to 0
95 percent confidence interval:
 -0.9566455 0.9566455
sample estimates:
   mean of x
2.363419e-17

One Sample t-test

data: model10$residuals
t = 0, df = 152, p-value = 1
alternative hypothesis: true mean is not equal to 0
95 percent confidence interval:
 -0.1801387 0.1801387
sample estimates:
    mean of x
-3.130722e-18

One Sample t-test

data: model11$residuals
t = 0, df = 152, p-value = 1
alternative hypothesis: true mean is not equal to 0
95 percent confidence interval:
 -0.1547317 0.1547317
sample estimates:
    mean of x
-1.496482e-17

One Sample t-test

data: model12$residuals
t = 0, df = 152, p-value = 1
alternative hypothesis: true mean is not equal to 0
95 percent confidence interval:
 -0.03067641 0.03067641
sample estimates:
   mean of x
1.964851e-18

One Sample t-test

data: model13$residuals
t = 0, df = 152, p-value = 1
alternative hypothesis: true mean is not equal to 0
95 percent confidence interval:
 -0.1521855 0.1521855
sample estimates:

```
  mean of x
5.925555e-18


	One Sample t-test

data:  model14$residuals
t = 0, df = 152, p-value = 1
alternative hypothesis: true mean is not equal to 0
95 percent confidence interval:
 -0.03067641  0.03067641
sample estimates:
  mean of x
7.989436e-18
```

Absence of Multicollinearity

```
Call:
lm(formula = IPR ~ PDI + IDV + MAS + UAI + LTO + IVR + GII, data = data)

Residuals:
     Min       1Q   Median       3Q      Max
-1.82134 -0.35142 -0.01457  0.43261  1.31867

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  6.773725   0.448922  15.089  < 2e-16 ***
PDI         -0.007787   0.003318  -2.347 0.020270 *
IDV          0.012648   0.003272   3.865 0.000167 ***
MAS          0.009826   0.002366   4.154 5.56e-05 ***
UAI          0.004943   0.002218   2.229 0.027351 *
LTO         -0.004057   0.003191  -1.271 0.205600
```

```
IVR         0.009543   0.002858   3.339 0.001068 **
GII         0.042409   0.002664  15.918  < 2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.5885 on 145 degrees of freedom
Multiple R-squared: 0.8788,  Adjusted R-squared: 0.8729
F-statistic: 150.1 on 7 and 145 DF,  p-value: < 2.2e-16


Call:
lm(formula = PDI ~ IPR + IDV + MAS + UAI + LTO + IVR + GII, data = data)

Residuals:
    Min      1Q  Median      3Q     Max
-43.295  -8.000  -1.371   7.375  35.580

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) 101.10488   15.56196   6.497 1.23e-09 ***
IPR          -4.70060    2.00268  -2.347 0.020270 *
IDV          -0.44188    0.07605  -5.810 3.80e-08 ***
MAS           0.22578    0.05856   3.856 0.000173 ***
UAI           0.02514    0.05537   0.454 0.650483
LTO           0.05132    0.07871   0.652 0.515484
IVR          -0.09463    0.07244  -1.306 0.193504
GII           0.07632    0.10831   0.705 0.482154
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 14.46 on 145 degrees of freedom
Multiple R-squared: 0.5678,  Adjusted R-squared: 0.547
```

```
F-statistic: 27.22 on 7 and 145 DF,  p-value: < 2.2e-16


Call:
lm(formula = IDV ~ PDI + IPR + MAS + UAI + LTO + IVR + GII, data = data)

Residuals:
    Min      1Q  Median      3Q     Max 
-35.072  -9.016   1.729   9.465  28.429 

Coefficients:
             Estimate Std. Error t value Pr(>|t|)    
(Intercept) 30.543606  17.203948   1.775 0.077932 .  
PDI         -0.427380   0.073556  -5.810  3.8e-08 ***
IPR          7.384618   1.910599   3.865 0.000167 ***
MAS          0.077682   0.060122   1.292 0.198391    
UAI          0.004911   0.054495   0.090 0.928324    
LTO         -0.029757   0.077486  -0.384 0.701514    
IVR         -0.147485   0.070606  -2.089 0.038470 *  
GII         -0.006850   0.106702  -0.064 0.948898    
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 14.22 on 145 degrees of freedom
Multiple R-squared: 0.6293,  Adjusted R-squared: 0.6114 
F-statistic: 35.17 on 7 and 145 DF,  p-value: < 2.2e-16


Call:
lm(formula = MAS ~ PDI + IDV + IPR + UAI + LTO + IVR + GII, data = data)

Residuals:
```

```
   Min      1Q  Median      3Q     Max 
-45.213 -12.747   0.258  12.565  41.399 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)    
(Intercept) -86.88732   22.76712  -3.816 0.000200 ***
PDI           0.41189    0.10682   3.856 0.000173 ***
IDV           0.14652    0.11340   1.292 0.198391    
IPR          10.82113    2.60522   4.154 5.56e-05 ***
UAI          -0.04319    0.07476  -0.578 0.564364    
LTO           0.24435    0.10452   2.338 0.020767 *  
IVR           0.08226    0.09818   0.838 0.403521    
GII          -0.59894    0.13785  -4.345 2.60e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 19.53 on 145 degrees of freedom
Multiple R-squared: 0.2125,  Adjusted R-squared: 0.1745 
F-statistic: 5.591 on 7 and 145 DF,  p-value: 1.012e-05


Call:
lm(formula = UAI ~ PDI + IDV + MAS + IPR + LTO + IVR + GII, data = data)

Residuals:
   Min      1Q  Median      3Q     Max 
-51.895 -17.378   1.937  17.102  44.420 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) -10.93850   26.48414  -0.413   0.6802
PDI           0.05647    0.12437   0.454   0.6505
```

```
IDV          0.01140    0.12655   0.090   0.9283
MAS         -0.05317    0.09204  -0.578   0.5644
IPR          6.70200    3.00670   2.229   0.0274 *
LTO          0.16616    0.11733   1.416   0.1589
IVR         -0.01340    0.10919  -0.123   0.9025
GII         -0.66832    0.15283  -4.373 2.33e-05 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 21.67 on 145 degrees of freedom
Multiple R-squared: 0.1881,  Adjusted R-squared: 0.1489
F-statistic:   4.8 on 7 and 145 DF,  p-value: 6.975e-05


Call:
lm(formula = LTO ~ PDI + IDV + MAS + UAI + IPR + IVR + GII, data = data)

Residuals:
   Min     1Q Median     3Q    Max
-31.84 -11.01  -0.55  11.95  33.17

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 97.48913   16.77681   5.811 3.79e-08 ***
PDI          0.05695    0.08736   0.652   0.5155
IDV         -0.03415    0.08891  -0.384   0.7015
MAS          0.14865    0.06359   2.338   0.0208 *
UAI          0.08211    0.05798   1.416   0.1589
IPR         -2.71788    2.13760  -1.271   0.2056
IVR         -0.50474    0.06431  -7.849 8.49e-13 ***
GII          0.53891    0.10517   5.124 9.39e-07 ***
---
```

```
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 15.23 on 145 degrees of freedom
Multiple R-squared: 0.5082,  Adjusted R-squared: 0.4845
F-statistic: 21.41 on 7 and 145 DF,  p-value: < 2.2e-16


Call:
lm(formula = IVR ~ PDI + IDV + MAS + UAI + LTO + IPR + GII, data = data)

Residuals:
    Min      1Q  Median      3Q     Max
-36.767  -8.687   0.030   6.768  46.784

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) 41.776343  19.851787   2.104  0.03707 *
PDI         -0.122919   0.094094  -1.306  0.19350
IDV         -0.198069   0.094823  -2.089  0.03847 *
MAS          0.058566   0.069905   0.838  0.40352
UAI         -0.007749   0.063152  -0.123  0.90251
LTO         -0.590732   0.075266  -7.849 8.49e-13 ***
IPR          7.482647   2.240833   3.339  0.00107 **
GII         -0.045114   0.123598  -0.365  0.71564
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 16.48 on 145 degrees of freedom
Multiple R-squared: 0.465,    Adjusted R-squared: 0.4392
F-statistic: 18.01 on 7 and 145 DF,  p-value: < 2.2e-16
```

```
Call:
lm(formula = GII ~ PDI + IDV + MAS + UAI + LTO + IVR + IPR, data = data)

Residuals:
    Min      1Q  Median      3Q     Max
-33.200  -7.739  -0.190   6.084  32.221

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -1.289e+02  8.285e+00 -15.554  < 2e-16 ***
PDI          4.471e-02  6.345e-02   0.705    0.482
IDV         -4.149e-03  6.463e-02  -0.064    0.949
MAS         -1.923e-01  4.427e-02  -4.345 2.60e-05 ***
UAI         -1.743e-01  3.987e-02  -4.373 2.33e-05 ***
LTO          2.845e-01  5.552e-02   5.124 9.39e-07 ***
IVR         -2.035e-02  5.575e-02  -0.365    0.716
IPR          1.500e+01  9.422e-01  15.918  < 2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 11.07 on 145 degrees of freedom
Multiple R-squared: 0.8652,  Adjusted R-squared: 0.8587
F-statistic: 132.9 on 7 and 145 DF,  p-value: < 2.2e-16
```

Homoscedasticity

```
        studentized Breusch-Pagan test

data:  modelA
BP = 34.4476, df = 1, p-value = 4.379e-09
```

studentized Breusch-Pagan test

data: modelB
BP = 29.2808, df = 7, p-value = 0.0001286

studentized Breusch-Pagan test

data: modelC
BP = 130.0357, df = 57, p-value = 1.241e-07

studentized Breusch-Pagan test

data: modelD
BP = 130.0357, df = 63, p-value = 1.439e-06

studentized Breusch-Pagan test

data: model1
BP = 130.0357, df = 57, p-value = 1.241e-07

studentized Breusch-Pagan test

data: model2
BP = 130.4453, df = 58, p-value = 1.693e-07

studentized Breusch-Pagan test

data: model3

BP = 130.0172, df = 57, p-value = 1.248e-07

studentized Breusch-Pagan test

data: model4

BP = 34.4476, df = 1, p-value = 4.379e-09

studentized Breusch-Pagan test

data: model5

BP = 32.6415, df = 2, p-value = 8.166e-08

studentized Breusch-Pagan test

data: model6

BP = 30.9399, df = 1, p-value = 2.661e-08

studentized Breusch-Pagan test

data: model7

BP = 34.4476, df = 1, p-value = 4.379e-09

studentized Breusch-Pagan test

data: model8

BP = 32.6415, df = 2, p-value = 8.166e-08

studentized Breusch-Pagan test

data: model9

BP = 30.9399, df = 1, p-value = 2.661e-08

studentized Breusch-Pagan test

data: model10

BP = 6.3069, df = 1, p-value = 0.01203

studentized Breusch-Pagan test

data: model11

BP = 22.0563, df = 4, p-value = 0.0001953

studentized Breusch-Pagan test

data: model12

BP = 97.9197, df = 56, p-value = 0.0004505

studentized Breusch-Pagan test

data: model13

BP = 25.9132, df = 6, p-value = 0.0002311

studentized Breusch-Pagan test

data: model14

BP = 97.9197, df = 62, p-value = 0.002465

Nonautocorrelation

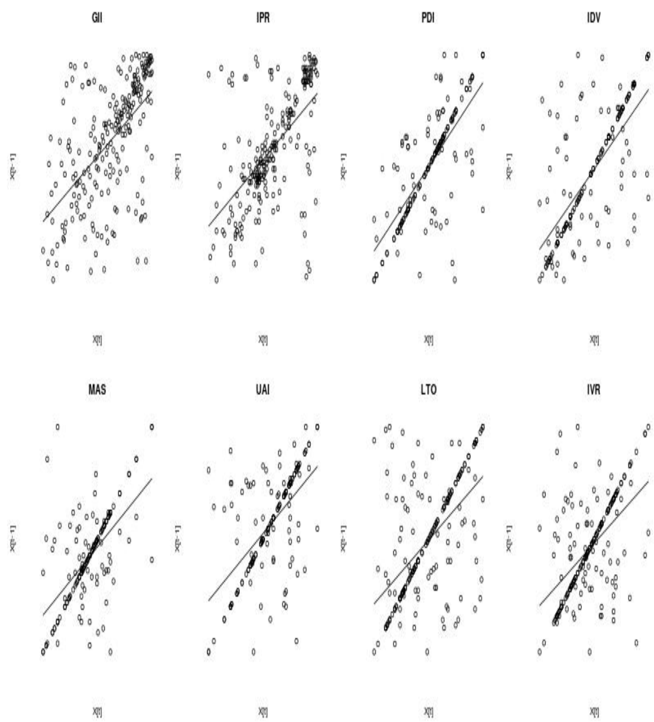


Illustration 5: Test of Autocorrelation in the Variables

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