ISSN No. 2454 - 1427

CDE
November 2023

The Political Economy of Intellectual Property Piracy: Do the Special 301 Pressures Matter?

Sunil Kanwar
Email: sunil_kanwar@econdse.org
Department of Economics,
Delhi School of Economic
University of Delhi

Working Paper No. 340

Centre for Development Economics
Delhi School of Economics
Delhi- 110007

The Political Economy of Intellectual Property Piracy:
Do the Special 301 Pressures Matter?

Sunil Kanwar

Abstract

This paper studies the impact that the exercise of Section 301 of the US Trade Act 1974 or the so-called Special 301 process has had on the phenomenon of global software piracy. The US authorities use these legal provisions to pressurize countries that they consider to be providing inadequate protection to US intellectual property, and which arguably hurts US producers, investors, and innovators. Opting for a panel vector autoregression framework which allows us to treat software piracy, Special 301 pressure, and intellectual property protection as endogenous, we study the piracy-Special 301 pressure nexus without predicating our analysis on untenable exclusion restrictions. Using data for the period 1994-2017, we find that piracy rates do not exhibit a statistically significant response to Special 301 pressure for the sample countries as a whole. The orthogonalized impulse response function adds useful detail to this insignificant response, revealing that the initial perturbation in piracy rates due to a change in Special 301 status of a country quickly damps out, and returns to even keel by the third period. The forecast error variance decomposition shows that the share of the change in Special 301 pressure is negligible in the total change in piracy rates, although this magnitude needs to be taken with caution, given that the variance decomposition ignores the contribution of the exogenous variables. Although US 301 pressure is not influential for the sample countries as a whole, the intellectual property protection variable appears to be strongly significant in curbing piracy. Finally, we find that the influence of Special 301 pressure on piracy is significantly stronger for countries with a US trade share exceeding the upper quartile of the distribution of US trade shares for the sample countries.

JEL Codes: O3, F5, K42, O57

Keywords: software piracy, section 301 pressure

* Corresponding Author: Department of Economics, Delhi School of Economics, University of Delhi, Delhi 110007, India; Email: sunil_kanwar@econdse.org

The Political Economy of Intellectual Property Piracy:
Do the Special 301 Pressures Matter?

Sunil Kanwar

1. Introduction

Intellectual property piracy pertains to the duplication and sale of copyrighted goods without the copyright holder's permission (Fink, Maskus and Qian 2016). This includes software, books, videos, and sound recordings. With steady advancements in the areas of reprographic technology, the piracy of intellectual property has become a serious issue in recent decades. Combating piracy has become even more difficult in today's age of the internet, where protection is national in scope but the theft occurs across borders (Maskus 2000; Varian 2005, and the references therein).

Piracy is perceived as a major problem on a number of counts. First, and possibly most importantly, it discourages the production of original works, insofar as it erodes the profits and thereby the monetary incentives of the innovators and authorized producers.[1] Second, pirated works (for example, cheap copies of books, and copied or downloaded software) are oftentimes of relatively inferior quality or without official support or carrying malware (BSA 2018), with possibly negative implications for consumer welfare. Third, in the context of international exchange, unless countries take measures to prevent piracy in their own economies, they would not be justified in expecting similar treatment from the rest of the world. Fourth, insofar as pirated products (such as books and compact discs) are sold in the grey market (often 'pavement markets' in the poorer economies), the government stands to lose revenue. Fifth, and not the least, it is not the moral thing to do.

Some would argue, however, that a part of piracy may well be justified. For innovators "stand on the shoulders of their forefathers", benefiting from earlier innovation, and yet are sanguine about hiding behind overly strong intellectual property protection, to earn extra-economic rents for their innovations. Thus, to the extent that software, books, videos, and audio recordings are often sold at undue super-normal profits, those business practices may be unjustified, and one is not surprised if that provokes piracy. Evidence on this phenomenon is provided by Kukla-Gryz (2021) and Lau (2006). In these situations, some may consider piracy (of the software) to be partially justified.

However, even when it is accepted that it's the pursuit of super-normal profit that provokes piracy, one finds it difficult to condone all piracy. In these circumstances, what methods ought to be adopted to reign in 'unacceptable piracy' becomes an important policy question. Of the several factors that impinge on piracy, in this paper we focus on the US political pressure imposed on its trading partners in an effort to reduce piracy. More specifically, we study the impact that the exercise of Section 301 of the US Trade Act 1974[2] might have had on the phenomenon of piracy worldwide. The US authorities use these legal provisions to pressurize countries that they consider to be providing inadequate protection to US intellectual property, and which therefore, purportedly hurts US producers, investors, and innovators. More specifically, drawing sustenance from Section 301 of the US Trade Act (Drahos 2006), the US Trade Representative places the countries deemed in violation, on various 'censure lists' for possible punitive action, a procedure termed the Special 301 process. With the exception of Shadlen, Shrank and Kurtz (2005), there are virtually no earlier formal studies of this issue, especially empirical, and our study purports to fill this gap.

1.1 *Theoretical studies*

The theoretical literature on the relationship between piracy in a given country, and political pressures from a specific country seeking to circumscribe that piracy, is non-existent. Therefore, we use theory constructed for other, though relatable contexts, to help us understand the ramifications of this coercive strategy.

McMillan (1990) uses game theoretic models to argue that the success of Section 301 pressures in achieving US objectives varies inversely with the counter-retaliation ability of targeted countries, varies directly with their dependence on the US market, and varies inversely with the compliance costs for the targeted country, although he does not study piracy in particular.

The piracy-Special 301 nexus is particularly difficult to theorize, and one could think about it in several alternative ways. One could argue that piracy diminishes as a result of sanctions imposed pursuant to the US political pressures. In fact, the office of the United States Trade Representative (USTR) makes this claim in several publications (see USTR 1990, and subsequent reports). Second, it could be the case that piracy diminishes to avoid the sanctions that would follow the threat that such political pressures signify. For instance, McMillan (1990) cites evidence that "To avoid being named in the first Super 301 list of priority countries … South Korea and Taiwan took steps to increase their imports from the US". Third, as a corollary of the previous view, one could argue that piracy remains small due to the threat of sanctions. Fourth, Sykes (1992) emphasizes that even though unilateral actions such as those under Special 301 may be beneficial for the US in some situations, the possibility is nevertheless non-zero that such threats may precipitate a trade war, and may increase protectionism. By implication, piracy may remain high as a mark of defiance to the threat of sanctions. In other words, the use of Special 301 pressures could be associated with piracy rates that decrease, remain the same, or possibly even increase. Therefore, argues Sykes (1992), the impact of unilateral sanctions under Special 301 ultimately remains an empirical question.

1.2 *Empirical studies*

For non-quantitative analyses in the legal tradition, striving to link Special 301 legislation with software and motion pictures piracy, we can turn to Shiu (2006), Kopczynski (2006), and Lee (2008). However, quantitative empirical studies in this area are virtually non-existent, Shadlen, Shrank and Kurtz (2005) being the only exception. A major lacuna of their study is that it does not consider endogeneity bias on account of reverse causality; for after all, the Special 301 process is initiated against countries on the basis of information regarding piracy of US intellectual property in those countries, provided by US agencies such as the International Intellectual Property Alliance. Further, the Special 301 pressure probably has both a direct as well as an indirect effect on piracy rates, where the former works to induce better implementation of statutes in the partner countries placed on various watch lists, and the latter likely works via its effect on the de jure strength of intellectual property protection that countries provide.

In view of these observations regarding the complexity of the piracy-Special 301 nexus, we eschew traditional regression estimation, and instead opt for a vector autoregression (VAR) framework to explore the relationship in question. This approach has several advantages in the present situation, which shall become evident as we proceed. Very briefly, it allows us to treat piracy, Speical 301 pressure, and de jure intellectual property protection as endogenous, without having to predicate our analysis on the exogeneity of the Special 301 pressure. Using data for the period 1994-2017, we find that piracy rates do not exhibit a statistically significant response to Special 301 pressures for the sample countries as a whole. This is evident not just from a bi-variate Granger causality test, but more pertinently from a block exogeneity test that considers both the direct and indirect influence of Special 301 pressures on piracy. The orthogonalized impulse response function adds useful detail to this insignificant response, revealing that the initial perturbation in piracy rates due to a change in Special 301 status of a country quickly damps out, and returns to even keel by the third period. The forecast error variance decomposition shows, additionally, that the share of the change in Special 301 pressure is negligible in the total change in piracy rates, although this magnitude needs to be taken with a pinch of salt, for this variance decomposition ignores the contribution of the exogenous variables. Although US 301 pressure is not influential for the sample countries as a whole, the intellectual property protection variable appears to be strongly significant in curbing piracy, at the 5% level. Finally, we find that the influence of US 301 pressure on piracy is significantly stronger for countries with a US trade share exceeding the upper-quartile of the distribution of US trade shares for the sample countries.

Section 2 spells out the estimation strategy. Section 3 completes the model specification by briefly discussing the system variables, and the data used. Section 4 presents and discusses the empirical results, as well as their robustness to various checks, and Section 5 provides a brief conclusion.

2. Estimation Strategy

The claimed relationship between national piracy rates and the extent of US political pressure upon these nations is complex. The US political pressure on its trading partners via Special 301 likely has both a direct as well as an indirect effect on piracy rates in these countries. The indirect effect operates via the de jure strength of intellectual property protection that countries provide, where this protection likely responds to the Special 301 pressure that the US exerts on its trade partners. We do not claim the exogeneity of this political pressure variable, and indeed acknowledge that the Special 301 actions of the USTR are motivated, on the one hand, by the high piracy rates of US intellectual property in its trading partner countries, and on the other, by the inadequate de jure levels of intellectual property protection that those countries provide.

Given the arbitrariness of specifying a structural model (Sims 1980), and the difficulty of removing endogeneity bias in the face of inter-dependence of the piracy, US political pressure, and intellectual property protection variables, an attractive solution would be to employ a vector autoregression. The vector autoregression is hypothesized to relate (percentage) changes in the national piracy rate ($PIRACY$), US political pressure via the Special 301 process ($S301$), and intellectual property protection (IPP), controlling for (percentage) changes in a vector of exogenous factors such as per capita income (PCY), education level (EDU), and trade share with the US ($TRSH$). Each of the variables used to construct these percentage change or log difference variables, is defined in detail in section 3 below.

We now spell out the model for clarity. Consider a k-variate panel vector autoregression ($PVAR$), with m exogenous covariates, and with entity-specific and time-specific fixed effects:

$$Y_{it} = B_1 Y_{i(t-1)} + B_2 Y_{i(t-2)} + \cdots + B_L Y_{i(t-L)} + \Gamma X_{it} + \alpha_i + \delta_t + \epsilon_{it} \quad (1)$$

where $i = 1, \dots, N; t = 1, \dots, T_i$; and L is the optimum lag order chosen on the basis of appropriate criteria. Y_{it} is a *k*x*1* vector of dependent variables $(PIRACY_{it} \ \ S301_{it} \ \ IPP_{it})'$, $B_1$to B_L are *k*x*k* matrices of parameters to be estimated, X_{it} is an *m*x*1* vector of exogenous covariates $(PCY_{it}\ \ EDU_{it}\ \ TRSH_{it})'$, Γ is a *k*x*m* matrix of parameters to be estimated, α_i is a *k*x*1* vector of regressand-specific entity fixed effects which control for unobserved heterogeneity across nations due to factors such as attitudes, moral values, etc., δ_t is a *k*x*1* vector of regressand-specific year fixed effects which control for factors that vary over time but are constant across nations (such as the 2008 financial crisis), and ϵ_{it} is a *k*x*1* vector of regressand-specific idiosyncratic errors. Substituting these matrices in equation (1) gives us

$$\begin{bmatrix} PIRACY_{it} \\ S301_{it} \\ IPP_{it} \end{bmatrix} = \begin{bmatrix} \beta_{11}^1 & \beta_{12}^1 & \beta_{13}^1 \\ \beta_{21}^1 & \beta_{22}^1 & \beta_{23}^1 \\ \beta_{31}^1 & \beta_{32}^1 & \beta_{33}^1 \end{bmatrix} \begin{bmatrix} PIRACY_{i(t-1)} \\ S301_{i(t-1)} \\ IPP_{i(t-1)} \end{bmatrix} + \begin{bmatrix} \beta_{11}^2 & \beta_{12}^2 & \beta_{13}^2 \\ \beta_{21}^2 & \beta_{22}^2 & \beta_{23}^2 \\ \beta_{31}^2 & \beta_{32}^2 & \beta_{33}^2 \end{bmatrix} \begin{bmatrix} PIRACY_{i(t-2)} \\ S301_{i(t-2)} \\ IPP_{i(t-2)} \end{bmatrix} + \cdots$$

$$+ \begin{bmatrix} \beta_{11}^L & \beta_{12}^L & \beta_{13}^L \\ \beta_{21}^L & \beta_{22}^L & \beta_{23}^L \\ \beta_{31}^L & \beta_{32}^L & \beta_{33}^L \end{bmatrix} \begin{bmatrix} PIRACY_{i(t-L)} \\ S301_{i(t-L)} \\ IPP_{i(t-L)} \end{bmatrix} + \begin{bmatrix} \gamma_{11} & \gamma_{12} & \gamma_{13} \\ \gamma_{21} & \gamma_{22} & \gamma_{23} \\ \gamma_{31} & \gamma_{32} & \gamma_{33} \end{bmatrix} \begin{bmatrix} PCY_{it} \\ EDU_{it} \\ TRSH_{it} \end{bmatrix}$$

$$+ \begin{bmatrix} \alpha_i^{PIRACY} \\ \alpha_i^{S301} \\ \alpha_i^{IPP} \end{bmatrix} + \begin{bmatrix} \delta_t^{PIRACY} \\ \delta_t^{S301} \\ \delta_t^{IPP} \end{bmatrix} + \begin{bmatrix} \epsilon_{it}^{PIRACY} \\ \epsilon_{it}^{S301} \\ \epsilon_{it}^{IPP} \end{bmatrix} \quad (2)$$

As a result of the lagged dependent variables on the right-hand side, ordinary least squares estimation of the above system yields inconsistent estimates (Nickell 1981; Abrigo and Love 2016), and this bias persists even when T is 'large' (Judson and Owen 1999). Generalized Method of Moments (GMM) estimation of the above system provides consistent estimators. Since these estimators may suffer from the weak instruments problem when the variables modelled have a near unit root, the variables must be rendered stationary via suitable transformations before estimation (Abrigo and Love 2016; and the references therein), or else model (2) must be re-specified appropriately (for instance, as an autoregressive distributed lag) before application of the GMM technique (Lütkepohl 2005).

3. Data and Variables

3.1 The Endogenous Variables

We first explain how the three endogenous variables – piracy, US Special 301 pressure, and intellectual property protection – have been computed. Since the focus is on the political pressure variable, how this variable works is explained in relative detail.

3.1.1 *Piracy*

Although intellectual property piracy includes the piracy of software, books, videos, and sound recordings, data availability limits us to a study of software piracy. The Bureau for Software Alliance, in association with various US trade bodies, provides annual estimates of software piracy across a large number of countries. These data are available from 1994 onwards (see, for instance, BSA 2018). The agencies in this alliance first derive estimates of software demand for a country, given its hardware infrastructure. Next, they obtain data on licensed software sales from distributors and retailers in that country. Software piracy is then defined as the difference between estimated demand and legitimate sales.[3] For this study, we use the software piracy rate or software piracy as a percentage of the estimated software demand ($piracy$).[4]

3.1.2 *The Special 301 variable*

Our focus in this paper is on the Special 301 process, and how it influences piracy rates worldwide. How does the Special 301 process work? The office of the United States Trade Representative has brought out from 1989 onwards an annual Special 301 report, which lists countries that provide inadequate intellectual property protection in comparison with US standards, which is (at least potentially) inimical to US producers and investors.

Countries are placed on a 'Watch List' (WL), a 'Priority Watch List' (PWL), or a 'Priority Foreign Country' (PFC) list, with these categories indicating a progressively greater degree of US concern, consequent to the greater severity of non-compliance.[5] The USTR undertakes this action on the advice of the Trade Policy Staff Committee, which itself obtains information from the private sector, civil society, academics, etc. An action plan to settle the issues between the US and its trading partner under watch is then proposed, and the progress monitored. This investigation could culminate in trade sanctions on the errant trading partner, if the USTR deems that insufficient progress has been made (USTR 1989).

In addition, the USTR conducts an 'out-of-cycle review' of countries, wherein their IP regimes are subjected to an exhaustive investigation. In such reviews, the USTR probes not just a country's IP statutes, but also its implementation, wherein it may castigate the country for ineffective customs and police procedures, and the inadequate penalties it imposes on IP violators (USTR 1993; Shadlen, Shrank and Kurtz 2005). Such out-of-cycle reviews may be undertaken for countries which are 'not listed', or are already on the Watch List, Priority Watch List or Priority Foreign Country list.

We create the categorical variable $s301$, to capture the political pressure exerted by the US by placing the intellectual property regime of its trading partners under formal observation. We define $s301 = 1$ if the US trading partner is not under surveillance of Section 301, $s301 = 2$ if the trade partner is on the Watch List (WL), $s301 = 3$ if the trade partner is on the Priority Watch List (PWL), $s301 = 4$ if the trade partner is on the Priority Foreign Country List (PFCL), $s301 = 1.5$ if the trade partner is not on any of these lists but is under Out-of-Cycle Review (OCR), $s301 = 2.5$ if the trade partner is on the Watch List and under out-of-cycle review, $s301 = 3.5$ if the trade partner is on the Priority Watch List as well as under the out-of-cycle review, $s301 = 4.5$ if the trade partner is on the Priority

Foreign Country List and also under out-of-cycle review. Finally, $s301 = 5$ if the trade partner is placed under Section 306 monitoring, which appears to exert relatively strong pressure, insofar as it implies "… that the USTR will … move *directly* to trade sanctions if there is slippage in … enforcement of the bilateral IPR agreements" (emphasis added; USTR 1997).

Sykes (1992) articulates the rationale underlying this coercive process succinctly: Some may suggest that the 'stick' (US retaliation) may be inferior to the 'carrot' (bilateral concessions), because the economic gains would be greater with the latter policy; for not only would it achieve the desired reduction in protection and piracy/strengthening of IPP by the allegedly guilty party, it would also diminish protection in the US. In addition, the 'carrot' policy would avoid political tensions. However, since reciprocity is not self-enforcing, a strong argument may arise for sanctions to remedy non-compliance. This was the thinking behind the Special 301 process.

The very fact that the US has persisted with these policies for over three decades, indicates that it considers the Special 301 process a potent instrument to pressure countries into increasing their effective levels of intellectual property protection and/or directly reducing piracy, as indeed is claimed by the USTR reports.

Let us briefly consider to what extent the USTR claims mentioned above are tenable. While the '301 process' may well increase the pressure for intellectual property reform in a given country, such pressure may be insufficient to overcome domestic resistance to such reform, especially If such pressures are regarded as bullying (Sykes 1992). Moreover, some researchers observe that although USTR pressure may have been effective in inducing countries to strengthen de jure protection, it was not necessarily effective in prompting de facto reform (Sell 1995). Further, such pressures may not represent a credible threat –

although numerous countries are placed on the ‘watch list’, relatively few are raised to the ‘priority foreign country’ list, and even fewer are actually sanctioned. Similar arguments appear to be valid for the ‘out-of-cycle review’ process (Shadlen, Shrank and Kurtz 2005).

3.1.3 *Intellectual property protection*

To compute the index of intellectual property protection, we take the Ginarte-Park index of de jure patent rights (Ginarte and Park 1997; Park 2008), and strengthen it to better reflect de facto protection. The Ginarte-Park index integrates five aspects of protection – coverage (what is legally patentable), duration (years of protection), membership of intellectual property agreements (signalling certain commitments), provisions to prevent patent revocation, and enforcement procedures (on the statutes). Each component varies between 0 and 1, so that the composite index ranges from 0 to 5. Although the original index is quinquennial, given its steady increase over time and lack of fluctuations, we derive the annualized series for our sample countries assuming proportional growth in the intervening years.

Since this index is a de jure measure of the strength of protection, we modify our annualized series to better reflect the implementation dimension across countries. For this, we employ the Area-2 sub-index from the Economic Freedom dataset of the Fraser Institute (Economic Freedom 2018). The Area-2 sub-index components capture various facets of legal enforcement in a country, namely, contract enforcement, impartiality of courts, judicial independence, impediments to property sale, property rights protection, and military intervention. Since the sub-index ranges from 0 to 10, we divide it by 10 to re-scale it from 0 to 1, in consonance with the components of the Ginarte-Park annualized series, and then add it to the latter. This sum gives us the index of intellectual property protection (ipp), which varies from 0 to 6, with larger numbers indicating stronger protection.[6]

3.2 The Exogenous Variables

It would be reasonable to argue that richer countries exhibit lower piracy probably because, ceteris paribus, their citizens can better afford the legal software and do not need to resort to illegal acquisition (Andres 2006a; Gopal and Sanders 1998). We capture this affordability factor in terms of per capita income (pcy), which we measure as per capita gross domestic product in constant 2017 PPP$ (World Bank 2023a).

The role of education in explaining the phenomenon of piracy, however, is more complex. More educated societies may pirate less, if education implies a greater awareness of intellectual property protection laws, and the penalties involved in violating them. On the other hand, more educated societies may manifest greater piracy, if education implies a greater facility with technology that can be used for piracy. Therefore, all other things given, the net influence of education on piracy remains à priori unclear. We represent education (edu) by the average years of schooling in the population aged 15 and above (Barro and Lee 2013, 2015). Using their quinquennial data till 2010 (the last year that it is available), and their quinquennial projections for the rest of our sample period, we compute the annual series for this variable presuming proportionate change between quinquennia.

It is plausible that US initiation of the Special 301 process against a given country may not elicit the desired response, for the reason that the US may not be an important trade partner for that country (Elliott and Richardson 1997). To allow for this possibility, we include the regressor trade share ($trsh$), which is defined as a given country's exports to the US as a proportion of that country's total exports.[7]

Heterogeneity across nations on account of difficult to measure factors such as ethical attitudes, cultural practices, etc. (Gupta, Gould and Pola 2004; Depken and Simmons 2004; Husted 2000), is controlled for via the entity fixed effects in our estimation system (2); and heterogeneity across time periods due to events such as the 2008 financial crisis, is controlled for by the year fixed effects.

3.3 Dataset

Compiling the data for all the system variables discussed above, and dropping the panel entities with insufficient data, we opt for a strongly balanced panel, pertaining to 71 countries[8] observed over the 24-year period 1994-2017. To jump ahead for a moment, we prefer to work with a strongly balanced panel, because some of the unit root tests that we shall employ in the following section require a balanced panel.

The sample statistics in Table 1 are provided both for the original variables $piracy, s301, ipp, pcy, edu, trsh$ (written in lower case), as well as the percentage change or log difference in these variables $PIRACY, S301, IPP, PCY, EDU, TRSH$ (expressed in upper case). From the sample statistics provided in Table 1, we note a small, negative contemporaneous correlation of –0.07 between the mean percentage change in the piracy rate and the mean percentage change in US political pressure, where both means have been computed for all sample countries in a given sample year. The Figure 1 scatterplot provides an alternative confirmation of this mildly negative contemporaneous relationship.

4. Estimation Results

GMM estimators of system (2) may suffer from the weak instruments problem if the system variables exhibit nonstationarity. Therefore, we begin by examining each variable for the presence of a unit root.

4.1 Testing for Unit Roots in the System Variables

Although a variety of panel data unit root tests are available, not all may be appropriate in our context. On the basis of extensive simulation studies, Hlouskova and Wagner (2006) point out that stationarity tests, such as the Hadri test, perform very poorly. These tests reject the null hypothesis of stationarity for all processes that 'differ even mildly' from white noise, and for all but the shortest of time periods T. Of the non-stationarity tests (see Baltagi 2013), the Breitung 'robust' test is infeasible in our case, because it requires more time periods (net of lags) than entities, which is untrue of our sample where N = 71 versus T = 24. The Harris-Tsavalis test takes the time dimension T to be fixed, whereas N is presumed to go to infinity for the asymptotics. This is implausible for our dataset, where the number of countries N is given, and only T can increase. Choi's Fisher-type tests yield conflicting answers depending on whether we use the Dickey-Fuller or Phillips-Perron specification.

Therefore, we conduct the panel unit root tests using the Levin-Lin-Chu, and Im-Pesaran-Shin tests (Baltagi 2013). The Figure 2 scatterplots of the means of each of the variables (computed for all sample countries in a given year) against the time dimension, reveal clear trends in $piracy$, ipp, pcy, and edu, but not in $s301$ and $trsh$. Therefore, we do not consider the trend version of the unit root tests for the latter variables.[9]

4.1.1 *Levin–Lin–Chu Test*

The Levin–Lin–Chu test is recommended for (balanced) panels having 10 to 250 entities, and 25 to 250 observations per entity (Baltagi 2013), which is consistent with our sample. For the test statistics to have optimal asymptotic properties, it requires that $N/T \rightarrow 0$, which implies that T increases faster than N, which fits our situation where N is given and T can increase. To ensure that the error term is white noise, this test estimates an augmented Dickey-Fuller specification, wherein we selected the optimal lag length by minimizing the Schwarz Information Criterion (SIC). Since many countries in our sample, for instance the European Union members and those in the Organization for Economic Cooperation and Development, follow various coordinated policies, there could be cross-section correlation in the sample, for which we control by removing the cross-sectional means. The test results are presented in Table 2, and we discuss these together with those of the Im-Pesaran-Shin unit-root test.

4.1.2 *Im-Pesaran–Shin Test*

Unlike the Levin-Lin-Chu test, the Im-Pesaran-Shin test allows for a heterogeneous autoregressive parameter across panel entities, which is reasonable given cultural, institutional, and other differences across the countries in our sample. It then derives the overall test statistic by averaging the individual test statistics. For the augmented Dickey-Fuller specification that is estimated to ensure a white noise error term, we chose the optimal lag length by minimizing the Schwarz Information Criterion, and opted to control for cross-section correlation in the sample by removing the cross-sectional means. Hall and Mairesse (2005) find this test preferable on the basis of its small sample performance in Monte Carlo studies.

Basing our judgement on the Levin-Lin-Chu and Im-Pesearan-Shin test results presented in Table 2, we find that the null hypothesis of a unit root is strongly rejected for the log differenced variables $PIRACY$, $S301$, IPP, PCY, EDU, and $TRSH$, although the underlying series do not appear to be stationary for pcy, edu, and $trsh$. It is the former that we employ in our estimations below.

4.2 Panel VAR and Granger Causality Test

To estimate the panel vector autoregression, we first determine the optimal lag order for the endogenous variables. We base this choice on the Andrews-Lu model and moment selection criteria (MMSC), which have been developed specifically in the context of GMM estimation of dynamic models (Andrews and Lu 2001). They find the Schwarz Information Criterion (MMSC-SIC) to be relatively the best on a number of counts. Allowing for 4 to 8 lags of the dependent variable in alternative specifications of the underlying PVAR, Table 3 reveals that lag order 1 minimizes the MMSC-SIC, and this choice is supported by the Hannan-Quinn Information Criterion.

Therefore, using lag order 1 for the endogenous variables $PIRACY$, $S301$, and IPP, we estimate the panel vector autoregression 'base model'. The estimation results are presented in Table 4, columns (1) to (3). The lagged US political pressure variable $S301_{t-1}$ is found to have a weak *positive* effect on piracy, significant at the 10% level; a result at variance with the claims of the sobering effect of this variable on piracy. The formal bi-variate Granger causality test in Table 5, column (1), confirms the mild significance of $S301_{t-1}$ in predicting changes in piracy.

In a system with more than two endogenous variables, however, testing for the Granger causality of $PIRACY$ vis-à-vis $S301$ becomes more complicated. This is because

$S301$ could have both a direct, and an indirect effect (via IPP) on $PIRACY$. To allow for this, we test the null hypothesis that the coefficient of $S301$ in the $PIRACY$ equation, and the coefficient of $S301$ in the IPP equation, are both 0 (Enders 2014). The associated p-value of 0.2607 at the bottom of Table 4, column (1), clearly indicates the lack of any predictive power of $S301$ in explaining inter-temporal movements in $PIRACY$. By contrast, IPP_{t-1} has a negative and mildly significant effect on $PIRACY$, and a joint test of the null hypothesis that the coefficient of IPP_{t-1} in the $PIRACY$ and $S301$ equations is 0, is strongly rejected at the 5% level, as is evident from the associated p-value of 0.0199 at the bottom of Table 4, column (1).

4.2.1 *Impulse Response Function*

Table 6 reveals that the eigenvalues associated with our base model are all less than one, indicating that the relationship is stable. This implies that the vector autoregression can be expressed as a vector moving average (VMA), allowing us to further analyse the estimated relationship using impulse response analysis.

Since the simple impulse response function (IRF) of $PIRACY$ w.r.t. $S301$ does not have a causal interpretation, because a shock in $S301$ is likely contemporaneously correlated with shocks in other variables, say IPP, the literature employs Sims' (1980) suggestion to orthogonalize the shocks using a Cholesky decomposition of the residual covariance matrix of the panel VAR, and to transform the VMA parameters into orthogonalized impulse-responses. The orthogonalized impulse response function of $PIRACY$ vis-à-vis $S301$ in the base model is presented in Figure 3(a),[10] and the simple IRF is presented in Figure 4(a) for comparison purposes. The shaded region in the graph is the 95%

confidence interval, which has been computed using 500 Monte Carlo draws from the distribution of the fitted reduced-form panel vector autoregression.

Figure 3(a) shows the impact on $PIRACY$ of a one standard deviation shock to $S301$. The orthogonalized IRF confirms that $S301$ does not have a significant impact on $PIRACY$, insofar as the 95% confidence region includes the zero line. While there is a small positive impact in the first period, this is reversed in the second period, and by the third period the response variable converges back to zero.

4.2.2 *Forecast Error Variance Decomposition*

Forecast-error variance decomposition (FEVD) explores the relative importance of shocks in the endogenous variables in explaining the overall forecast error variance, and how these contributions change over time. We must process this decomposition with some reserve, however, because it ignores the contribution of the exogenous variables. Table 7 reports the FEVD of the software piracy variable $PIRACY$. The contribution of changes in $S301$ to the variation in $PIRACY$ remains very small right from the start, and converges to only about 0.4%. Even the indirect contribution of $S301$, via its contribution to changes in IPP, remains small. Therefore, overall, the contribution of the US political pressure variable is quite trivial in predicting changes in the piracy variable.[11]

4.3 Robustness Checks

To strengthen our confidence in the above results and analysis, we subject our estimation to several robustness checks.

4.3.1 *Redefining S301*

Since $S301$ is the major variable of interest, further scrutiny of this variable would be in order. Instead of defining its underlying variable $s301$ as in section 3.1 above, we redefine it as follows. Variable $s301$ = 1.5 is merged with $s301 = 1$, $s301$ = 2.5 is merged with $s301 = 2$, $s301$ = 3.5 is merged with $s301 = 3$, and $s301$ = 4.5 is merged with $s301 = 4$. In other words, we only go by the 'lists' announced by the USTR's office, and do not impute any meaning to placing a country under an 'out-of-cycle-review'. We do, however, retain the category $s301 = 5$, if the trade partner is placed under Section 306 monitoring. The optimal lag order of the panel VAR remains unchanged at 1 (results not reported for brevity). A glance at the panel VAR results in Table 4 columns (4) to (6), and the supporting results reported in Tables 5 to 7 as well as Figure 3(b), confirm that this variation does not alter the base model results in any meaningful manner.

4.3.2 *Alternative measures of exogenous EDU and $TRSH$*

We redefine the education variable EDU as the human capital index from the Penn World Tables 10 (Feenstra, Inklaar and Timmer 2015), which is based on years of education and returns to schooling. This may be an improvement compared to our base model measure, which is based on years of schooling alone, and therefore does not correct for quality of education across countries. We also redefine the trade share variable $TRSH$ as the sum of exports to and imports from the US, as a proportion of the total trade of the sample country. This may be more comprehensive than the base model measure which focused on exports alone; after all, the US could penalise a trading partner both by hurting its exports to as well as its imports from the US. Also, since the re-definition of $S301$ in the previous robustness exercise made no difference, we revert to its original definition. A perusal of the panel VAR estimation results reported in Table 4, columns (7) to (9), and the other results presented in Tables 5 to 7, as well as Figure 3(c), confirms that this robustness check does not alter the base model results discussed previously.

4.3.3 *Alternative measure of endogenous IPP with greater weight on implementation*

We re-compute the patent rights variable IPP, by placing greater weight on implementation of the intellectual property laws. Instead of adding the implementation component (the re-scaled 'Area-2' sub-index) to the five components of the Ginarte-Park index, we now multiply the 'Area-2' sub-index by 2, and then add it to the Ginarte-Park index. From the panel VAR results reported in columns (10) to (12) of Table 4, and the other results in Tables 5 to 7 and Figure 3(d), it is apparent that the estimates do not change appreciably compared to the base model.

4.3.4 *Additional exogenous variable GINI*

It has been argued that piracy may be influenced by the extent of income inequality in a country. Thus, Husted (2000) and Andres (2006b) appear to claim that more inequality implies a smaller middle class which would imply less piracy, ceteris paribus, although why the size of the 'middle class' should vary positively with piracy is not explained. It would be reasonable to argue, on the contrary, that greater inequality implies high purchasing power in the hands of just a few, with the rest unable to afford expensive software, so that more inequality implies more piracy. We represent income inequality by the Gini index ($GINI$), and include this as another exogenous variable in the system (World Bank 2023b). From the panel VAR results in columns (13) to (15) of Table 4, and those in Tables 5 to 7 and Figure 3(e), we do not have any reason to alter our observations from our base model. Note that we prefer to exclude variable $GINI$ from our base model, because the data were very patchy for most countries, forcing us to resort to interpolation. Therefore, we use the Gini index data just for the robustness check.

4.3.5 *Unbalanced panel*

So far we have used a balanced panel for all our estimations, because some of the unit root tests employed above required a strongly balanced panel. As a final robustness check, we now use an unbalanced panel that includes all the observations available, and we also revert to the endogenous and exogenous variables as included and defined in the base model. The panel VAR estimation results are presented in Table 4 columns (16) to (18), as well as Tables 5 to 7 and Figure 3(f). Despite the somewhat larger sample size, our earlier results remain unchanged.

4.4 Further insights using an alternative specification

As we noted in section 3.2 above, some researchers argue that US Special 301 pressure is likely to be effective against its trading partners only when the latter have significant trade with the US (Elliott and Richardson 1997). In an attempt to test for this differential effect, we define the dummy variable $d^{trsh} = 1$ if a country's share of trade with the US exceeds the upper-quartile of the distribution of US trade shares for the sample countries, and $= 0$ otherwise. As in the base model, trade share ($trsh$) is defined as a given country's exports to the US as a proportion of that country's total exports. The dummy is so-defined for each year of the sample period, using the upper-quartile of the distribution of US trade shares of the sample countries specific to that year. Interacting the dummy with $S301$, we replace $S301$ in equation-system (2) by the interaction term $S301' = d^{trsh} * S301$. A joint test of the significance of this term in the first and third equations of equation-system (2) allows us to test the hypothesis that the effect of $S301$ on $PIRACY$ is significantly larger for countries with above-upper quartile US trade shares.

The panel VAR estimation results for the base model are presented in Table 8, columns (1) to (3), and from the bottom of column (1) we note that the p-value of the 'differential effect' test mentioned in the previous paragraph is 0.0058, which strongly supports the contention that the influence of $S301$ on $PIRACY$ is indeed significantly larger for countries with US trade shares above the upper-quartile of the distribution of US trade shares for the sample countries. This is also evident from a comparison of the orthogonalized impulse response function in Figure 4(a) with that of Figure 3(a). Thus, one finds that the first period response of $PIRACY$ to a unit change in $S301$ is a lot larger for countries with above-upper quartile US trade shares. From the subsequent columns of Table (8), and the subsequent graphs of Figure 4, it is evident that this conclusion remains unchanged under alternative scenarios.

5. Conclusions

In this study, we explore the relationship between software piracy and US pressure to curb this phenomenon via the 'Special 301 process' of placing trading partners on what may be termed 'censure lists', with the implicit threat of concrete action that would hurt their economic interests. The latter would typically take the form of higher trade tariffs and, as a consequence, lower trade competitiveness (of the censured trade partner) in the US economy. Observing that a traditional structural regression specification appears inappropriate in the present context, because the 'treatment variable' of section 301 pressure is itself motivated by considerations of intellectual property protection and the degree of piracy in the trading partner countries, we propose a panel vector autoregression specification. This permits us to treat piracy, section 301 pressure, and de jure intellectual property protection as endogenous. Using data for the period 1994-2017, application of GMM techniques yields consistent and efficient estimates, which shed useful light on the issues under consideration.

Our estimates reveal that US Special 301 pressures do not appear to have any significant influence on international software piracy for the sample countries as a whole, in broad conformity with Shadlen, Shrank and Kurtz (2005), but contrary to Shiu (2006), Kopczynski (2006), Lee (2008), as well as claims in USTR (1990) and later reports. This is evident both from a bi-variate Granger causality test, as well as from a block exogeneity test that considers both the direct and indirect influence of Special 301 pressures on piracy. The orthogonalized impulse response function shows that the initial response of piracy rates to a change in the Special 301 status of a country rapidly dies out by the third period. The forecast error variance decomposition reveals, further, that the share of the change in Special 301 pressure is negligible in the total change in piracy rates. Although US 301 pressure is not influential for the sample countries as a whole, the intellectual property protection variable appears to be strongly significant in curbing piracy, at the 5% level. Finally, we find that the influence of US 301 pressure on piracy, is significantly stronger for countries with an above-upper quartile US trade share.

The reasons underlying the statistical insignificance of the US Section 301 pressures vis-à-vis global piracy are probably multiple. For one, such pressures may have been insufficient to overcome domestic resistance in a trading partner, particularly if they are regarded as bullying (Sykes 1992). Further, although USTR pressure may have resulted in somewhat stronger de jure protection, it may not have brought about stronger de facto reform (Sell 1995). Alternatively, such pressures may not represent a credible threat insofar as few countries are raised to the ‘priority foreign country’ list, and even fewer actually sanctioned. Finally, the costs of non-compliance may not be high enough for most nations; anecdotal evidence shows that fines tend to be small and conviction rates pathetic in many medium- and low-income countries (see Shiu 2006 for some evidence from Taiwan). To formally link the benefits and costs of compliance with the Section 301 pressures, however, falls firmly beyond the ambit of this study.

References

Abrigo, Michael R.M., Inessa Love, 2016, Estimation of Panel Vector Autoregression in Stata, *Stata Journal*, 16(3), 778-804.

Andres, Antonio R., 2006a, The Relationship between Copyright Software Protection and Piracy: Evidence from Europe, *European Journal of Law and Economics*, 21(1), 29-51.

Andres, Antonio R., 2006b, Software Piracy and Income Inequality, *Applied Economics Letters*, 13(2), 101-105.

Andrews, Donald W.K. and Biao Lu, 2001, Consistent Model and Moment Selection Procedures for GMM Estimation with Application to Dynamic Panel Data Models, *Journal of Econometrics*, 101(1), 123-164.

Baltagi, Badi H., 2013, *Econometric Analysis of Panel Data*, John Wiley and Sons, Fifth Edition, Chichester, England.

Barro, Robert J. and Jong-Wha Lee, 2013, A New Data Set of Educational Attainment in the World, 1950-2010, Journal of Development Economics, 104(1), 184-198. http://www.barrolee.com/ (Accessed August 2023)

Barro, Robert J. and Jong-Wha Lee, 2015, Education Matters: Global Schooling Gains from the 19th to the 21st Century, Oxford University Press, New York. http://www.barrolee.com/ (Accessed August 2023)

BSA, 2018, *BSA Global Software Survey June 2018 – Software Management: Security Imperative, Business Opportunity*, Business Software Alliance, Washington D.C. https://gss.bsa.org/wp-content/uploads/2018/05/2018_BSA_GSS_Report_en.pdf (Accessed June 2023)

Depken II, Craig A., L.C. Simmons, 2004, Social Construct and the Propensity for Software Piracy, *Applied Economics Letters*, 11(2), 97-100.

Drahos, Peter, 2006, BITs and BIPs: Bilateralism in Intellectual Property, in Alexandra George (ed) *Globalization and Intellectual Property*, Routledge, London.

Economic Freedom, 2018, Economic Freedom of the World: 2018 Annual Report, Fraser Institute, Vancouver. www.fraserinstitute.org/studies/economic-freedom-of-the-world-2018-annual-report (Accessed August 2023)

Elliott, Kimberly Ann and J. David Richardson, 1997, Determinants and Effectiveness of "Aggressively Unilateral" U.S. Trade Actions, in Robert C. Feenstra (ed), The Effects of U.S. Trade Protection and Promotion Policies, Ch. 8, 215-243, University of Chicago Press, Chicago, IL.

Enders, Walter, 2014, *Applied Econometric Time Series*, John Wiley and Sons, New Jersey.

Feenstra, Robert C., Robert Inklaar, Marcel P. Timmer, 2015, The Next Generation of the Penn World Table, *American Economic Review*, 105(10), 3150-3182. https://www.ggdc.net/pwt (Accessed August 2020)

Fink, Carsten, Keith E. Maskus, Yi Qian, 2016, The Economic Effects of Counterfeiting and Piracy: A Review and Implications for Developing Countries, World Bank Research Observer, 31(1), 1-28.

Ginarte, Juan C., Park Walter G., 1997, Determinants of Patent Rights: A Cross-national Study, *Research Policy*, 26(3), 283-301.

Gopal, Ram D., G. Lawrence Sanders, 1998, International Software Piracy: Analysis of Key Issues and Impacts, *Information Systems Research*, 9(4), 380-397.

Gupta, Pola B., Stephen J. Gould, Bharath Pola, 2004, To Pirate or Not to Pirate: A Comparative Study of the Ethical Versus Other Influences on the Consumer's Software Acquisition-Mode Decision, *Journal of Business Ethics*, 55(3), 255-274.

Hall, Bronwyn H., and Jacques Mairesse, 2005, Testing for Unit Roots in Panel Data: An Exploration Using Real and Simulated Data, in Donald W.K. Andrews, James H. Stock (eds), *Identification and Inference for Econometric Models: Essays in Honor of Thomas Rothenberg*, Cambridge University Press, New York.

Hirst, Monica, 1998, 'Strategic Coercion, Democracy, and Free Markets in Latin America', In Lawrence Freedman (ed), *Strategic Coercion: Concepts and Cases*, Ch. 7, pp. 151-178, Oxford University Press, Oxford.

Hlouskova, Jaroslava and Martin Wagner, 2006, The Performance of Panel Unit Root and Stationarity Tests: Results from a Large-Scale Simulation Study, *Econometric Reviews*, 25(1), 85–116.

Husted, Bryan W., 2000, The Impact of National Culture on Software Piracy, *Journal of Business Ethics*, 26(3), 197-211.

Judson, Ruth A., and Ann L. Owen, 1999, Estimating Dynamic Panel Data Models: A Guide for Macroeconomists, *Economics Letters*, 65(1), 9-15.

Kopczynski, Mary, 2006, Robin Hood versus the Bullies: Software Piracy and Developing Countries, *Rutgers Computer and Technology Law Journal*, 33(2), 299-330.

Kukla-Gryz, Anna, Joanna Tyrowicz, Michał Krawczyk, 2021, Digital Piracy and the Perception of Price Fairness: Evidence from a Field Experiment, *Journal of Cultural Economics*, 45(1), 105-131.

Lau, Eric K., 2006, Factors Motivating People Toward Pirated Software, *Qualitative Market Research*, 9(4), 404-419.

Lee, Kevin, 2008, The Little State Department: Hollywood and the MPAA's Influence on U.S. Trade Relations, *Northwestern Journal of International Law and Business*, 28(2), 370-397.

Lütkepohl, Helmut, 2005, *New Introduction to Multiple Time Series Analysis*, Heidelberg, Springer.

Maskus, Keith E., 2000, *Intellectual Property Rights and the Global Economy*, Institute for International Economics, Washington, D.C.

McMillan, John, 1990, The Economics of Section 301: A Game-theoretic Guide, *Economics and Politics*, 2(1), 45-57.

Nickell, Stephen, 1981, Biases in Dynamic Models with Fixed Effects, *Econometrica*, 49(6), 1417-1426.

Park, Walter G., 2008, International Patent Protection: 1960–2005, *Research Policy*, 37(4): 761–766.

https://www.american.edu/cas/faculty/wgp.cfm (Accessed August 2023)

Feenstra, Robert C., Robert Inklaar and Marcel P. Timmer, 2015, The Next Generation of the Penn World Table, *American Economic Review*, 105(10), 3150-3182.

www.ggdc.net/pwt (Accessed August 2023)

Png, Ivan P.L., 2010, On the Reliability of Software Piracy Statistics, *Electronics Commerce Research and Applications*, 9(5), 365-373.

Sell, Susan K., 1995, Intellectual Property Protection and Antitrust in the Developing World: Crisis, Coercion, and Choice. *International Organization*, 49(2), 315-349.

Shadlen, Kenneth C., Andrew Schrank and Marcus J. Kurtz, 2005, The Political Economy of Intellectual Property Protec ion: The Case of Software, *International Studies Quarterly*, 49(1), 45-71.

Shiu, Stephen K., 2006, Motion Picture Piracy: Controlling the Seemingly Endless Supply of Counterfeit Optical Discs in Taiwan, *Vanderbilt Journal of Transnational Law*, 39(2), 607-643.

Sims, Christopher A., 1980, Macroeconomics and reality, *Econometrica*, 48(1), 1-48.

USTR, 1989, *'Special 301' on Intellectual Property*, Office of the United States Trade Representative, Washington, D.C. https://ustr.gov/sites/default/files/1989%20Special%20301%20Report.pdf (Accessed June 2023)

USTR, 1990, 'Hills Announces Results of Special 301 Review', Office of the United States Trade Representative, Washington, D.C. https://ustr.gov/sites/default/files/1990%20Special%20301%20Report.pdf (Accessed June 2023)

USTR, 1993, *USTR Announces Three Decisions: Title VII, Japan Supercomputer Review, Special 301*, Office of the United States Trade Representative, Washington, D.C. https://ustr.gov/sites/default/files/1993%20Special%20301%20Report.pdf (Accessed June 2023)

USTR, 1997, 'USTR Announces Results of Special 301 Annual Review', Office of the United States Trade Representative, Washington, D.C. https://ustr.gov/sites/default/files/1997%20Special%20301%20Report.pdf (Accessed June 2023)

World Bank, 2023a, 'GDP per capita, PPP (constant 2017 international $)', World Development Indicators, World Bank Group. https://data.worldbank.org/indicator/NY.GDP.PCAP.PP.KD (Accessed August 2023).

World Bank, 2023b, 'Gini Index', World Development Indicators, World Bank Group. https://datacatalog.worldbank.org/public-licenses#cc-by (Accessed August 2023).

Table 1: Sample Statistics – All Sample Countries 1994-2017						
Variable	Units	Mean	Median	Standard Deviation	Minimum	Maximum
$piracy$	Percent	56.34	58.50	21.08	16.00	99.00
$s301$	Index	1.72	1.50	0.87	1.00	5.00
ipp	Index	4.19	4.28	0.91	1.22	6.06
pcy	PPP$	25761.51	19949.59	19901.92	434.26	120647.80
edu	Years	9.18	9.35	2.20	3.36	13.64
$trsh$	Percent	15.19	7.27	18.28	0.09	82.63
$PIRACY$		–0.0225	–0.0171	0.0524	–0.4654	0.2877
$S301$		0.0017	0.0000	0.2028	–1.0986	1.0986
IPP		0.0154	0.0046	0.0317	–0.1543	0.3319
PCY		0.0203	0.0228	0.0637	–1.5889	0.2327
EDU		0.0125	0.0109	0.0111	–0.0163	0.0533
$TRSH$		–0.0102	–0.0071	0.2025	–2.1828	1.6046
	Contemporaneous Correlation					
	$PIRACY$	$S301$	IPP	PCY	EDU	$TRSH$
$PIRACY$	1.0000					
$S301$	–0.0657	1.0000				
IPP	–0.0810	0.0442	1.0000			
PCY	–0.0291	–0.0053	0.0201	1.0000		
EDU	0.0777	0.0090	0.0717	0.0413	1.0000	
$TRSH$	–0.0449	0.0169	0.0548	–0.0240	0.0318	1.0000

Notes: Variables in lowercase denote the original series;
Variables in uppercase denote the percentage change or log difference of the original variables

Table 2: Unit Root Tests					
		Levin-Lin-Chu Test		Im-Pesaran-Shin Test	
Variable	Specification	Test Statistic: Bias adjusted t^*	P-value	Test Statistic: $\bar{t}$	P-value
PANEL A					
$piracy$	Constant, no trend	–8.0039	0.0000	–7.0854	0.0000
	Constant, Trend	–12.3350	0.0000	–9.2414	0.0000
$s301$	Constant, no trend	–8.8308	0.0000	–8.3253	0.0000
	Constant, Trend	Not relevant	Not relevant	Not relevant	Not relevant
ipp	Constant, no trend	–14.4898	0.0000	–6.2104	0.0000
	Constant, Trend	–4.5408	0.0000	–1.1394	0.1273
pcy	Constant, no trend	–4.0951	0.0000	0.1734	0.5688
	Constant, Trend	–5.8632	0.0000	0.6655	0.7471
edu	Constant, no trend	–4.3528	0.0000	0.1443	0.5574
	Constant, Trend	–3.5676	0.0002	0.7007	0.7582
$trsh$	Constant, no trend	–0.3538	0.6382	2.6409	0.9959
	Constant, Trend	Not relevant	Not relevant	Not relevant	Not relevant
PANEL B					
$PIRACY$	Constant, no trend	–25.5393	0.0000	–25.1344	0.0000
	Constant, Trend	–17.6792	0.0000	–19.7683	0.0000
$S301$	Constant, no trend	–27.2139	0.0000	–31.3611	0.0000
	Constant, Trend	Not relevant	Not relevant	Not relevant	Not relevant
IPP	Constant, no trend	–15.9586	0.0000	–19.7145	0.0000
	Constant, Trend	–24.7299	0.0000	–25.7654	0.0000
PCY	Constant, no trend	–12.0680	0.0000	–12.5114	0.0000
	Constant, Trend	–11.0127	0.0000	–9.9613	0.0000
EDU	Constant, no trend	–5.7514	0.0000	–4.5263	0.0000
	Constant, Trend	–8.0710	0.0000	–6.4744	0.0000
$TRSH$	Constant, no trend	–26.8247	0.0000	–26.5205	0.0000
	Constant, Trend	Not relevant	Not relevant	Not relevant	Not relevant
Notes: Variables in lowercase denote the original series; Variables in uppercase denote the percentage change or log difference of the original variables					

Table 3: Andrews-Lu Model and Moment Selection Criteria				
Lag Order of endogenous variables	Lag order of dependent variable in underlying PVAR	Schwarz Information Criterion	Hannan-Quinn Information Criterion	Akaike Information Criterion
1	4	–131.8032	–44.9180	7.3292
2	4	–79.7592	–21.8357	12.996
3	4	–42.6469	–13.6851	3.7306
4	4	–	–	–
1	5	–191.3177	–76.9507	–7.8655
2	5	–133.7725	–47.9973	3.8166
3	5	–97.0719	–39.8884	–5.3458
4	5	–47.4092	–18.8175	–1.5462
1	6	–219.1947	–78.1918	7.3924
2	6	–168.0571	–55.2548	13.2126
3	6	–140.3626	–55.7609	–4.4104
4	6	–104.2634	–47.8623	–13.6286
1	7	–270.7718	–104.0582	–2.3524
2	7	–225.8865	–86.9585	–2.2037
3	7	–191.0106	–79.8682	–12.0644
4	7	–148.6235	–65.2666	–14.4138
1	8	–330.8057	–139.3996	–21.9962
2	8	–280.4387	–116.3764	–15.7449
3	8	–244.3534	–107.6348	–23.7753
4	8	–194.5619	–85.18708	–18.0993

Table 4: Panel Vector Autoregressions									
	Base Model			Robustness Check 1: Alternative S301			Robustness Check 2: Alternative EDU, TRSH		
Regressor	Eq. 1: $PIRACY_{it}$	Eq. 2: $S301_{it}$	Eq. 3: IPP_{it}	Eq. 1: $PIRACY_{it}$	Eq. 2: $S301_{it}$	Eq. 3: IPP_{it}	Eq. 1: $PIRACY_{it}$	Eq. 2: $S301_{it}$	Eq. 3: IPP_{it}
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$PIRACY_{i(t-1)}$	0.0164	0.0667	0.0194**	0.0159	0.0987	0.0193**	0.0097	0.0700	0.0199**
	(0.0756)	(0.1931)	(0.0085)	(0.0753)	(0.1820)	(0.0085)	(0.0043)	(0.1905)	(0.0086)
$S301_{i(t-1)}$	0.0131	–0.0433	0.0030	0.0108	–0.0333	0.0026	0.0133	–0.0420	0.0032
	(0.0083)	(.0378)	(0.0033)	(0.0084)	(0.0391)	(0.0032)	(0.0082)	(0.0383)	(0.0033)
$IPP_{i(t-1)}$	–0.1837*	–0.9083*	0.4181***	–0.1852*	0.9333*	0.4177***	–0.1787*	0.8829*	0.4144***
	(0.1024)	(0.5142)	(0.0806)	(0.1019)	(0.5182)	(0.0805)	(0.1013)	(0.5032)	(0.0773)
PCY_{it}	–0.0255	0.0906	–0.0026	–0.0252	0.0982	0.0027	–0.0257	0.0799	0.0009
	(0.0303)	(0.1072)	(0.0082)	(0.0304)	(0.1132)	(0.0081)	(0.0284)	(0.1031)	(0.0082)
EDU_{it}	0.7566	2.5464	–0.3200	–0.7535	2.0244	–0.3197	–1.2158	3.0959	–1.2029
	(0.5717)	(1.6041)	(0.4077)	(0.5714)	(1.5164)	(0.4086)	(1.2522)	(4.5065)	(1.2541)
$TRSH_{it}$	0.0001	0.0212	0.0060	0.0002	0.0278	0.0060	0.0187*	0.0155	0.0081
	(0.0052)	(0.0280)	(0.0038)	(0.0052)	(0.0287)	(0.0038)	(0.0114)	(0.0428)	(0.0053)
Observations	1491			1491			1512		
N	71			71			72		
T	21			21			21		
H_0: Coefficient of S301 = 0 in equations 1 and 3	P-value: 0.2607			P-value: 0.3528			P-value: 0.2545		
H_0: Coefficient of IPP = 0 in equations 1 and 2	P-value: 0.0199			P-value: 0.0181			P-value: 0.0200		
Notes: Clustered robust standard error in parentheses below the coefficient; ***, ** and * denote significance at the 1%, 5% and 10% levels, using a two-tail test									

Table 4 continued: Panel Vector Autoregressions									
	Robustness Check 3: Alternative IPP			Robustness Check 4: Adding variable GINI			Robustness Check 5: Unbalanced Panel		
Regressor	Eq. 1: $PIRACY_{it}$	Eq. 2: $S301_{it}$	Eq. 3: IPP_{it}	Eq. 1: $PIRACY_{it}$	Eq. 2: $S301_{it}$	Eq. 3: IPP_{it}	Eq. 1: $PIRACY_{it}$	Eq. 2: $S301_{it}$	Eq. 3: IPP_{it}
	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
$PIRACY_{i(t-1)}$	0.0157	0.0649	0.0176	0.0215	0.0826	0.0218^{**}	0.0164	0.0755	0.0191^{**}
	(0.0756)	(0.1935)	(0.0114)	(0.0811)	(0.1982)	(0.0091)	(0.0751)	(0.1908)	(0.0080)
$S301_{i(t-1)}$	0.0129	–0.0441	0.0033	0.0140	–0.0390	0.0019	0.0127	–0.0384	0.0029
	(0.0084)	(0.0379)	(0.0033)	(0.0091)	(0.0396)	(0.0031)	(0.0081)	(0.0385)	(0.0032)
$IPP_{i(t-1)}$	-0.1614^{**}	0.5290	0.3090^{***}	–0.1806	0.8166	0.4264^{***}	-0.1816^{*}	0.8774^{*}	0.4189^{***}
	(0.0638)	(0.3350)	(0.1105)	(0.1125)	(0.5505)	(0.0878)	(0.0974)	(0.5099)	(0.0812)
PCY_{it}	–0.0252	0.0880	–0.0060	–0.0385	0.0114	0.0080	–0.0305	0.0438	0.0079
	(0.0303)	(0.1062)	(0.0121)	(0.0259)	(0.0969)	(0.0081)	(0.0271)	(0.1046)	(0.0122)
EDU_{it}	–0.7267	2.3567	–0.2376	–0.7980	2.3807	–0.3866	–0.3271	1.6631	–0.2939
	(0.5601)	(1.5708)	(0.3344)	(0.6629)	(1.7108)	(0.4733)	(0.3668)	(1.0224)	(0.2357)
$TRSH_{it}$	–0.0004	0.0207	0.0104	–0.0007	0.0218	0.0057	0.0012	0.0082	0.0040
	(0.0053)	(0.0277)	(0.0065)	(0.0053)	(0.0286)	(0.0038)	(0.0039)	(0.0207)	(0.0030)
$GINI_{it}$				0.0157	–0.1870	0.0009			
				(0.0467)	(0.2124)	(0.0145)			
Observations	1491			1407			1622		
N	71			67			83		
T	21			21			19.54		
H_0: Coefficient of S301 = 0 in equations 1 and 3	P-value: 0.2945			P-value: 0.2058			P-value: 0.2592		
H_0: Coefficient of IPP = 0 in equations 1 and 2	P-value: 0.0276			P-value: 0.0465			P-value: 0.0222		
Notes: Clustered robust standard error in parentheses below the coefficient; ***, ** and * denote significance at the 1%, 5% and 10% levels, using a two-tail test									

Table 5: Granger Causality Test

H_0: Excluded regressor (all lagged terms) does not Granger-cause dependent variable

		Base Model	Robustness Check 1: Alternative S301	Robustness Check 2: Alternative EDU, TRSH	Robustness Check 3: Alternative IPP	Robustness Check 4: Adding variable GINI	Robustness Check 5: Unbalanced Panel
		(1)	(2)	(3)	(4)	(5)	(6)
Regressand	Excluded Regressor	χ^2 test statistic (P-value)	χ^2 test statistic (P-value)	χ^2 test statistic (P-value)	χ^2 test statistic (P-value)	χ^2 test statistic (P-value)	χ^2 test statistic (P-value)
$PIRACY$	$S301$	2.469	1.671	2.668	2.353	2.373	2.458
		(0.116)	(0.196)	(0.102)	(0.125)	(0.123)	(0.117)
	IPP	3.221^{*}	3.308^{*}	3.113^{*}	6.403^{**}	2.578	3.477^{*}
		(0.073)	(0.069)	(0.078)	(0.011)	(0.108)	(0.062)
	ALL	6.303^{**}	5.254^{*}	6.352^{**}	9.772^{***}	5.209^{*}	6.658^{**}
		(0.043)	(0.072)	(0.042)	(0.008)	(0.074)	(0.036)
$S301$	$PIRACY$	0.119	0.294	0.135	0.113	0.174	0.157
		(0.730)	(0.588)	(0.713)	(0.737)	(0.677)	(0.692)
	IPP	3.120^{*}	3.244^{*}	3.078^{*}	0.493	2.200	2.961^{*}
		(0.077)	(0.072)	(0.079)	(0.114)	(0.138)	(0.085)
	ALL	3.150	3.359	3.112	2.55	2.283	2.999
		(0.207)	(0.186)	0.211	(0.279)	(0.319)	(0.333)
IPP	$PIRACY$	5.251^{**}	5.168^{**}	5.363^{**}	2.391	5.716^{**}	5.689^{**}
		(0.022)	(0.023)	(0.021)	(0.122)	(0.017)	(0.017)
	$S301$	0.797	0.664	0.957	0.982	0.380	0.790
		(0.372)	(0.415)	(0.328)	(0.322)	(0.538)	(0.374)
	ALL	5.816^{*}	5.473^{*}	6.092^{**}	3.806	5.835^{*}	6.674^{**}
		(0.055)	(0.065)	(0.048)	(0.149)	0.054	(0.036)

Notes: ***, ** and * denote significance at the 1%, 5% and 10% levels, using a two-tail test;
† denotes significance at the 10% level using a one-tail test

Table 6: Eigenvalues of the Companion Matrix			
Specification	Eigenvalue		Modulus
	Real	Imaginary	
Base Model			
	0.4161	0	0.4161
	–0.0544	0	0.0544
	0.0294	0	0.0294
Robustness Check 1: Alternative S301			
	0.4149	0	0.4149
	–0.0483	0	0.0483
	0.0338	0	0.0338
Robustness Check 2: Alternative EDU, TRSH			
	0.4129	0	0.4129
	–0.0546	0	0.0546
	0.0238	0	0.0238
Robustness Check 3: Alternative IPP			
	0.3049	0	0.3049
	–0.0559	0	0.0559
	0.0315	0	0.0315
Robustness Check 4: Adding variable GINI			
	0.4212	0	0.4212
	–0.0506	0	0.0506
	0.0383	0	0.0383
Robustness Check 5: Unbalanced Panel			
	0.4167	0	0.4167
	–0.0511	0	0.0511
	0.0313	0	0.0313
Note: All eigenvalues lie inside the unit circle; Panel VARs satisfy the stability condition			

Table 7: Forecast Error Variance Decomposition					
Specification	Response Variable:	Forecast Horizon (i.e., years)	Impulse Variable:		
Base Model	$PIRACY$		$S301$	IPP	$PIRACY$
		0	0	0	0
		1	0	0	1
		2	0.00378	0.00382	0.99240
		3	0.00378	0.00434	0.99188
		4	0.00378	0.00443	0.99179
		5	0.00378	0.00445	0.99177
		6	0.00378	0.00445	0.99177
		7	0.00378	0.00445	0.99177
		8	0.00378	0.00445	0.99177
		9	0.00378	0.00445	0.99177
		10	0.00378	0.00445	0.99177
Robustness Check1: Alternative $S301$	$PIRACY$		$S301$	IPP	$PIRACY$
		0	0	0	0
		1	0	0	1
		2	0.00256	0.00389	0.99355
		3	0.00256	0.00444	0.99300
		4	0.00256	0.00454	0.99290
		5	0.00256	0.00456	0.99288
		6	0.00256	0.00456	0.99288
		7	0.00256	0.00456	0.99288
		8	0.00256	0.00456	0.99288
		9	0.00256	0.00456	0.99288
		10	0.00256	0.00456	0.99288
Robustness Check 2: Alternative EDU, TRSH	$PIRACY$		$S301$	IPP	$PIRACY$
		0	0	0	0
		1	0	0	1
		2	0.00388	0.00399	0.99213
		3	0.00388	0.00450	0.99161
		4	0.00388	0.00459	0.99152
		5	0.00388	0.00461	0.99151
		6	0.00388	0.00461	0.99151
		7	0.00388	0.00461	0.99151
		8	0.00388	0.00461	0.99151
		9	0.00388	0.00461	0.99151
		10	0.00388	0.00461	0.99151
Robustness Check 3: Alternative IPP	$PIRACY$		$S301$	IPP	$PIRACY$
		0	0	0	0
		1	0	0	1
		2	0.00352	0.00479	0.99169
		3	0.00352	0.00517	0.99131
		4	0.00352	0.00521	0.99127
		5	0.00352	0.00521	0.99127
		6	0.00352	0.00521	0.99127
		7	0.00352	0.00521	0.99127
		8	0.00352	0.00521	0.99127
		9	0.00352	0.00521	0.99127
		10	0.00352	0.00521	0.99127

Robustness Check 4: Adding variable GINI	$PIRACY$		$S301$	IPP	$PIRACY$
		0	0	0	0
		1	0	0	1
		2	0.00396	0.00336	0.99268
		3	0.00396	0.00385	0.99218
		4	0.00396	0.00394	0.99209
		5	0.00396	0.00396	0.99208
		6	0.00396	0.00396	0.99208
		7	0.00396	0.00396	0.99208
		8	0.00396	0.00396	0.99208
		9	0.00396	0.00396	0.99208
		10	0.00396	0.00396	0.99208
Robustness Check 5: Unbalanced Panel	$PIRACY$		$S301$	IPP	$PIRACY$
		0	0	0	0
		1	0	0	1
		2	0.00362	0.00410	0.99229
		3	0.00362	0.00467	0.99171
		4	0.00362	0.00477	0.99161
		5	0.00362	0.00479	0.99160
		6	0.00362	0.00479	0.99159
		7	0.00362	0.00479	0.99159
		8	0.00362	0.00479	0.99159
		9	0.00362	0.00479	0.99159
		10	0.00362	0.00479	0.99159
Note: Numbers in each row may not add up to 1 due to rounding errors					

Table 8: Panel Vector Autoregressions – Further Insight from an Alternative Specification

	Base Model			Robustness Check 1: Alternative S301			Robustness Check 2: Alternative EDU, TRSH		
Regressor	Eq. 1: $PIRACY_{it}$	Eq. 2: $S301'_{it}$	Eq. 3: IPP_{it}	Eq. 1: $PIRACY_{it}$	Eq. 2: $S301'_{it}$	Eq. 3: IPP_{it}	Eq. 1: $PIRACY_{it}$	Eq. 2: $S301'_{it}$	Eq. 3: IPP_{it}
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$PIRACY_{i(t-1)}$	0.0154	0.0005	0.0198**	0.0139	–0.0243	0.0199**	0.0107	0.0295	0.0194**
	(0.0761)	(0.0563)	(0.0088)	(0.0754)	(0.0320)	(0.0088)	(0.0755)	(0.0545)	(0.0087)
$S301'_{i(t-1)}$	0.0484***	0.0348	–0.0041	0.0368**	0.0645	–0.0047	0.0465***	0.0174	–0.0037
	(0.0165)	(0.0769)	(0.0044)	(0.0164)	(0.0858)	(0.0046)	(0.0161)	(0.0700)	(0.0041)
$IPP_{i(t-1)}$	–0.1895*	0.2567	0.4134***	–0.1893*	0.2998	0.4135***	–0.1930**	0.2354	0.4106***
	(0.0994)	(0.2221)	(0.0796)	(0.0996)	(0.2333)	(0.0796)	(0.0983)	(0.2178)	(0.0767)
PCY_{it}	–0.0269	0.0254	0.0007	–0.0271	0.0075	0.0008	–0.0299	0.0286	0.0003
	(0.0295)	(0.0407)	(0.0078)	(0.0295)	(0.0413)	(0.0078)	(0.0284)	(0.0410)	(0.0080)
EDU_{it}	–0.7834	0.3536	–0.3194	–0.7628	0.1729	–0.3193	–1.3419	–0.8577	–1.1870
	(0.5639)	0.8920	(0.3999)	(0.5621)	(0.8981)	(0.3995)	(1.2746)	(2.9906)	(1.2430)
Observations	1491			1491			1512		
N	71			71			72		
T	21			21			21		
H_0: Coefficient of $S301'$ = 0 in equations 1 and 3	P-value: 0.0058			P-value: 0.0382			P-value: 0.0062		

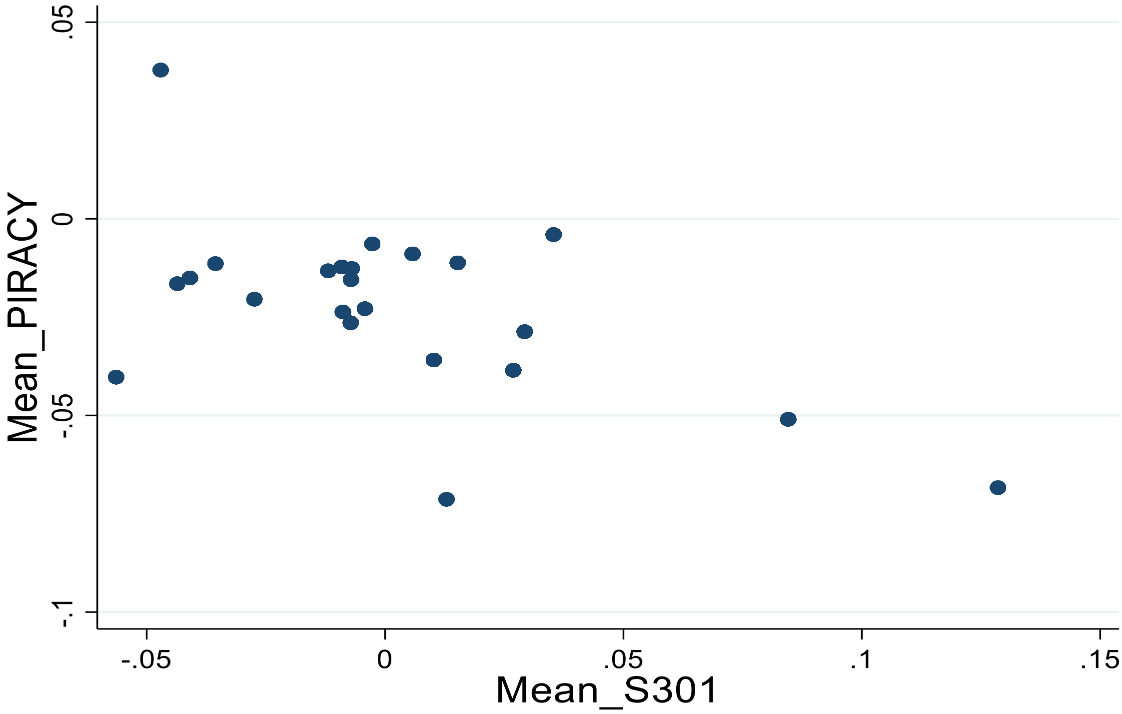
Notes: Clustered robust standard error in parentheses below the coefficient;
***, ** and * denote significance at the 1%, 5% and 10% levels, using a two-tail test

Table 8 continued: Panel Vector Autoregressions – Further Insights from an Alternative Specification

	Robustness Check 3: Alternative IPP			Robustness Check 4: Adding variable GINI			Robustness Check 5: Unbalanced Panel		
Regressor	Eq. 1: $PIRACY_{it}$	Eq. 2: $S301'_{it}$	Eq. 3: IPP_{it}	Eq. 1: $PIRACY_{it}$	Eq. 2: $S301'_{it}$	Eq. 3: IPP_{it}	Eq. 1: $PIRACY_{it}$	Eq. 2: $S301'_{it}$	Eq. 3: IPP_{it}
	(10)	(11)	(12)	(13)	(14)	(15)			
$PIRACY_{i(t-1)}$	0.0146	0.0006	0.0188	0.0215	0.0240	0.0225*	0.0163	–0.0051	0.0190**
	(0.0761)	(0.0559)	(0.0124)	(0.0819)	(0.0576)	(0.0094)	(0.0758)	(0.0573)	(0.0084)
$S301'_{i(t-1)}$	0.0487***	0.0343	–0.0057	0.0496***	0.0176	–0.0044	0.0476***	0.0866	–0.0034
	(0.0164)	(0.0767)	(0.0040)	(0.0169)	(0.0727)	(0.0044)	(0.0153)	(0.0830)	(0.0043)
$IPP_{i(t-1)}$	–0.1666***	0.1785	0.3008***	–0.1823*	0.3600	0.4226***	–0.1892**	0.2239	0.4161***
	(0.0602)	(0.1418)	(0.1075)	(0.1096)	(0.2251)	(0.0871)	(0.0950)	(0.2185)	(0.0803)
PCY_{it}	–0.0265	0.0248	–0.0097	–0.0395	0.0161	0.0063	–0.0321	0.0301	0.0072
	(0.0294)	(0.0408)	(0.0114)	(0.0256)	(0.0418)	(0.0080)	(0.0267)	(0.0424)	(0.0123)
EDU_{it}	–0.7530	0.3048	–0.2426	0.0197	0.0292	0.0045	–0.3495	0.2825	–0.2853
	(0.5522)	(0.8910)	(0.3253)	(0.0465)	(0.1469)	(0.0137)	(0.3706)	(0.5024)	(0.2329)
$GINI_{it}$				–0.8200	0.4141	–0.3901			
				(0.6518)	(1.0289)	(0.4640)			
Observations	1491			1407			1622		
N	71			67			83		
T	21			21			19.54		
H_0: Coefficient of $S301'$ = 0 in equations 1 and 3	P-value: 0.0032			P-value: 0.0055			P-value: 0.0040		

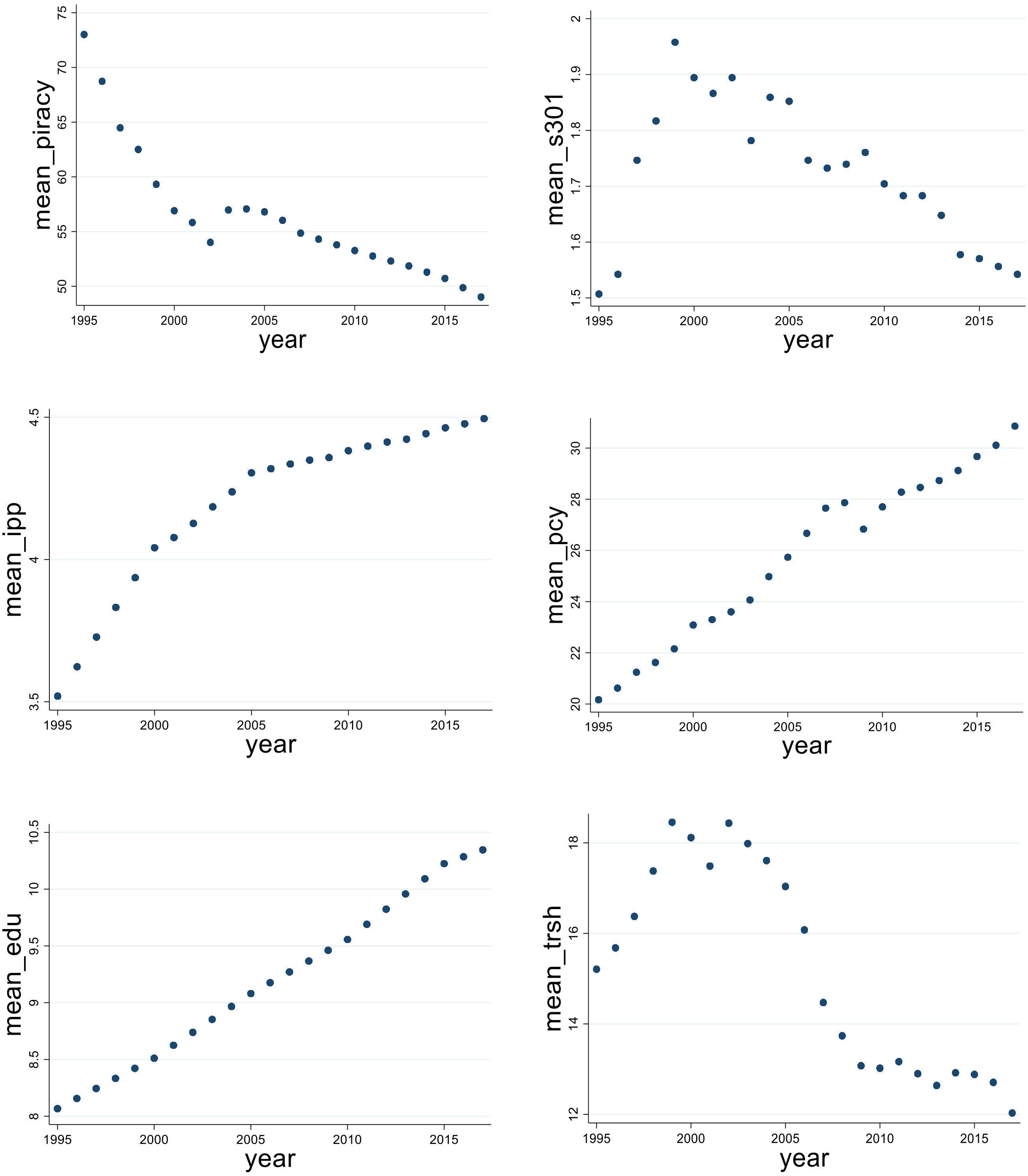
Notes: Clustered robust standard error in parentheses below the coefficient; ***, ** and * denote significance at the 1%, 5% and 10% levels, using a two-tail test

Figure 1: Mean_PIRACY-Mean_S301 Scatterplot



NOTE: 'Mean' refers to the average across all sample countries in a given year

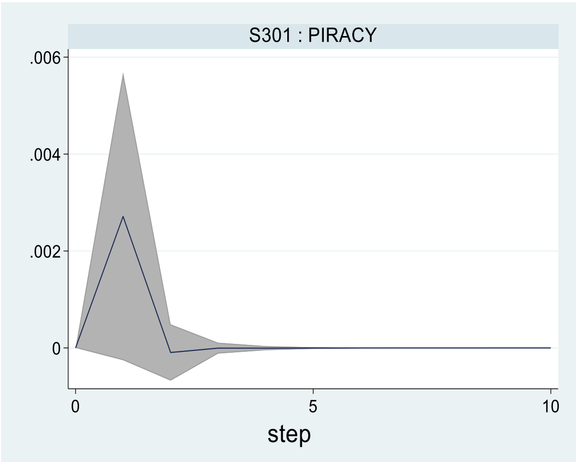
Figure 2: Scatterplots of Means of Original Variables over Sample Period



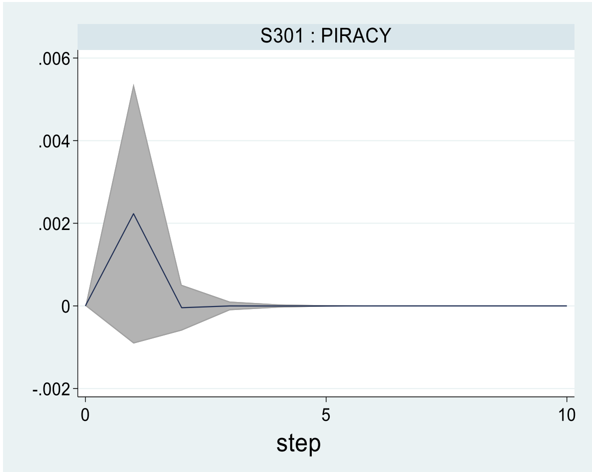
NOTE: ‘Mean’ refers to the average across all sample countries in a given sample year

Figure 3: Orthogonalised Impulse Response Functions

(a) Base Model



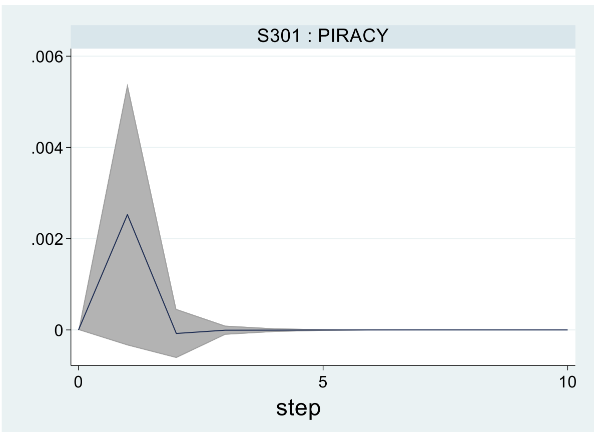
(b) Robustness Check 1: Alternative S301



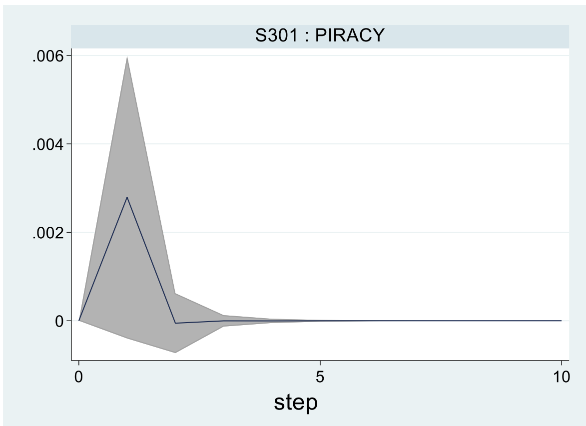
(c) Robustness Check 2: Alternative EDU, TRSH

(d) Robustness Check 3: Alternative IPP

(e) Robustness Check 4: Adding GINI



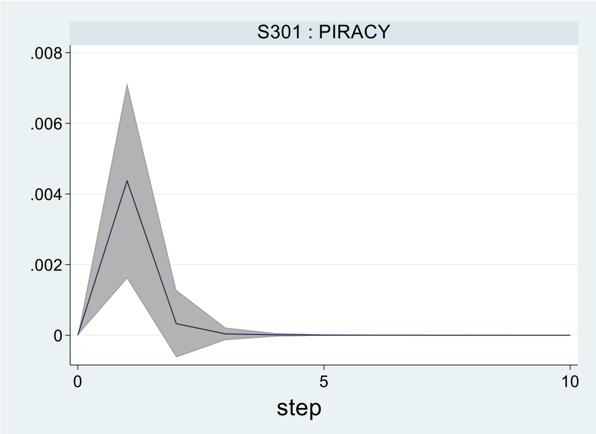
(f) Robustness Check 5: Unbalanced Panel



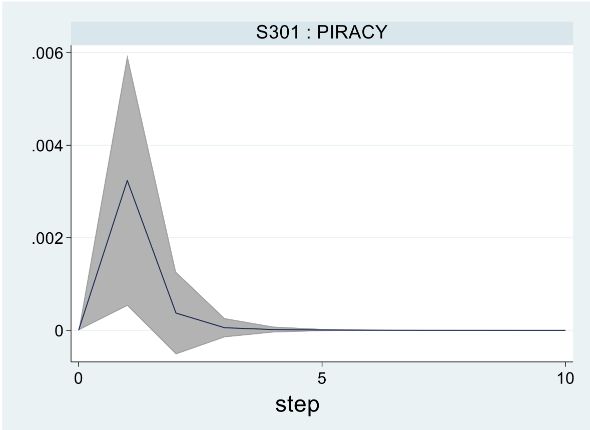
NOTE: The shaded region is the 95% confidence interval

Figure 4: Orthogonalised Impulse Response Functions

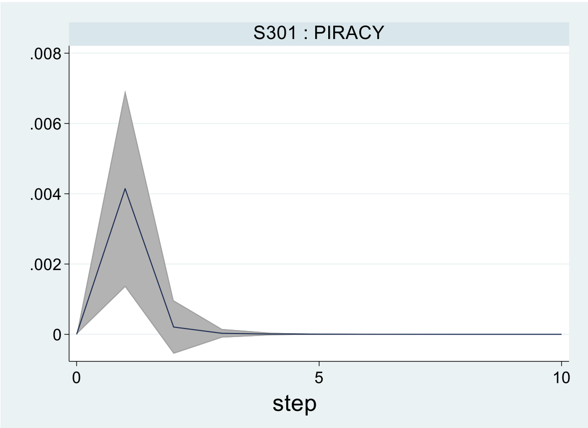
(a) Base Model



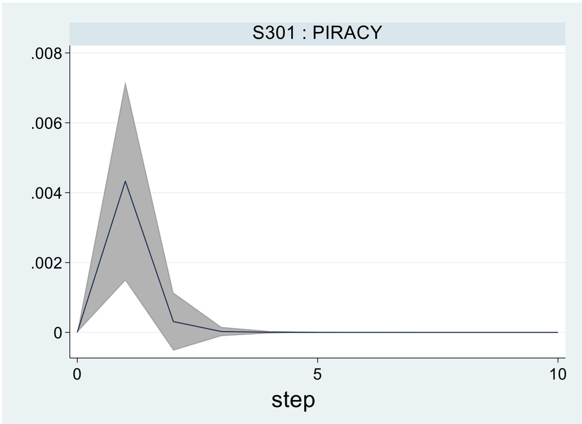
(b) Robustness Check 1: Alternative S301



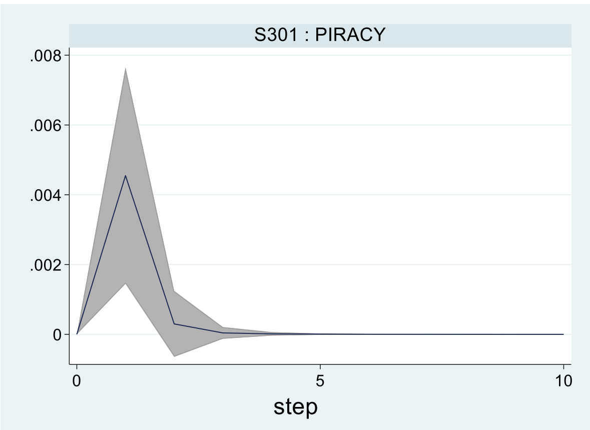
(c) Robustness Check 2: Alternative EDU, TRSH



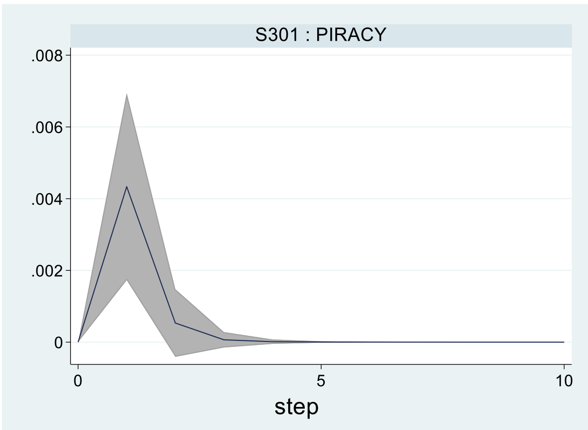
(d) Robustness Check 3: Alternative IPP



(e) Robustness Check 4: Adding GINI



(f) Robustness Check 5: Unbalanced Panel



NOTE: The shaded region is the 95% confidence interval

Endnotes

[1] While this argument applies equally to both domestic and international piracy, in the latter context Varian (2005) brings to our notice that "… American authors and publishers pushed to extend copyright to foreign authors to limit cheap foreign competition – such as Charles Dickens".

[2] And its subsequent enhancements via the Trade Act 1984, and the Omnibus Trade and Competitiveness Act 1988.

[3] This dataset, though hotly debated, remains the only source of reasonably reliable piracy data with a wide enough and long enough coverage. For a thorough and illuminating discussion, see Png (2010).

[4] Data on software piracy in value terms ($ million) are not used, because that would require an appropriate deflator to enable cross-entity and inter-temporal comparison.

[5] In the period 1989-2022, the USTR office placed a total of 971 countries on the Watch List (i.e. 39 countries every year), a total of 370 countries on the Priority Watch List (i.e. 11 countries per year), and a total of 18 countries on the Priority Foreign Country List (i.e. about 0.5 country per year). Note, that for these estimates, we treat a given country placed on a censure list in two different years as two different countries.

[6] Given our focus on software piracy, ideally we should include some copyright index in addition to the modified patent index, but no such series is available for our sample countries and time periods.

[7] Including a variable for International Investment Treaties, i.e., Bilateral Investment Treaties (BITs), and Treaties with Investment Provisions (TIPs), would not suffice in this regard, and the trade share vis-à-vis the US does a better job of reflecting the importance of the US in

the eyes of the trading partner. Understandably, the trading partner would take the US threat seriously only to the extent that the US is important for its economic well-being.

[8] The sample countries are: Argentina, Australia, Austria, Belgium, Bolivia, Brazil, Bulgaria, Canada, Chile, China, Colombia, Costa Rica, Cyprus, Czech Republic, Denmark, Dominican Republic, Ecuador, Egypt, El Salvador, Finland, France, Germany, Greece, Guatemala, Honduras, Hong Kong, Hungary, India, Indonesia, Ireland, Israel, Italy, Japan, Jordan, Kenya, Korea Republic, Luxembourg, Malaysia, Malta, Mauritius, Mexico, Morocco, Netherlands, New Zealand, Nicaragua, Norway, Pakistan, Panama, Paraguay, Peru, Philippines, Poland, Portugal, Romania, Russian Federation, Saudi Arabia, Singapore, Slovak Republic, South Africa, Spain, Sweden, Switzerland, Taiwan, Thailand, Turkey, Ukraine, United Kingdom, Uruguay, Venezuela, Vietnam, Zimbabwe.

[9] However, we do not consider the case of a zero intercept, because that would imply the hypothesis that the intercept is zero for all entities in the panel.

[10] Note that the Cholesky decomposition to orthogonalize the shocks is non-unique, and depends on the ordering of the endogenous variables when estimating the panel VAR. In our case, however, the change in variable ordering does not alter our results.

[11] As in the case of the orthogonalized IRF, this decomposition is non-unique, and depends on the ordering of the endogenous variables when estimating the panel VAR. In our case, the change in variable ordering does not change the results.