International Relocation of Production and Growth*

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Abstract

Over the last decades, the relocation of production from developed to developing economies have generated notable political unrest in some rich countries and precipitated a certain return to protectionism. Using data on approximately 5,000 products, this paper describes the relocation process between 1996 and 2014 and assesses its impact on cross-country growth. Relocation to developing countries –mostly, but not only, to China– had a significant negative aggregate impact on the low-income countries that were initial exporters of the relocated products. In the case of a country at the first quartile of the income distribution, a one-standard negative deviation of the country's exposure to the relocation process reduced its annual growth by 0.61 percentage points. However, this potentially negative impact on the original exporters of the relocated products was zero or not significant in the case of high-income countries. On average, high-income countries facing increased competition from developing economies changed and upgraded their export baskets, whereas low-income countries in the same circumstances failed to do so.

Keywords: globalization; trade; product shocks; offshoring; growth; China shock.

JEL Classification: F62; F43; O47.

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1 Introduction

The relocation of production and exports from higher- to lower-income countries has been a central feature of economic globalization in recent decades. The phenomenon is apparent in Figure 1 that shows the evolution of the percentage of world merchandise exports originating in high-income economies (as defined by the World Bank), which went from 77% in 1996 to 58% in 2014. The figure also shows the dynamics of the $AVEX_t/GDPpc_{Wt}$ ratio, where $GDPpc_{Wt}$ is the world's per capita GDP at time t and $AVEX_t$ (the *average exporter income*) is a weighted average of all the countries' per capita GDP using the country shares in world merchandise exports as weights (i.e., $AVEX_t \equiv \sum_{c=1}^{C} s_{ct} GDPpc_{ct}$, where c denotes any of the C countries in the sample and s_{ct} is this country's weight in world merchandise exports). This ratio went from a value of approximately 3 in 1996 to a value of 2.25 in 2014 as the gap between the exporter's average income and the global average income diminished.[1]

Economic theory is clear on the aggregate benefits of opening to trade starting from autarky. However, the aggregate impact of other countries' increase in export capacity on an already open economy is not necessarily positive as this shock can negatively affect the countries' terms of trade. The dynamics of international trade over the last two decades appears to have significantly affected relative income, generated notable political unrest in some rich countries, and precipitated a certain return to protectionism. What has been the cross-country growth impact of the latest wave of international production relocation? Although numerous studies have analyzed the impact of the relocation process on particular industries, regions, countries, and occupations (specially in connection to the so-called *China trade shock* on the US labor markets),[2] there is no global assessment of its aggregate-growth impact across countries. This paper describes the relocation process and assesses its impact on cross-country growth for the 1996-2014 period.

To be more specific, by international production relocation (IPR) we mean the shift of global market shares across countries that have different income levels. Hence, our concept of IPR is relative and could take place without any country reducing its output and exports. If lower-income (higher-income) countries gain share in the global market of a particular good, then we say that the good's production is being relocated to the South (the North). Figure 1 only captures IPR at the aggregate level but IPR has been highly heterogeneous across and within industries. We take advantage of this heterogeneity and the diversity

[1] See the next section for details on the data. To be consistent with the rest of the paper, we use per capita GDP in PPP in this figure. If this ratio is calculated using values in current dollars, then it goes from a value of approximately 4 in 1996 to a value near 3 in 2014.

[2] The *China trade shock* has been associated to the loss of more than 3.5 million manufacturing jobs in the US between 2001 and 2007 (Pierce and Schott 2016) and to widely different disturbances across industries and local labor markets (see Autor, Dorn, and Hanson 2016 for survey of the literature).

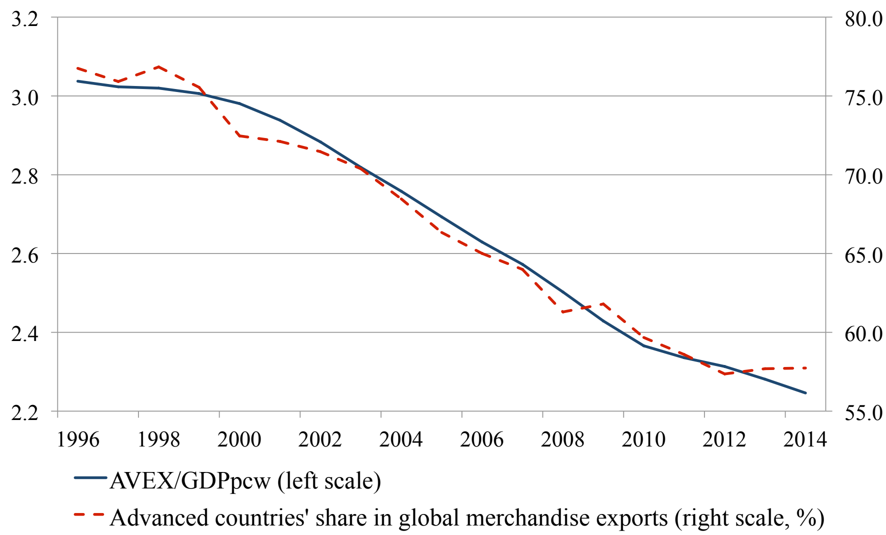

Figure 1: Exporting countries' relative average income ($AVEX_t/GDPpc_{Wt}$) and high-income countries' share in global merchandise exports

of the specialization patterns across countries to identify the cross-country growth impact of IPR. Using trade data at the HS 6-digit level (which involves approximately 5,000 product categories), we investigate whether being an exporting country of products in which lower-income countries gained global market share over the period, had a negative impact on the country's aggregate performance. We measure how each country's initial exports were affected by IPR and estimate the differential impact that this relocation had on the countries' aggregate growth. The paper is silent, however, on the absolute impact of the global IPR on each country (and the world economy), which could potentially be positive for all the countries.

Shocks leading to the IPR of a country's current exports can have a negative impact on its aggregate GDP besides having a distributional effect within the country. To be sure, the loss of a country's comparative advantage in some products brings about a gain of comparative advantage in other products and the reallocation of factors from the first products to the latter. However, this process tends to depreciate the product-specific factors of the relocated products (e.g., specific machinery, know-how, workers' technical abilities) and the reallocation of the less product-specific factors to new industries involves time and mobility costs, as emphasized by Autor, Dorn, and Hanson (2016).

IPR can be the result of different mechanisms, such as increased export capacity of Southern countries, technological change, and the deployment of global value chains. The augmented export capacity of Southern countries experiencing structural economic reforms and lower trade costs, the main example of which is China, has been a key mechanism leading to IPR. This type of shock is likely to have negative consequences on the initial exporters of the relocated products as competition increases and the terms of trade tend to deteriorate. Second, technological change affects product sophistication, modifies comparative advantage, and leads to IPR. In particular, production standardization increases developing countries' comparative advantage and is likely to affect negatively the developed countries that exported the standardized products (whereas the intensification of innovation in a particular industry is likely to favor the developed countries' comparative advantage). Third, offshoring and the deployment of global value chains, i.e., the *voluntary* effort of Northern firms to standardize and relocate part of their production process to the South, also lead to IPR but can have different consequences. The offshoring of some stages of production may harm some product-specific factors in the North while benefiting the factors in which the stages that do not relocate are intensive. Therefore, the aggregate consequences of this type of shocks for the initial developed exporting countries are uncertain. However, the relocated products are likely to be produced not only in the Northern countries but also in some developing economies that will be negatively affected by the new competition from other similar economies. Hence, while the Northern exporting countries that relocate production can be positively affected by this IPR process, the Southern exporters that observe an exogenous deepening of the relocation to the South of products similar to their current exports, are likely to be harmed by the new competition.

Summarizing, the different shocks that can give rise to IPR to the South can have different aggregate impacts on the initial exporting countries, which could depend on these countries' initial level of development. Relocation caused by the increased export capacity of emerging economies such as China are likely to harm all the initial exporters regardless of their development level, technological standardization is likely to harm relatively more the developed exporters, and offshoring is likely to harm relatively less (or even benefit) the developed economies. The potentially negative impact of IPR on the initial exporting countries could also be milder in the more developed economies because several characteristics that facilitate the reallocation of resources from the industries loosing comparative advantage to those gaining it (e.g., product diversification, favorable business environment, abundant generic human capital) are more common in these economies. Although we do not identify the specific role played by each of the potential mechanisms leading to IPR, in this paper we investigate how the effect of IPR on the initial exporting countries of the relocated products depends on these countries' initial development level.

Our analysis focuses on the 1996-2006 period, when international trade boomed and IPR peaked, although we also consider the Great Recession period and its aftermath (2006-2014) as an extension that allows us to conduct some panel data analysis. We find that the countries initially specialized in products whose production was relocated to the South over the period, were negatively affected by this process. However, this negative impact decreased with the country's income and was zero or not significant for the higher-income countries. For lower-income countries, the marginal effect of our exposure-to-relocation measure (the *relocation index*) is statistically significant, very robust, and quantitatively important. For example, at the first quartile of the countries' income distribution, a one-standard negative deviation of a country's *relocation index* reduced its annual aggregate growth by 0.61 percentage points. We also explore why advanced economies escaped the negative consequences of their exports' relocation and find that when facing increased competition from developing economies, high-income countries upgraded their export baskets, whereas low-income countries in the same circumstances failed to do so.

Consequently, in spite of the political debate in some rich countries like the US, advanced economies whose initial exports were relocated to the South did not experience, on average, a negative aggregate impact. Hence the social and political unrest observed in some developed countries in relation to international trade cannot be attributed to an aggregate negative impact of IPR on these countries but to their within-country distributional effects. However, the low-income countries whose initial export basket included the products that underwent an intense IPR towards the South did experience a significantly negative impact. Our findings also suggests that the optimistic view according to which, following trade shocks, factors are reallocated from industries losing comparative advantage to industries gaining it, thereby avoiding aggregate output reductions, can be a good approximation for advanced economies but not for developing ones. The effectiveness of the reallocation of factors across industries and products following trade shocks appear to depend on the economy's characteristics: the characteristics that are common to advanced economies such as having a well-educated workforce, a diversified output, and a favorable business environment are likely to facilitate the successful reallocation of factors to new activities and products.

A few cases can illustrate these results. Bangladesh, the Philippines, Malaysia, and Thailand are large economies whose performance during the period of analysis stayed below what would be be predicted by their economic fundamentals. Although their economic growth was satisfactory in absolute terms, their residual growth after considering a long list of growth determinants (initial GDPpc, human capital, rule of law, trade openness, GDP size, export diversification, economic complexity, and continent location) was negative and among the largest in the sample. It turns out that these countries specialized in the industries and products that experienced the most intense relocation towards the South over the period. According to the data described in the next section, electrical equipment and textiles, footwear, and leather products featured the most intense relocation to the South.

Machinery and mechanical appliances also ranked at the top of this relocation process. Textiles, footwear, and leather products happened to represent 84% of Bangladesh's exports in 1996, whereas electrical equipment and machinery and mechanical appliances represented 57% of the Philippines' exports, 56% of Malaysia's, and 38% of Thailand's. Apparel also represented a large share of these latter countries' exports. Outside Asia, Honduras is a similar case: it features one of the largest negative residuals in growth regressions that exclude the relocation shocks index, while textiles, footwear, and leather products represented 45% of Honduras' exports in 1996. Among the advanced economies, Singapore also featured a strong specialization in textiles and electrical equipment in 1996. However, this country does not show a negative but a positive residual in the growth regressions that exclude the relocation shocks index. As with other rich economies (South Korea and Hong Kong are similar cases), Singapore was able to re-specialize and upgrade its exports, thereby overcoming the increased competition from lower-wage exporters.[3]

To assess the growth impact of IPR, we calculate a *relocation shocks index* that measures how IPR affects each country's initial export basket. Using this measure to identify the cross-country impact of IPR on growth involves some potential difficulties, as we discuss below: (a) countries with similar export baskets could be affected by common shocks that are different from the relocation shocks (but that can be correlated with them), thereby biasing estimates of the coefficient on the relocation shocks index; (b) country-specific shocks to large countries could contaminate the relocation shocks index, thereby creating a spurious correlation between their growth and the index; and (c) to the extent that neighboring countries have similar export baskets and growth spillovers, country-specific shocks to neighbors could create a spurious correlation between country growth and the relocation shocks index. We confront these potential problems by: (a) introducing a control for *other product shocks* (e.g., demand shocks) that can affect countries with similar export baskets; (b) building an instrument for the relocation shocks index that, for each country, does not use any data related to this country; and (c) carrying out robustness tests using an alternative instrument for each country the calculation of which excludes not only all the data related to the country but also all the data related to its neighbors.

[3]At any rate, the dynamics of relocation were very heterogenous within industries, as already noted, and country specialization at the industry level (as opposed to specialization at the 6-digit product level) is not always informative about the impact of IPR on a country. Below we provide more details on these country cases.

Literature

This paper is related to numerous strands of the literature on trade and growth. The analysis of the IPR has a long tradition that starts with Vernon (1966). His *product life-cycle theory* provided the first approach to the dynamics of the reorganization of production across countries at different levels of development. According to this theory, new products are invented and developed in the advanced economies, from which they are initially exported. Then, as production becomes increasingly standardized, part or all of the production shifts to less-developed countries. These dynamics lead to a continual process of IPR. The analysis of the product life-cycle has been extended in numerous directions. These extended analyses do not tackle the particular question considered in this paper (i.e., the aggregate growth consequences on the initial exporters of the IPR), but their insights are consistent with the analysis in this paper. For instance, Krugman (1979) builds a two-country model in which the North develops and produces new goods whose production is eventually transferred to the South. The ratio between the rate of innovation in the North and the rate of technology transfer to the South determines the relative wage between the North and the South. Translating Krugman (1979)'s predictions to a world with multiple products and random technological shocks across products, we would expect that a standardization shock leading to the relocation of a product to the South reduces the relative wage of the Northern exporters of the relocated product (whereas an innovation shock raises the relative wage of the Northern exporters). This is the pattern we find in this paper, though because each product is not exported by only Northern or Southern countries, further relocation of a product to the South can also harm initial Southern exporters (possibly, even more than it harms initial Northern exporters, as these exporters have more opportunities to reallocate their resources to alternative productions).

Grossman and Helpman (1991a, 1991b) and Antràs (2005) endogenize the technological progress causing IPR in product life-cycle trade models. In particular, Antràs (2005) shows that continuous technical progress and incomplete contracts lead to transfers of production to the South, first to affiliate plants and then to independent firms. This analysis connects the product life-cycle to production fragmentation and offshoring (Feenstra 1998; Hummels, Ishii and Yi 2001). Note that the relocation of some stages of production to the South by parent firms from the North is voluntary and can favor employment in the production of the more innovative products and stages that remain in the North. This could explain the zero negative impact of IPR to the South that we find at the top of the country income distribution. Also, using a quantifiable general equilibrium model, Arkolakis, Ramondo, Rodríguez-Clare, and Yeaple (2018) show that multinationals' IPR to the South and the integration of China in the world economy does not hurt employment in the countries specialized in innovation but can hurt countries that specialize in production. Again, this is consistent with our empirical findings.[4]

The product life-cycle and the offshoring literatures are related to the second and third mechanisms leading to IPR to the South that we discussed above. On the first mechanism, i.e., the increased export capacity of Southern countries, several papers (Autor, Dorn, and Hanson 2013; Acemoglu, Autor, Dorn, and Price 2016; Pierce and Schott 2016) show that the rise of China's exports had a substantial negative impact on US manufacturing employment and that this impact was very unequally distributed across geographical areas and industries. This does not imply, however, that the *China trade shock* had a negative aggregate impact on the US GDP once the general equilibrium effects across all sectors and areas are considered. Using a quantitative approach that accounts for market frictions, geographic factors, and general equilibrium effects, Caliendo, Dvorkin, and Parro (2019) find that the China trade shock resulted in a large reduction of U.S. manufacturing jobs from 2000 to 2007 and substantial distributional effects on labor markets. Notwithstanding, the country gained in the aggregate. On the impact of China and Eastern Europe imports on the German economy, Dauth, Findeisen and Suedekum (2014) find that the employment reduction in regions specialized in import-competing industries was more than offset by the increase in regions specialized in export-oriented industries. Similarly for the case of Spain, Donoso, Martín, and Minondo (2014) find that the manufacturing employment in the areas most exposed to China imports were compensated by increases in employment in other activities. Bloom, Draca and Van Reenen (2016) show that in Western Europe, Chinese import competition led to increased technical change within the firms most affected by the imports and employment reallocation towards the more technologically advanced firms. These results are consistent with the finding in this paper of a null negative impact of IPR to the South on the advanced economies' aggregate output. In comparing the analysis of the literature on the China trade shock with this paper, note also that we consider the IPR impact of a set of countries whose exports represent more than 98% of all the world's merchandise exports and not only the impact of China's exports. Between 1996 and 2006, China's annual exports of manufactures increased by 767 USD billions, while the other low- and medium-income countries' annual exports of manufacturers increased by 680 USD billions. Thus, although China has been the main protagonist of IPR in recent times, the joint impact of the other developing countries

[4]Other contributors of the product life-cycle literature are Dollar (1986), Jensen and Thursby (1986), and Acemoglu, Gancia, and Zilibotti (2012). Ebenstein et al. (2014) also find little impact of globalization and offshoring on US wages (they only find a moderate negative impact on unskilled workers, though their empirical study ends in 2002), whereas Utar and Torres-Ruiz (2013) find a substantial negative effect of intensified Chinese competition on Mexican maquiladoras.

is likely to have also been substantial.

This paper is also related to the work of Hanson, Lind, and Muendler (2015) who conduct an in depth analysis of the stochastic properties of the dynamics of comparative advantage and quantify some of its implications for trade policy. The analysis in this paper, which starts in Section 2 by describing the dynamics of IPR over the 1996-2014 period, could be seen as assessing some of the cross-country growth consequences of the stochastic dynamics studied in Hanson, Lind, and Muendler (2015). The shocks leading to changes in comparative advantage and IPR are a particular type of product shock. Most of the growth literature has ignored product shocks as a potential factor explaining cross-country growth differences. However, product shocks had an important role in the pioneering work of Barro and Sala-i-Martin, who used in this respect an approach similar to the one in this paper. In Barro and Sala-i-Martin (1992), they study income convergence across US states covering the 1880-1988 period. They observe that agricultural products' terms of trade and oil prices had large swings and argue that these and other sectoral shocks could have a common impact on subgroups of states that would lead to biased estimates. Thus, they define a proxy to control for common effects across states related to their sectoral output composition (similar to our relocation and other-product shocks indices) and find that these effects are statistically significant in explaining growth differences across states.

Finally, this paper is also related to the literature arguing that the specific products in which a country specializes are important for growth. In this respect, Lall, Weiss, and Zhang (2006), Hausmann, Hwang, and Rodrik (2007), Hidalgo and Hausmann (2009), and Hausmann et al. (2011) have developed different approaches to export sophistication and complexity. According to this approach, economies with more sophisticated or complex initial exports have better opportunities for further development and, therefore, initial export sophistication help to predict future growth. Our $AVEX$ measure of a product's average exporter is analogous to the sophistication measures used in those papers. However, instead of analyzing the growth impact of a country's initial export sophistication or complexity, we analyze the growth impact of the global relocation of a country's initial export basket using indices that measure the change of its exports' $AVEX$ (while controlling for initial export complexity).

The remainder of the paper is organized as follows. Section 2 describes the dynamics of IPR over the 1996-2014 period. Section 3 estimates the cross-country growth impact of these IPR dynamics. Section 4 investigates whether the countries whose initial exports experienced increased competition from the South, as measured by IPR, adjusted their export baskets by upgrading them and whether this potential adjustment was favored by the country's development level. Section 5 concludes.

2 Measuring and describing IPR

2.1 The average exporter income

In this section we describe the main features of the dynamics of IPR over the 1996-2014 period. The product-k's average exporter income at time t is defined as:

$$AVEX_{kt} = \sum_{c=1}^{C} s_{ckt} GDPpc_{ct},$$

where C is the number of countries, $GDPpc_{ct}$ is country c's GDP per capita at time t, and s_{ckt} is this country's share in the global exports of product k. A decrease in the $AVEX_k$ (using $GDPpc$ at constant prices) indicates that, on average, good k is now exported by poorer countries.

We calculate the $AVEX_{kt}$ using data on disaggregated exports from BACI (Base pour l'Analyse du Commerce International, Gaulier and Zignago 2010), which are provided by CEPII (Centre d'Études Prospectives et d'Informations Internationales). The original BACI data come from the United Nations Statistical Division (COMTRADE database), over which a harmonization procedure is applied to reconcile the data reported by the exporting and importing countries and generate a single figure consisting of each bilateral flow in FOB values. GDP per capita, measured in 2011 PPP prices, are from the World Bank's World Development Indicators. These data present a number of potential outliers, especially in the mid 1990s, that appear to be the result of large shocks such as civil wars, the traumatic dismemberment of the Soviet Union, and the discovery of new large reserves of natural resources. Including these countries in the calculations of the $AVEX$ could seriously distort the subsequent analysis of the economic determinants of growth. Thus, we check the sample for potential outliers by identifying the countries for which the value of initial and final output gap deviated by more than three times the interquartile range from the sample median of the corresponding variable. Following this procedure, we exclude the following outliers: Azerbaijan, Belarus, Georgia, Guinea Bissau, Equatorial Guinea, Iraq, Kyrgyz Republic, Liberia, Rwanda, Tajikistan, Ukraine, Central African Republic, and Zimbabwe. We also exclude countries with populations below 500,000 inhabitants in 2007. As a result, the initial set of 142 countries that provided trade data throughout the reference period (1996-2014) is reduced to a consistent sample of 129 countries that is used to construct the $AVEX_{kt}$.[5]

[5] As Hausmann et al. (2007) emphasize in their analysis of the growth impact of export sophistication, it is essential to use a consistent sample of countries to avoid index changes that arise from changes in sample composition. Since non-reporting is likely to be correlated with income, constructing the $AVEX$s using different sets of countries at different points in time could introduce a serious bias into the index.

For each year, the $AVEX$s are calculated using average trade data over three years to attenuate the potential distorting effect of atypical values that may arise from unusual exports in a given year. We assign each three-year average index to the central year. Thus, although our analysis draws on data from 1995 to 2015, we refer to 1996-2014 as the period of analysis. We use the Harmonized System (HS)-1992 classification, which provides data on 5,036 6-digit products. These 6-digit products are reduced to a consistent list of 4,875 products that were exported every year by at least one country throughout the 1995-2015 period. This constant sample of products represents 99% of world trade over these years.

2.2 Relocation of industries and products over 1996-2014

In Figure 1, we use the ratio $AVEX_t/GDPpc_{Wt}$ to capture the $AVEX_t$ the macroeconomic trend of IPRNow, as a first approximation to describe the heterogeneity of the dynamics of IPR at the product level we use $\log(AVEX_{kt}/AVEX_t)$. Table 1 shows the transition matrix of $\log(AVEX_{kt}/AVEX_t)$ between 1996 and 2014 for the 4,875 HS 6-digit products. We consider nine symmetric intervals for $\log(AVEX_{kt}/AVEX_t)$. Each element a_{mn} $(m, n = 1, ..., 9)$ of the matrix indicates the frequency (in percentage terms) with which a product whose $\log(AVEX_{kt}/AVEX_t)$ was included in the interval m in 1996 had shifted to interval n by 2014. To interpret the size of these transitions, note that because the length of the intervals is 0.1 points, going from the limit of an interval to the limit of the next interval implies a change of 10 percentage (log) points in the product's $AVEX_k$ with respect to the aggregate $AVEX$ (also, recall that an $AVEX$ is an average per capita GDP in constant PPP US dollars). The table reveals an intense and diverse relocation in both directions, upward and downward, from any initial interval. Over the period, 67% of the products moved to a different interval (26% moved up and 41% moved down) and 30% of the products moved over more than one interval. This is in spite of the concentration of probability on the two extremes of the main diagonal, which is due to these intervals not having outer bounds. The matrix has almost no zeros, confirming the wide heterogeneity of IPR dynamics at the product level. Figure 2 display the kernels of the initial (1996) and final (2014) distributions of $\log(AVEX_{kt}/AVEX_t)$. The distribution spread out over the 1996-2014 period. This larger spread in 2014 suggests that international specialization has intensified in the sense that more products are now exported by only a group of countries that have a similar income level (which can be high or low).[6] The initial and final distributions of $\log(AVEX_{kt}/AVEX_t)$

[6] If all the countries had the same composition of exports (i.e., if revealed comparative advantage were equal to one for all the products and countries), then the distribution would concentrate on $\log(AVEX_k/AVEX) = 0$ for all k. The distribution of the $AVEX_k$ spreads out as more products are exported by only a small number of countries that have a similar $GDPpc$.

Table 1: Transition matrix of $\log(AVEX_{kt}/AVEX_t)$ for 1996-2014

Intervals	(-∞, -0.45]	[-0.45, -0.35]	[-0.35, -0.25]	[-0.25, -0.15]	[-0.15, -0.05]	(-0.05, 0.05]	[0.05, 0.15]	[0.15, 0.25]	[0.25, ∞)
(-∞, -0.45]	74.8	11.2	5.6	4.4	2.0	0.7	0.9	0.2	0.3
[-0.45, -0.35]	43.7	14.7	15.8	13.7	7.4	3.7	1.1	0.0	0.0
[-0.35, -0.25]	32.2	16.5	19.1	12.7	8.6	6.4	2.6	1.1	0.8
[-0.25, -0.15]	22.2	13.7	14.6	15.5	16.1	11.7	3.8	1.8	0.6
[-0.15, -0.05]	8.8	11.3	14.8	19.4	20.4	14.8	8.3	2.3	0.0
(-0.05, 0.05]	3.9	4.5	7.0	12.9	24.4	22.0	17.1	5.8	2.5
[0.05, 0.15]	2.0	1.1	3.0	3.9	10.6	23.2	33.1	18.8	4.3
[0.15, 0.25]	0.9	0.9	0.4	1.1	1.4	9.9	21.5	38.9	25.1
[0.25, ∞)	1.9	1.9	0.0	0.0	0.0	9.3	9.3	25.9	51.9
Initial distribution	12.1	3.9	5.5	7.0	9.9	17.9	31.1	11.5	1.1
Final distribution	16.4	6.2	7.0	8.4	12.0	15.2	17.3	12.1	5.4
Ergodic distribution	40.8	10.1	8.7	8.4	7.9	7.5	6.8	5.5	4.4

Note: Each element a_{mn} $(m, n = 1, ..., 9)$ of the matrix indicates the frequency (in percentage) with which a 6-digit product whose $\log(AVEX_{kt}/AVEX_t)$ was included in the interval m in 1996 had shifted to interval n by 2014.

are far away from the ergodic distribution resulting from the transition matrix (see Table 1). This suggests that the recent dynamics of IPR is notably different from the one in previous periods and, if maintained, would lead in the future to a substantially different distribution of the relative $AVEX$s. In particular, many more products would be exported mostly by poorer countries.

The change over time in a product's $AVEX$ has two components: the change in the exporting countries' market shares and the change in their $GDPpc$ (at constant prices). The first component is the *relocation effect*, whereas the second component is the result of other shocks common to the exporters of a given product (e.g., demand and technological shocks that do not necessarily affect comparative advantage and, thus, do not lead to relocation). We denote the *constant income* average exporter, which combines incomes at the beginning of a given period $(t-T)$ with market shares at the end of the period (t), by $ciAVEX_{k,t-T,t} = \sum_{c=1}^{C} s_{ckt} GDPpc_{c,t-T}$. Then, the *product k's relocation index* from time $t-T$ to time t is given by:

$$R_{k,t-T,t} = \frac{1}{T}\log\frac{ciAVEX_{k,t-T,t}}{AVEX_{k,t-T}} = \frac{1}{T}\log\frac{\sum_{c=1}^{C} s_{ckt} GDPpc_{c,t-T}}{\sum_{c=1}^{C} s_{ck,t-T} GDPpc_{c,t-T}}.$$

Because the $GDPpc$s in the numerator and the denominator are constant and equal to the values at the beginning of the period, $R_{k,t-T,t}$ is positive or negative depending only on the changes in market shares across exporting countries over the period. A negative $R_{k,t-T,t}$ indicates that exports of good k have relocated to poorer countries (i.e., to the South), whereas a positive value indicates relocation to richer countries (the North).

The mean absolute deviation of the $R_{k,t-T,t}$ provides a measure of the heterogeneity of

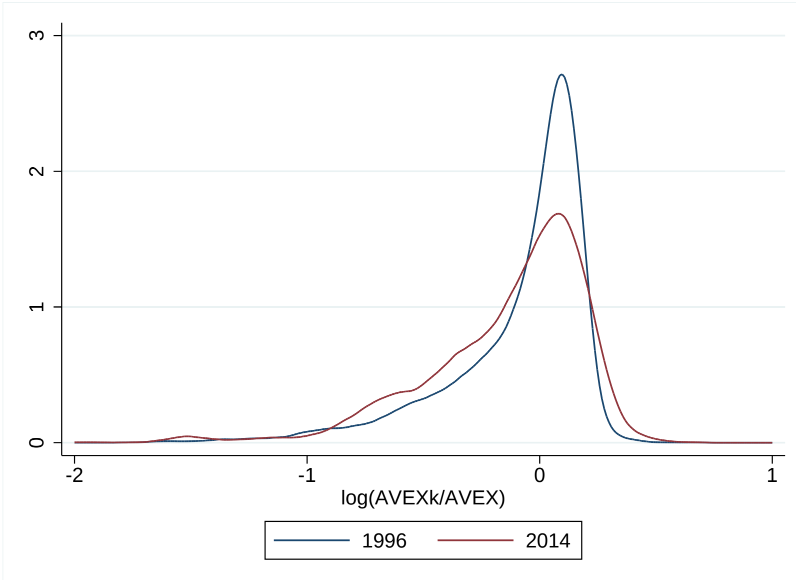

Figure 2: Kernel of $\log\left(AVEX_{kt}/AVEX_t\right)$ for 1996 and 2014

IPR across products. We use the following formula:[7]

$$MAD\left(R_{k,t-T,t}\right) = \sum_{k=1}^{K} \left|R_{k,t-T,t} - \overline{R}_{k,t-T,t}\right| \frac{b_{Wk,t} + b_{Wk,t-T}}{2},$$

where $\overline{R}_{k,t-T,t} = \sum_{k=1}^{K} R_{k,t-T,t} \frac{b_{Wk,t}+b_{Wk,t-T}}{2}$ and where $b_{Wk,t}$ is the value-share of product k in world trade at time t. This mean relocation index $\overline{R}_{k,t-T,t}$ exhibits an annual average growth of -0.9 over the 1996-2014 period, which is the result of the persistent increase in the developing countries' weight in global markets. Higher $MAD\left(R_{k,t-T,t}\right)$ also implies more intense IPR. In fact, IRP could be substantial and have significant consequences for cross-country economic performance even if the aggregate relocation, as measured for example by $\overline{R}_{k,t-T,t}$, were zero. Because different products within the same industry can move in opposite directions, thereby offsetting each other's movement when using data at the industry level, the intensity of IPR, as measured by $MAD\left(R_{k,t-T,t}\right)$, increases as we use more disaggregated data. Figure 3 shows the path of $MAD\left(R_{t-1,t}\right)$ for 1997-2014, using data at different levels of disaggregation: 18 sectors, 2-digit (96) industries, 4-digit (1,240) product categories, and 6-digit (4,875) products of the HS-92 classification.[8] The average

[7]We use the MAD instead of a more common dispersion measure such as the standard deviation because the latter gives extra weight to outliers, which might be large in this dataset.

[8]The 18-industry classification is based on the 21 sections in the HS92 classification and is constructed by splitting some sections that are quantitatively very large and by merging into a single industry some other sections that encompass a very small share of international trade. Specifically, we split section 6 (chemicals) into pharmaceuticals (chapter 30) and the rest of chemicals; section 15 (metals and their manufactures) into

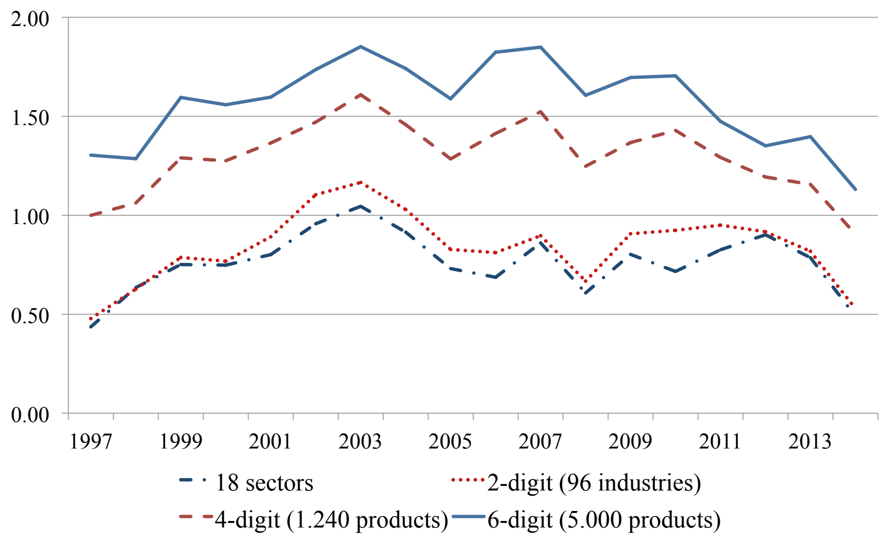

Figure 3: Dispersion of the annual relocation indices $R_{k,t-1,t}$ at different disaggregation levels, as measured by the mean absolute deviation of these indices

$MAD\left(R_{k,t-T,t}\right)$ over the 1997-2014 period when we consider 6-digit products roughly doubles the average $MAD\left(R_{k,t-T,t}\right)$ when we consider 18 sectors or 96 industries. Interestingly, all the paths in Figure 3 display a similar profile and peak in 2003.

The within-industry dispersion of the relocation indices is at least as important as their dispersion across industries. For each industry i, the within-industry MAD of product relocation is defined as:

$$MAD_i\left(R_{k,t-T,t}\right) = \sum_{k \in i} \left| R_{k,t-T,t} - \overline{R}_{i,t-T,t} \right| \frac{b_{Wkt} + b_{Wk,t-T}}{b_{Wit} + b_{Wi,t-T}},$$

where $\overline{R}_{i,t-T,t} = \sum_{k \in i} R_{k,t-T,t} \frac{b_{Wkt}+b_{Wk,t-T}}{b_{Wit}+b_{Wi,t-T}}$. Table 2 shows the industry $AVEX_i$ growth rates, the industry relocation indices R_i, and the within-industry $MAD_i(R_k)$ for 1996-2006 and 1996-2014 using a 18-industry classification (see footnote 8). Industries are ordered according to their R index for the whole period. For 1996-2014, the average of the within-industry $MAD_i(R_k)$ (in the last column of the table) is 0.76. It is, thus, larger than the mean absolute deviation of the industry R_i indices (in the second column of data), which is 0.57. Hence, much of the IPR is the result of movements in opposite directions within industries, which implies that data at the industry level can conceal much of the IPR process.

iron+steel (chapters 72 and 73) and the rest of metals; section 16 (machinery) into electrical equipment (chapter 85) and mechanical appliances (chapter 84); section 17 (transport equipment) into motor vehicles (chapter 87) and the rest of transport equipment. Conversely, we merge sections 8, 11 and 12 (leather, textiles and footwear); sections 9 and 10 (wood and paper); sections 13 and 20 (furniture and other manufactures and stones); and sections 3, 14, 19 and 21 (fats and oils, pearls, arms and works of art). We call this latter, very heterogenous group. *miscellanea*. This is also the classification used in Table 2.

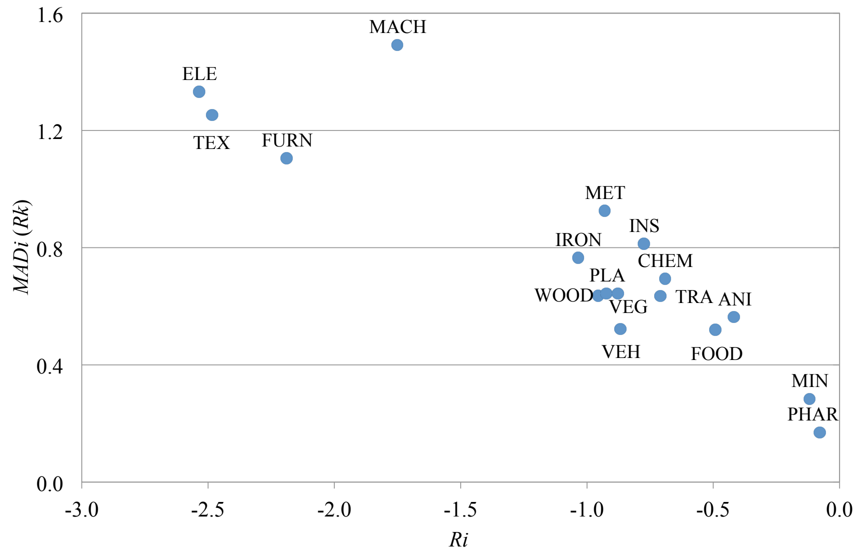

Figure 4: Industry relocation (R_i) versus within-industry relocation ($MAD_i(R_k)$), 1996-2014

There is a strong negative correlation between industry relocation and the dispersion of relocation within the industry. Excluding the miscellanea group, which is a jumble of very diverse products such as fats, pearls, arms, and art, the correlations between R_i and $MAD_i(R_k)$ in Table 2 is -0.89 for 1996-2006 and -0.90 for 1996-2014. This negative correlation is apparent in Figure 4, where these two variables are displayed for 1996-2014 (industry acronyms are explained in Table 2). Hence, even in those industries experiencing the most intense relocation to the South, there are products that relocate little or nothing at all. This is consistent, for example, with the development of global value chains, by which some stages of production within a given industry (and, thus, the production of some of its intermediates) are offshored while other stages are not. The industries with the most intense relocation towards the South over the 1996-2014 period were electrical equipment and textiles, footwear, and leather, which are well-known industries experiencing intense production fragmentation and offshoring. Conversely, pharmaceuticals is the industry showing the lowest relocation to the South, once we leave aside the Miscellanea group. Interestingly, the largest difference between the growth of the $AVEX$ and the R index occurs for minerals, which is a sector that experiences large price shocks. Price shocks are product shocks affecting the exporters' income (and, thus, the product's $AVEX$) that do not lead to relocation. They are an example of the *other product shocks*, i.e., other shocks common to the exporters of a given product that do not necessarily lead to relocation.

In panel A of Table 3 we provide several examples of products with an interesting relocation dynamics that will also be useful later on in illustrating the relocation shocks experienced by some countries. We mostly include textile and electronic products, as they showed the

Table 2: $AVEX_i$ growth, relocation indices (R_i), and within-industry mean absolute deviation of the product R_k indices ($MAD_i(R_k)$) by industry

Industry		AVEX growth		R index		MAD (R)	
		1996-2006	1996-2014	1996-2006	1996-2014	1996-2006	1996-2014
Electrical equipment	ELE	0.02	-0.18	-2.37	-2.54	1.27	1.33
Textiles, footwear, leather	TEX	0.06	-0.01	-2.47	-2.48	1.43	1.25
Furniture, stone, and other manufactures	FURN	-0.10	0.00	-2.44	-2.19	1.46	1.11
Machinery and mechanical appliances	MACH	0.25	0.02	-1.91	-1.75	1.65	1.49
Iron and manufactures thereof	IRON	0.96	0.65	-1.24	-1.04	0.71	0.77
Wood and paper	WOOD	1.41	0.76	-0.92	-0.96	0.68	0.64
Metals and manufactures, exc. iron	MET	0.99	0.63	-1.19	-0.93	0.79	0.93
Plastics	PLA	1.20	0.71	-0.87	-0.92	0.64	0.64
Vegetable products	VEG	1.39	0.71	-0.78	-0.88	0.82	0.64
Motor vehicles	VEH	1.11	0.57	-0.76	-0.87	0.41	0.52
Instruments	INS	1.24	0.89	-0.87	-0.77	0.92	0.81
Transport equipment, exc. motor vehicles	TRA	1.52	0.84	-0.58	-0.71	0.62	0.64
Chemicals exc. pharmaceuticals	CHEM	1.74	1.00	-0.60	-0.69	0.67	0.69
Food, beverage and tobacco	FOOD	1.65	0.99	-0.49	-0.49	0.65	0.52
Animal products	ANI	1.70	1.13	-0.54	-0.42	0.87	0.56
Minerals	MIN	1.36	1.04	-0.29	-0.12	0.40	0.28
Pharmaceuticals	PHAR	2.22	1.37	-0.04	-0.08	0.19	0.17
Miscellanea	MISC	1.50	1.50	-0.29	0.33	1.01	0.73

Note: The $AVEX_i$ growth and R_i indices correspond to the average annual growth rates over the indicated period, in percentage terms. The within-industry mean absolute deviation of the R_k indices are calculated using HS 6-digit product data.

most intense and diverse IPR over the period, though we also include petroleum distillates and a raw material such as unmanufactured tobacco. The textile and electronics 6-digit products that we use as examples are among the most traded products within their sector and among those with the highest or the lowest relocation to the South. For example, on average, the $AVEX$ of computer input or output units (HS-847192) went annually down by 6.5% over 1996-2006 as a consequence of relocation. Petroleum distillates (HS-271000) exhibits the lowest relocation index among our examples. China appears to be the country with the largest global market share gain over 1996-2006 for all our textile and electronic products, while US, Japan, Singapore, and Honk Kong are usually among the countries with largest market share losses.

Finally, the relocation indices of the 18 industries show a strong persistence over the two sub-periods 1996-2006 and 2006-2014 (the correlation between the R_i of these two periods is 0.87). However, the persistence at the 6-digit product level is almost non-existing (the correlation of the product R_{ik} between the two periods is below 0.1, even if we restrict the sample to values of R_k between -5 and 5 to exclude potential outliers). Although past relocation dynamics appears to be helpful in predicting future relocation at the level of broad industries (e.g., textiles and electronics have persistently championed relocation to the South

Table 3: Examples of product relocation, country relocation shocks, and export upgrading

PANEL A: PRODUCT RELOCATION

		HS-240120	HS-271000	HS-610910	HS-611030	HS-620462	HS-847192	HS-847193	HS-847330	HS-854211	HS-854219
		Tobacco, unmanufactured, stemmed or stripped	Oils petroleum, bituminous, distillates, except crude	Cotton T-shirts, knit	Pullovers & cardigans of manmade fibers	Women & girls trousers & shorts, cotton, not knit	Computer input or output units	Computer data storage units	Parts & accessories of data processing equipment	Monolithic integrated circuits, digital	Monolithic integrated circuits, except digital
R_k 1996-2006 (%)		-3.1	-0.5	-3.8	-4.2	-3.7	-6.5	-4.1	-3.6	-1.4	-1.3
AVEXk growth 1996-2006 (%)		-1.1	1.7	-1.2	-1.1	-0.9	-3.4	-1.1	-0.9	1.1	1.2
Changes in global market share 1996-2006	Largest increases (percentage points)	BRA 9.3	RUS 4.3	CHN 6.2	CHN 16.1	CHN 11.3	CHN 42.3	CHN 15.8	CHN 23.2	CHN 7.8	CHN 6.4
		CHN 2.1	IND 3.0	BGD 4.4	BGD 3.9	TUR 2.8	NLD 1.4	THA 7.6	KOR 2.6	PHL 3.4	SGP 3.4
		DEU 2.0	ARE 1.3	TUR 4.2	KHM 2.0	BGD 2.7	SVK 0.8	PHL 3.4	MYS 2.2	SGP 2.8	PHL 2.5
	Largest reductions (percentage points)	DOM -0.7	NLD -1.8	HKG -2.2	HKG -3.7	MEX -4.3	SGP -6.2	USA -6.2	SGP -3.3	GBR -1.8	FRA -1.7
		NLD -1.5	DZA -2.4	GRC -3.3	KOR -5.5	USA -5.3	USA -8.1	JPN -12.5	JPN -5.5	USA -6.2	JPN -7.2
		USA -19.5	SGP -3.1	USA -7.3	ITA -6.7	HKG -5.5	JPN -18.7	SGP -12.8	USA -13.1	JPN -7.4	USA -8.0

PANEL B: COUNTRY RELOCATION SHOCKS

	RS_c (%)	ins_RS_c(%)	Share of the product in the country's exports in 1996 (percentage)*									
	1996-2006	1996-2006	HS-240120	HS-271000	HS-610910	HS-611030	HS-620462	HS-847192	HS-847193	HS-847330	HS-854211	HS-854219
Malawi	-2.36	-2.40	52.4		1.5							
Bangladesh	-2.50	-2.54			6.5	4.2	2.2					
Honduras	-1.94	-2.22			6.3		1.8					
Philippines	-2.25	-1.96							7.2	6.4	14.3	4.6
Thailand	-2.14	-2.30						2.5	6.0	4.7	2.7	1.3
Malaysia	-2.09	-2.30		1.2				2.2	4.4	5.2	9.0	2.7
Singapore	-2.24	-2.25		9.6				3.1	12.8	7.8	6.2	3.3

PANEL C: EXPORT UPGRADING

	GDPpc 1996	Export sophisticat. 2014	Change between 1996 and 2014 of the product's share in the country's exports (difference of percentage points)**									
			HS-240120	HS-271000	HS-610910	HS-611030	HS-620462	HS-847192	HS-847193	HS-847330	HS-854211	HS-854219
Malawi	872.2	21,639	-9.2		-1.5							
Bangladesh	1,474.3	15,995			7.2	1.0	5.7					
Honduras	3,384.3	20,448			2.4	5.6	-1.7					
Philippines	4,097.2	27,533							-1.0	-2.3	-13.1	15.5
Thailand	9,847.6	28,673		2.5				-1.6		-3.2	-2.6	2.1
Malaysia	15,483.3	30,647		7.1				-1.8	-2.4	-2.4	-8.9	13.3
Singapore	46,317.7	37,073		10.5				-2.8	-11.8	-6.6	-6.0	13.2
Product's 2014 *AVEX* (US $)			19,875	38,527	15,871	15,046	15,434	22,070	24,444	25,153	30,738	34,920

Note: R_k, $AVEX_k$ growth, RS_c, and ins_RS_c are annual averages over the indicated period.
*We only show shares above 1%.
**We only show changes higher than one percentage point.

much before 1996), it appears that the future dynamics of relocation at the 6-digit level is rather unpredictable on the basis of the products' previous dynamics.

3 The growth impact of IPR

In this section, we estimate the growth impact of IPR across countries. The dispersion of the IPR dynamics at the product level and the differences in the country specialization patterns across products will help identify this impact. First, we introduce the indices that measure how each country's export basket has been affected by relocation and by other product shocks. Second we set out the equation to be estimated, discuss the potential identification problems, and introduce the data. And third, we present the econometric findings.

3.1 Measuring relocation and other product shocks

We define the country c's product shocks index between times $T-t$ and t, denoted by $PS_{c,t-T,t}$, as follows:

$$PS_{c,t-T,t} = \frac{1}{T}\log\frac{\sum_k b_{ckt-T}AVEX_{k,t}}{\sum_k b_{ckt-T}AVEX_{k,t-T}}.$$

Because we hold constant each product's share b_{ckt-T} in the country's exports, this index is only affected by the change over time in the products' $AVEX$s. A negative (positive) value of $PS_{c,t-T,t}$ means that, on average, country c's initial exports were exported at the end of the period by poorer (richer) countries. Because of the two sources of changes in the $AVEX_k$s already discussed in the previous section, the PS indices capture different types of product shocks: (a) product shocks that change comparative advantage and, thus, country market shares s_{ck}; and (b) other product shocks that do not lead to relocation (i.e., demand shocks and other technological shocks that are neutral on comparative advantage). To capture the specific effect of the IPR, we define the country c's *relocation shocks* index between times $T-t$ and t, $RS_{c,t-T,t}$, as follows:

$$RS_{c,t-T,t} = \frac{1}{T}\log\frac{\sum_k b_{ckt-T}ciAVEX_{k,t-T,t}}{\sum_k b_{ckt-T}AVEX_{k,t-T}} = \frac{1}{T}\log\frac{\sum_k b_{ckt-T}\sum_{c=1}^{C} s_{ckt}GDPpc_{ct-T}}{\sum_k b_{ckt-T}\sum_{c=1}^{C} s_{ckt-T}GDPpc_{ct-T}}.$$

This index only captures changes in world market shares s_{ck} across country income groups and weights these changes according to how important each product was in the country c's export basket (i.e., according to b_{ckt-T}). In the econometric analysis of cross-country growth that follows, we use the difference $OPS \equiv PS - RS$ to control for the impact of *other product shocks* (i.e., demand shocks and relocation-neutral technology shocks). This OPS index is, thus, given by the following expression:

$$OPS_{c,t-T,t} \equiv PS_{c,t-T,t} - RS_{c,t-T,t} = \frac{1}{T}\log\frac{\sum_k b_{ckt-T}\sum_{c=1}^{C} s_{ckt}GDPpc_{ct}}{\sum_k b_{ckt-T}\sum_{c=1}^{C} s_{ckt}GDPpc_{ct-T}}.$$

The RS and OPS indices are calculated using the $AVEX$ and $ciAVEX$ described in Section 2 and the information on each country's export shares from BACI. Panel B of Table 3 provides some illustrative data on the specialization patterns and relocation dynamics of the countries with the most negative RS over the 1996-2006 period: Bangladesh, Malawi, Honduras, Philippines, Thailand, Malaysia, and Singapore. In 1996, Bangladesh and Honduras were highly specialized in textiles, which was the sector experiencing the most intense relocation to the South over the 1996-2006 period. For example, a single item such as cotton T-shirts knit (HS-610910) accounted for 6.5% of Bangladesh's exports and 6.3% of Honduras' exports in 1996. This product exhibited a relocation index of -3.8% over 1996-2006 (recall that this rate corresponds to the average annual rate of change in the $AVEX$ due to the changes in market shares). China's global market share in this product went from 14.4% in 1996 to 20.6% in 2006. Malawi, in turn, is an exporter of agriculture products. Its main export, unmanufactured tobacco, experienced a substantial relocation to the South after the US reduced its global market share by almost 20 percentage points. The strongly negative RS indices of Philippines, Thailand, Malaysia, and Singapore are explained mostly by their initial specialization in electronics. For example in 1996, computer data storage units (HS-847193) represented 7.2% of Philippines' exports, 6% of Thailand's, 4.4% of Malaysia's, and 12.8% of Singapore's. This product's $AVEX$ exhibited a relocation index of -4.1% over 1996-2006. This notable relocation processes is the consequence, among other shifts, of the increase in the China's global market share in this product, which went from 3.4% in 1996 to 19.2% in 2006. Also, Thailand's market share went from 7.9% to 15.4%, and Philippines' went from 3.9% to 7.3%. Conversely, the main losers in this product's market were Singapore (with its market share going from 27.6% to 14.8%), Japan (from 14.6% to 2.1%), and US (from 12.1% to 5.9%). The table shows a number of other examples of products that experienced some of the largest relocations to the South and that figured in 1996 as some of the main exports of the cited seven countries.

3.2 Empirical approach

The econometric analysis of the link between IPR and economic growth is conducted within the framework of cross-country growth regressions (e.g., Barro and Sala-i-Martin 2003). Average GDP per capita growth for 1996–2006 in the cross-sectional regressions and for

1996–2006 and 2006–2014 in the panel regressions is regressed on (the log of) initial per capita GDP, relocation shocks RS, and a vector of controls X_c^0. Growth rates are calculated using GDP per capita in PPP-constant 2011 international dollars from the World Bank's World Development Indicators. Motivated by the discussion in the Introduction, we also include the interaction between RS and initial per capita GDP in the regression. According to that discussion, some shocks leading to IPR to the South are likely to have a relatively higher impact on the more developed economies, while other shocks are likely to have a relatively lower impact on these economies. Also, some characteristics that can facilitate the reallocation of resources from declining industries that have lost comparative advantage to new industries –i.e., characteristics such as efficient markets, product diversification, and high-quality governance– are relatively more abundant in richer countries. Therefore, given a country's exposure to IRP as measured by its RS index, the impact of IRP on $GDPpc$ growth is likely to depend on the country's level of development (though the sign of this dependence cannot be ascertained on theoretical grounds).

Hence, denoting the error term by u_c, our econometric specification is:

$$\begin{aligned}\frac{1}{T}\log\frac{GDPpc_{c,t}}{GDPpc_{c,t-T}} &= \beta_0 + \beta_1 RS_{c,t-T,t} + \beta_2 RS_{c,t-T,t} * \log\left(GDPpc_{c,t-T}\right) \\ &+\beta_3 \log\left(GDPpc_{c,t-T}\right) \\ &+\beta_4 X_{c,t-T} + u_c, \qquad (1)\end{aligned}$$

Estimating equation (1) presents three potential problems. First, economies with similar export baskets could be affected by other common shocks that do not lead to relocation but that could be correlated with relocation shocks (i.e., demand shocks and neutral technical shocks). Omitting to control for these *other product shocks* would bias the estimated coefficients. To address this potential problem, we always include our proxy OPS for other product shocks as one of the covariates in the estimated equation.

Second, the $RS_{c,t-T,t}$ and $OPS_{c,t-T,t}$ indices are designed to only capture the impact of product shocks (i.e., shocks that affect all the countries exporting a given product) on each country over a given period. However, under some circumstances, these indices could also be affected by country-specific shocks. If there is an exporter with a large global market share of a particular product, a country-specific shock to this country would also affect the product's $AVEX$ and $ciAVEX$. This could in turn affect the country's RS and OPS indices if the products in which the country is an important global exporter also represent a significant share of this country's total exports. Consequently, country-specific shocks could give rise to a spurious correlation between $GDPpc$ growth and the RS_c and OPS_c indices. To address this potential problem, we calculate specific $AVEX_ks$ and $ciAVEX_ks$ for each country that are constructed excluding all data related to this country (i.e., data on this country's GDP per capita and exports). Then, we use these country-specific $AVEX$s and $ciAVEXs$ to construct instruments for the country's RS_c and OPS_c indices. Formally, we define the country c's specific $AVEX$ and $ciAVEXs$ for good k (which are denoted by adding an ins prefix to indicate that are to be used to calculate instruments) as follows:

$$insAVEX_{kct} = \sum_{i \neq c} \frac{s_{ikt}}{\sum_{i \neq c} s_{ikt}} GDPpc_{it},$$
$$insciAVEX_{kc,t-T,t} = \sum_{i \neq c} \frac{s_{ikt}}{\sum_{i \neq c} s_{ikt}} GDPpc_{it-T}.$$

Then, the instruments for the RS and OPS indices are, respectively,

$$insRS_{c,t-T,t} = \frac{1}{T} \log \frac{\sum_k b_{ckt-T}\ insciAVEX_{kc,t-T,t}}{\sum_k b_{ckt-T}\ insAVEX_{kc,t-T}},$$
$$insOPS_{c,t-T,t} = \frac{1}{T} \log \frac{\sum_k b_{ckt-T}\ insAVEX_{kct}}{\sum_k b_{ckt-T}\ insciAVEX_{kc,t-T,t}}.$$

For each country, these instruments are not affected by the country's specific shocks. Figure 5 shows the scatter plot of the RS index on its instrument $insRS$. The high correlation between the variable and the instrument is apparent.[9] However, the variable and its instrument are markedly different from each other in a few cases. The most important of these cases is China. China has gained a large global market share in many products whose $AVEX$ is above China's $GDPpc$. Therefore, the measured relocation of its exports is more negative when China is included in the calculations (i.e., when considering China's RS) than when it is excluded (i.e., when considering China's $insRS$).

A third potential problem in identifying the impact of relocation shocks could arise if country shocks are correlated across neighboring countries (or there are spillovers across them), neighboring countries have similar export baskets, these neighbors jointly hold a large global share of a product's market, and this product represents a large share of some of the neighbors' exports. In such a case, that is, if country n is a globally large exporter of product k and a neighbor of country c, k represents a large share of c's exports, and country shocks to n and c are correlated, then a country shock to n at time t affects $AVEX_{kt}$,

[9] Accordingly, the first-stage regressions show very large F statistics, thereby confirming that these instruments are good predictors of the instrumented variables. Table 10 in Appendix A reports the first-stage regressions for our preferred specifications in the cross-section and panel data regressions (corresponding to the results in column 4 of Table 5 and column 1 of Table 7). The results are similar for the other specifications.

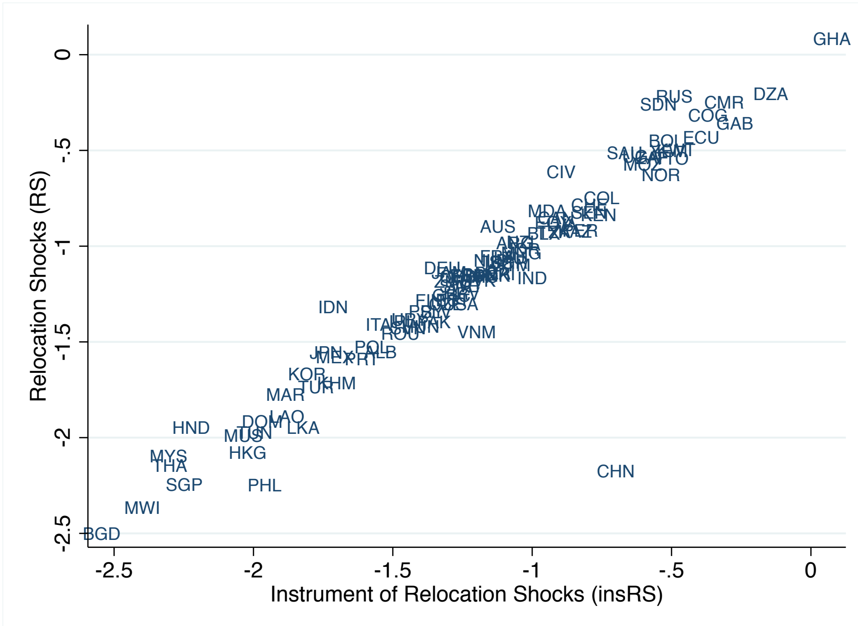

Figure 5: The RS versus its instrument ($insRS$)

$insciAVEX_{kc,t-T,t}$, and $insAVEX_{kc,t}$, and therefore it affects $insRS_{c,t-T,t}$ and $insOPS_{c,t-T,t}$. As a result, because the country shocks in n are correlated with country shocks in c, there will be a spurious correlation between country c's $GDPpc$ growth between $t-T$ and t, and the instruments for the product shocks indices $insRS_{c,t-T,t}$ and $insOPS_{c,t-T,t}$. This potential problem is addressed by constructing new instruments of the product shocks based on country-specific $AVEX$s the calculation of which not only excludes all data related to this country but also exclude all the data related to its neighbors. These new instruments are used to carry out some final robustness checks.

As other covariates, we always control in our regressions for human capital, institutional quality, share of oil in exports, export openness, economy size, export diversification, and export complexity. Our measure for human capital is years of schooling from Barro and Lee (2013), although we also consider enrollment in secondary education from the World Bank and human capital from PWT 9.0 (Feenstra, Inklaar, and Timmer 2015) in robustness checks (see Appendix C, where we also consider capital intensity –i.e., the country's capital stock per person engaged in production– from this same dataset). We use rule of law from the World Bank's World Governance Indicators as our main measure of institutional quality and consider three other alternatives in robustness checks: regulatory quality, government effectiveness, and corruption control. The share of oil exports is defined as the share of exports from chapter 27 (mineral fuels, mineral oils, and products of their distillation) of the HS in total merchandise exports, and it is also calculated using data from BACI (we use the average ratios over 1995-1997 and 2005-2007). As a measure of trade openness we use the *real export openness ratio* advocated in Alcalá and Ciccone (2004): $real\ export\ openness_{ct} = Exports_{ct}/GDP_{ct}$, where the GDP_{ct} is measured in PPP. Real export openness is interacted with the country's GDP, as foreign markets tend to matter more for countries with smaller domestic markets (Alesina et al., 2000).

In turn, Lederman and Maloney (2012) among others have argued that economic diversification is a potentially important determinant of growth. We control for export diversification by including the percentage of products for which the country has a revealed comparative advantage greater than 1, where country c's revealed comparative advantage in product k in period t is $RCA_{ckt} = b_{ckt}/b_{Wkt}$ and b_{Wkt} is the value share of product k in global trade.[10] This index is also interacted with log$GDPpc$ to allow for potentially varying effects of diversification along the countries' level of development. We also control for *export complexity* and its interaction with $GDPpc$ This variable has been developed by Hausmann, Hidalgo, and coauthors (Hidalgo et al. 2007, Hidalgo and Hausmann 2009, Hausmann, et al. 2011). According to their approach, goods requiring more collective-coordinated capabilities, knowledge, and skills are less ubiquitous (fewer countries export a significant amount of them), whereas more diversified economies have a wider array of these factors. Combining measures of the *ubiquity* of each good's exports and the *diversity* of each country's exports, the authors construct an economic complexity index (ECI) that ranks all the countries' economies. These authors find that initial complexity is positively correlated with future growth, with an impact that decreases with country income. In addition, we always include continent dummies for Africa, America, Asia, and Europe (the dummy for Oceania is the omitted one) and interact them with time fixed effects in the panel regressions.

The sample of 129 countries used to construct the $AVEXs$ is reduced to 96 countries when we consider our covariates because the data on human capital, openness, and the economic complexity index are missing for some countries. Table 5 in Appendix B lists the countries used at different stages of the paper and annotates those for which some data are missing. Table 4 reports the main descriptive statistics and correlations for our key variables RS, OPS, $GDPpc$ growth, and log$GDPpc$.

3.3 Findings

We now report the results of estimating equation (1) using different controls and samples. Our focus is on the cross-country analysis for the 1996-2006 period in which IPR peaked

[10] We also considered other measures of diversification using a threshold of 0.5 instead of 1 for revealed comparative advantage and a Herfindhal index ($diversification_{ct} = \sum_k (b_{ckt})^2$) and found almost identical results for the variables of interest.

Table 4: Descriptive statistics ad correlations

Descriptive statistics	Mean	Median	Std. Dev.	Min	Max
Relocation shocks (*RS*)	-1.18	-1.15	0.54	-2.50	0.08
Other product shocks (*OPS*)	2.16	2.19	0.27	1.26	2.67
GDPpc growth	2.87	2.49	1.91	-2.08	8.36
log GDPpc	9.11	9.15	1.09	6.12	11.29

Correlations	GDPpc growth	*RS*	*OPS*	log GDPpc
Relocation shocks (*RS*)	-0.16			
Other product shocks (*OPS*)	0.45	-0.69		
log GDPpc	-0.14	0.01	-0.17	
log Human Capital (years schooling)	0.14	-0.07	0.16	0.71
log Capital Intensity	-0.06	-0.08	0.00	0.90
Rule of law	-0.02	-0.15	0.12	0.77
Share of oil exports	-0.11	0.51	-0.79	0.16
log export openness	-0.05	-0.16	0.05	0.71
log GDP	-0.13	-0.11	-0.05	0.54
International diversification	0.26	-0.39	0.45	0.17
Economic Complexity Index (*ECI*)	0.09	-0.14	0.13	0.75

Note: RS, OPS, and $GDPpc$ growth correspond to annual averages for 1996-2006, whereas all the other variables correspond to values at the beginning of the period (1996).

and trade was not yet affected by the Great Recession. However, we also conduct panel data regressions for 1996-2014 as a robustness check. In all the regressions, the left-hand-side variable is the average annual rate of GDP per capita growth in percentage terms, all the correlates correspond to values at the beginning of the corresponding period except for the RS and OPS variables whose construction has already been explained. Robust standard errors are reported in parentheses.

3.3.1 Cross-country regressions for 1996-2006

Table 5 contains the main results of estimating equation (1) using cross-country regressions. Columns 1 to 2 reports OLS estimates, whereas all the other columns in this table as well as in the following tables report 2SLS estimates. Before considering the impact of relocation, column 1 shows the estimates from running the growth regression on the controls that we use in almost all the regressions. Starting with column 2, we always include the variables of interest in this paper –i.e., RS, OPS, and the interaction between RS and $GDPpc$. Column 3 shows the results of estimating the same specification as in column 2 using now 2SLS. Column 4 checks how the results would change if the control OPS was not included in the regression. In columns 5-7, we check that the results are not driven by the dynamics of natural resource exporters or of some peculiar products. Although we always control for the share of oil products in total exports, in columns 5 to 7 we exclude altogether the oil producers from our sample (see Table 11 in Appendix B for a list of the different groups of countries),[11] thereby reducing the sample to 83 countries. In column 6, we add a control for the share of exports in chapters 25-27 (minerals), 71 (precious and semi-precious stones and metals, and pearls) and 97 (art and antiques) of the HS classification and also exclude from the previous 83-country sample those countries for which exports in these five chapters exceed 35% of their total exports. This reduces the sample to 79 countries. RS, its interaction with $\log GDPpc$, and OPS are instrumented in columns 3 to 6 using the already explained instruments $insRS$, $insOPS$, and $insRS * \log(GDPpc)$. Finally, as a further test that the results do not depend on natural resource exports or exporters, in column 7 we use different RS and OPS indices that are calculated excluding the data on natural resources and other non-produced or special items. Specifically, the new indices, which are called $Nat.Res.excl\_RelocationShocks$ and $Nat.Res.excl\_OtherProductShocks$, are calculated by excluding the data on exports of the HS chapters 25, 26, 27, 71, and 97. Besides excluding trade in these chapters, the calculation of the instruments for each country also exclude, as before, each country's own data.

The results for the variables of interest are very similar across all the different regressions in Table 5. We always find positive coefficients on RS and OPS, and a negative coefficient on the interaction term. These coefficients are always significant at 1%, except in two cases in which the significance of OPS is 5%. The sign and significance of RS is not affected by dropping OPS from the equation (column 4), by excluding from the sample the countries exporting mostly natural resources (columns 5 to 7), or by excluding the exports on natural resources in the constructions of the shock indices (column 7). [12] Therefore, the IPR to the South had a negative effect on the relative $GDPpc$ growth of the countries whose initial export basket included products in which lower income countries gained global market share. However, this negative impact decreases with the country's income. The point estimates of the marginal effect of RS on annual growth at the first quartile of $\log(GDPpc)$ are shown in the last raw of the table. Figure 6 shows the decreasing pattern of this marginal effect as a function of the country $\log(GDPpc)$, with 95% confidence intervals. The figures are drawn using the estimates in columns 3 (left figure) and 7 (right figure) of Table 5. In the case of the figure using the full sample (left figure), the positive marginal effect of RS

[11] Oil producers are defined as the countries whose oil exports represent more than 35% of their total merchandise exports.

[12] We also find identical signs and statistical significance for the coefficients of interest and similar point-estimates using alternative measures of institutional quality (e.g., regulatory quality, government effectiveness, control of corruption) and human capital (e.g., secondary enrollment and data from the Penn World Table 9) or including additional controls such as physical capital intensity (see Appendix C).

Table 5: Relocation and cross-country growth

	(1) OLS	(2) OLS	(3) IV	(4) IV	(5) IV	(6) IV	(7) IV
Relocation shocks (*RS*)		7.39***	7.65***	7.18***	6.50***	6.30***	
		(1.44)	(1.28)	(1.96)	(1.43)	(1.48)	
*RS**log *GDPpc*		-0.74***	-0.78***	-0.82***	-0.67***	-0.63***	
		(0.17)	(0.15)	(0.22)	(0.17)	(0.18)	
Other Product Shocks (*OPS*)		7.04***	4.69***		3.83***	3.80**	
		(1.21)	(1.22)		(1.47)	(1.49)	
Nat. Res. excl_Relocation shocks							6.19***
							(1.61)
Nat.Res.excl_*RS**log *GDPpc*							-0.61***
							(0.19)
Nat. Res. excl_Other Product Shocks							4.00**
							(1.56)
log *GDPpc*	-1.64**	-1.26*	-1.15*	-1.08	0.28	0.33	0.26
	(0.75)	(0.65)	(0.61)	(0.79)	(0.70)	(0.75)	(0.77)
log Human Capital (years schooling)	1.01**	1.39***	1.46***	1.67***	1.47***	1.56***	1.62***
	(0.49)	(0.38)	(0.34)	(0.39)	(0.42)	(0.45)	(0.49)
Rule of Law	0.40	0.29	0.27	0.26	0.33	0.34	0.34
	(0.42)	(0.31)	(0.31)	(0.40)	(0.28)	(0.29)	(0.28)
Share of Oil Exports	1.81	9.31***	7.30***	3.66**	7.53**	8.94**	6.52
	(1.53)	(1.79)	(1.65)	(1.58)	(3.70)	(4.22)	(4.21)
log export openness	3.28	5.82*	5.76**	4.61	5.10*	4.52	4.73*
	(3.79)	(3.15)	(2.92)	(3.48)	(2.63)	(2.77)	(2.71)
log *GDP*	0.08	0.41	0.41	0.29	0.42	0.37	0.40
	(0.39)	(0.32)	(0.29)	(0.34)	(0.28)	(0.31)	(0.31)
log export openness*log *GDP*	-0.13	-0.23*	-0.22**	-0.18	-0.20**	-0.17*	-0.18*
	(0.14)	(0.12)	(0.11)	(0.13)	(0.10)	(0.10)	(0.10)
International diversification		49.50**	61.25***	78.53***	102.98***	103.66***	100.98***
		(19.18)	(18.13)	(18.60)	(22.39)	(23.18)	(23.07)
International diversification*log *GDPpc*		-4.36**	-5.59***	-7.53***	-10.01***	-10.06***	-9.79***
		(1.93)	(1.83)	(1.89)	(2.27)	(2.35)	(2.34)
Economic Complexity Index *(ECI)*	5.37**	-0.95	-0.42	1.05	-2.04	-1.90	-1.75
	(2.48)	(1.96)	(1.85)	(2.17)	(1.72)	(1.83)	(1.83)
*ECI** log *GDPpc*	-0.48*	0.14	0.08	-0.07	0.20	0.18	0.17
	(0.25)	(0.19)	(0.18)	(0.21)	(0.16)	(0.18)	(0.17)
Share of natural resource exports						0.10	-0.38
						(1.76)	(1.62)
Constant	13.15	-3.42	-13.10	-13.10	-24.77**	-23.66**	-24.15**
	(11.04)	(10.88)	(10.19)	(10.19)	(10.27)	(11.14)	(11.16)
Observations	96	96	96	96	83	79	79
R^2	0.42	0.70	0.68	0.51	0.69	0.69	0.70
Marginal effect of *RS* at 25th-percentile *GDPpc*		1.21	1.14	0.33	0.90	1.04	1.09

Notes: Results from estimating equation (1) using OLS (columns 1-2) and 2SLS (columns 3-7). The dependent variable is the average growth rate of GDP per capita over the 1996-2006 period in percentage terms. All the specifications include dummies for continents. Robust standard errors are in parentheses. Columns 5-7 check for the robustness of the results with respect to excluding natural resource exports and exporters. Specifically, in columns 5 to 7 we exclude from the sample the countries for which oil exports represent more than 35% of their merchandise exports. In columns 6 and 7, we also exclude the countries for which exports of products in chapters 25, 26, 27, 71, and 97 of the HS classification represent more than 35% of their merchandise exports (see Table 11 in Appendix B for the list of these countries). The *relocation* and the *other product shocks* indices used in column 7 ($Nat.Res.excl\_RelocationShocks$ and $Nat.Res.excl\_OtherProductShocks$) are calculated excluding the exports of those five chapters of the HS classification. RS, OPS, $Nat.Res.excl\_RS$ and $Nat.Res.excl\_OPS$, and their interactions with log$GDPpc$ are instrumented using the instruments explained in the main text. Significance levels: *** 1%, ** 5%, * 10%.

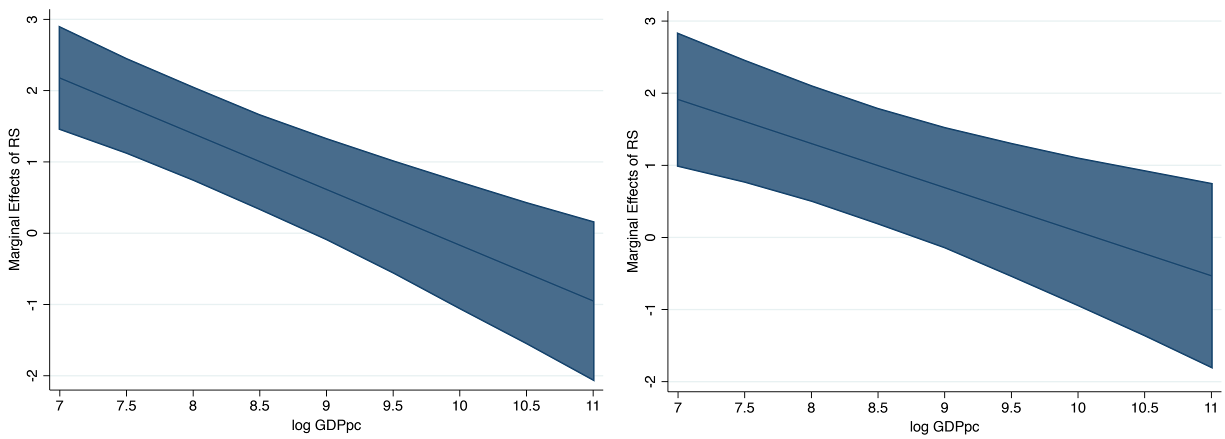

Figure 6: Average marginal effects of Relocation Shocks on GDPpc growth with 95% confidence intervals. They correspond to the estimates in columns 3 (left figure) and 7 (right figure) of Table 5.

(which implies a negative impact of the relocation to the South) is significant at the 5% level for $GDPpc$s below the 40th percentile of the countries' income distribution. For richer countries, this marginal effect is not significant. These estimates imply that a one-standard negative deviation of a country's export *relocation index* reduced the average annual $GDPpc$ growth of a country at the first quartile of the income distribution by 0.61 percentage points. The point estimates and confidence intervals of the marginal effects of RS are very similar when we exclude natural resource exports from the calculation of the indices and the natural resource exporters from the sample (right figure of Figure 6).

Hence, on average, the developing countries that at the beginning of the period specialized in product categories that subsequently exhibited a relocation process towards low-wage economies, experienced a significantly lower growth than the growth that would be expected according to their *growth fundamentals* (i.e., the large list of potential determinants of long run growth that we include in the regressions). However, developed economies whose exports were affected by IPR to the South did not experience a negative aggregate growth impact. The potential output losses in some products were offset by gains in other products. At any rate, the absence of a negative aggregate impact of IPR on the richer economies does not preclude IPR having large distributional effects within these economies, as documented by the literature cited in the Introduction.

Figure 7 shows the scatter plot of the relocation shocks instrument $insRS$ (horizontal axis) on the residuals from the growth regression in column 4 except that we exclude from this specification RS and its interaction with income (vertical axis). The developing countries with some of the most negative RS, of which we discussed some of their initial international

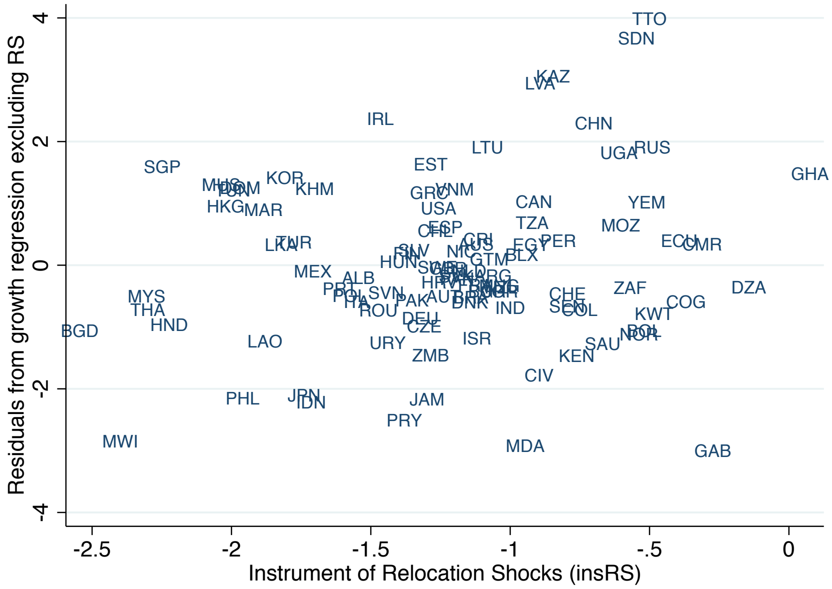

Figure 7: Relocation shocks (as measured by $insRS$) versus the residuals from the growth regression excluding RS and its interaction with $GDPpc$.

specialization (Bangladesh, Malawi, the Philippines, and Honduras) appear on the lower-left side of the figure with a strongly negative residual growth. However, rich economies with relatively low RS such as Singapore, Honk Kong, and South Korea do not present a negative growth residual. This is consistent with the estimated negative interaction between RS and per capita income. Also on the left side of the figure and between the previous two groups of countries, we find the two medium-income countries whose specialization was also briefly discussed (Thailand and Malaysia) and that exhibit relatively low RS but a small negative growth residual.

A few comments on the covariates' estimated coefficients might be in order. Overall, the controls included in the equation have the expected signs and are mostly statistically significant. In our preferred specification in column 3, years of schooling, share of oil exports, export openness, international diversification and the interactions of these two variables are statistically significant at least at the 5% level. The negative coefficient on initial per capita GDP is only significant at 10% though its interactions with RS and with diversification are both negative and significant at the 1% level. In fact, if the interaction between per capita GDP and diversification is dropped, the coefficient on initial $GDPpc$ becomes significant at the 1% level with a value around 2. Economic complexity is significant at 5% in column 1 but becomes insignificant once we include the product shock indices in the estimated equation. Rule of law is not statistically significant, which could be attributed to large measurement errors and not having an appropriate option to instrument this variable. However, rule of law becomes statistically significant at 5% once we exclude the Asian countries from the sample.[13] This could the consequence of the number of Asian countries that have performed extraordinarily well over the period of analysis in spite of a relatively low rating of their governance institutions.

Table 6: Relocation and cross-country growth: Alternative subsamples

	Excl. America (1)	Excl. Africa (2)	Excl. Asia (3)	Excl. Europe (4)
Relocation shocks (*RS*)	8.35***	7.04***	9.03***	7.38***
	(1.32)	(2.25)	(2.11)	(1.71)
RS *log *GDPpc*	-0.86***	-0.64***	-0.99***	-0.78***
	(0.16)	(0.23)	(0.28)	(0.22)
Other Product Shocks (*OPS*)	4.52***	6.65***	5.02***	3.53***
	(1.27)	(2.13)	(1.38)	(1.22)
Observations	75	77	72	66
R^2	0.72	0.73	0.71	0.63

Notes: Results from estimating equation (1) using 2SLS and different subsamples. The dependent variable is the average growth rate of GDP per capita over the 1996-2006 period in percentage terms. All the specifications include dummies for continents, all the controls in column 3 of Table 5, and use the same instruments as in this regression. We alternatively exclude from the sample the countries in America, Africa, Asia, and Europe. Robust standard errors are in parentheses. Significance levels: *** 1%, ** 5%, * 10%.

In Table 6, we check that our results are not due to the dynamics of the countries in a particular continent. This table reports the results of estimating equation (1) with a sample that excludes, alternatively, the countries in America (column 1), Africa (column 2), Asia (column 3), and Europe (column 4). We use the same controls and instruments as in column 3 of Table 5. As before, we find the RS and OPS coefficients positive and the interaction of RS negative, with statistical significance at the 1% level for all the samples.

3.3.2 Panel regressions

Our findings so far correspond to a boom period in terms of output, trade, and IPR: 1996-2006. We now check for the robustness of the findings by conducting panel regressions using data for two periods (1996-2006 and 2006-2014), the second of which corresponds to the Great Recession and its aftermath. Table 7 reports the results. We always estimate by 2SLS using analogous instruments to those constructed for the cross-country analysis. Standard errors reported in parentheses are clustered by country. Columns 1 to 3 correspond to the

[13]This result corresponds to the estimation in column 3 in Table 6, though we only show the results for the variables of interest in this table.

Table 7: Relocation and cross-country growth. Panel estimations

	Full sample	Excluding nat. resource exporters		Excl. America	Excl. Africa	Excl. Asia	Excl. Europe
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Relocation shocks (*RS*)	6.03***	6.34***		5.79***	6.28***	6.72***	6.46***
	(1.27)	(1.24)		(1.32)	(2.18)	(1.47)	(1.52)
RS *log *GDPpc*	-0.62***	-0.64***		-0.58***	-0.63***	-0.71***	-0.68***
	(0.15)	(0.15)		(0.16)	(0.23)	(0.18)	(0.18)
Other product shocks (*OPS*)	1.71*	2.46***		1.99*	1.23	2.36***	1.31
	(0.88)	(0.80)		(1.05)	(1.27)	(0.77)	(0.99)
Nat. Res. excl_Relocation shocks			6.09***				
			(1.11)				
Nat.Res.excl_*RS* *log *GDPpc*			-0.59***				
			(0.14)				
Nat. Res. excl_Other product shocks			2.33***				
			(0.73)				
Observations	192	152	152	150	154	144	132
R^2	0.61	0.67	0.67	0.68	0.62	0.60	0.51

Notes: Results from estimating equation (1) using 2SLS and panel data. The dependent variable is the average growth rate of GDP per capita, in percentage terms, over the 1996-2006 and 2006-2014 periods. Standard errors clustered by country are in parentheses. All the specifications include time fixed effects interacted with the continent dummies and all the controls in column 3 of Table 5. The RS, OPS, $Nat.Res.excl\_RS$ and $Nat.Res.excl\_OPS$ variables are instrumented using the instruments explained in the main text. In columns 2 and 3 we exclude from the sample oil countries and those countries for which exports of natural resources represent more than 35% of their exports (see Table 11 in Appendix B). In columns 4-7, we alternatively exclude the countries in America, Africa, Asia, and Europe from the sample. Significance levels: *** 1%, ** 5%, * 10%.

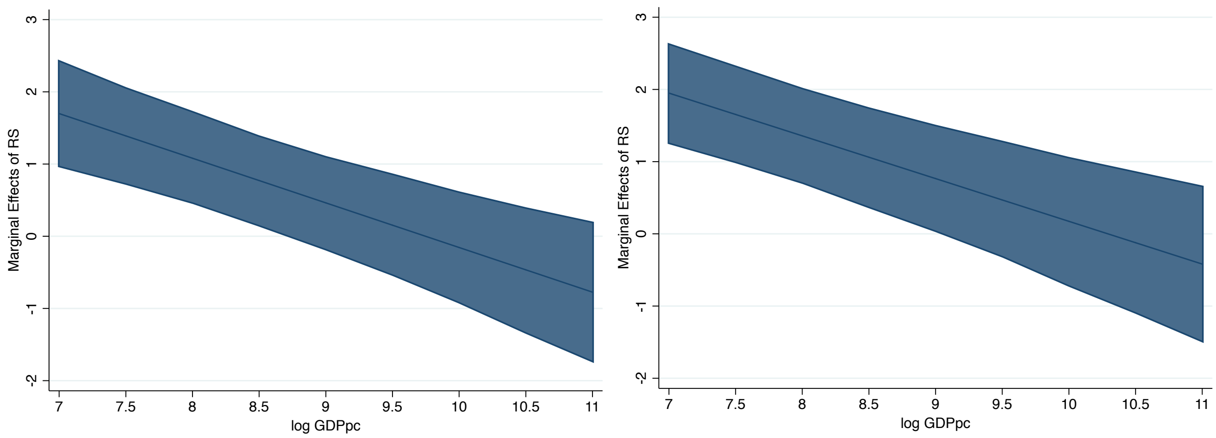

Figure 8: Average marginal effects of Relocation Shocks on GDPpc growth with 95% confidence intervals. They correspond to the estimates in columns 1 (left figure) and 3 (right figure) of Table 7.

same specifications and samples as in columns 3, 5, and 7 of Table 5, respectively, using now panel data with the continent dummies interacted with time fixed effects. Thus, in column 1 we use the full sample (192 observations), column 2 excludes the oil-exporting countries from the sample, and column 3 also excludes the countries for which exports of natural resources represent more than 35% of total exports. Also, in this latter regression we use the $Nat.Res.excl\_RelocationShocks$ and $Nat.Res.excl\_OtherProductShocks$ indices and its instruments, which are calculated by excluding all the trade in natural resources. In columns 4 to 7, we keep using our preferred specification (the one in column 4 of Table 5) and alternatively exclude from the sample the countries from each of the four main continents: America (column 4), Africa (column 5), Asia (column 6), and Europe (column 7).

The results confirm the findings of the previous analysis, not only in terms of the sign and significance of the relocation shocks but also in terms of the estimated quantitative impact. In all the regressions, we find a positive coefficient on RS and a negative interaction with $GDPpc$ that are always significant at the 1% level. Figure 8 displays the marginal effects of RS on average annual growth as a function of the country $GDPpc$ with 95% confidence intervals corresponding to the estimates in columns 1 (left figure) and 3 (right figure) of Table 7. The marginal impact of RS is significant at the 5% level for $GDPpc$ below the 30th percentile of the countries' income distribution in the case of the full sample (left figure), and for $GDPpc$ below the 38% percentile in the case of the sample that excludes natural resource exporters (right figure). For richer countries, the growth impact of RS is not statistically significant. The point estimate of the RS's marginal impact for the full sample implies that a one-standard negative deviation of a country's export *relocation index* reduced the annual growth of a country at the first quartile of the income distribution by 0.71 percentage points.[14]

3.3.3 Using instruments that exclude the neighbors' data

As previously discussed, if country shocks are correlated across neighboring countries, neighboring countries have similar export baskets, and neighbors are large exporters of products that represent a large share of a country's exports, then country shocks could create a spurious correlation between the RS index and $GDPpc$ growth. To conduct a final robustness test that accounts for this possibility, we run regressions using new *no-neighbors* instruments for RS and OPS that are based on country-specific $AVEX$s and $ciAVEX$s for each product, the calculation of which not only excludes all data related to this country but also exclude all the data related to its neighbors. Therefore, country shocks to a country or its neighbors do not affect the instruments used for the country's RS and OPS. Using these new instruments has a difficulty for the 1996-2006 period. As China played a crucial role in the dynamics of IPR over this period, the use of these instruments for the particular case of China's neighbors would miss a crucial portion of the IPR. As this problem only affects China's neighbors, it can be solved by excluding China's neighbors from the sample in these new regressions. This reduces our previous 96-country sample to a sample of 88 countries (see Table 11 in Appendix B for the list of countries that were in the 96-country sample and are neighbors of China).

The results from estimating equation (1) using 2SLS and the *no-neighbors* instruments are shown in Table 8. The specifications include all the controls used in the regression in column 3 of Table 5. Columns 1-2 correspond to cross-section estimations with continent dummies for 1996-2006, whereas columns 3-4 correspond to panel estimations for 1996-2006 and 2006-2014 that include time fixed effects interacted with the continents. Standard errors are clustered by country in the panel regressions. In columns 2 and 4, we exclude from the sample the oil and other natural-resource exporters. The significance appears to drop for OPS, especially when we exclude natural-resource exporters, but the coefficients and significance of RS and its interaction with $GDPpc$ stays almost unchanged. Hence, our results are not driven by potential GDP spillovers and export similarities across neighbors.

[14]Note that although the marginal impact is almost identical in the panel estimation (1.13 in the panel versus 1.14 in the initial cross section), the standard deviation of RS is larger (0.63 in the panel versus 0.54 in the cross section).

Table 8: Relocation and cross-country growth. Estimations using *no-neighbors* instruments.

	(1)	(2)	(3)	(4)
Relocation shocks (*RS*)	7.59***	5.28**	7.21***	6.74***
	(1.82)	(2.32)	(1.23)	(1.41)
RS *log *GDPpc*	-0.84***	-0.58**	-0.74***	-0.74***
	(0.20)	(0.27)	(0.14)	(0.17)
Other Product Shocks (*OPS*)	1.97	0.86	3.16**	1.10
	(2.29)	(2.17)	(1.26)	(1.25)
Observations	88	74	176	142
R^2	0.63	0.64	0.64	0.65

Notes: Results from estimating equation (1) using 2SLS and either cross-section data with continent dummies for 1996-2006 (columns 1-2) or panel data with time-continent fixed effects interacted with the continent dummies for the 1996-2006 and 2006-2014 periods (columns 3-4). The dependent variable is the average growth rate of GDP per capita. All the specifications include all the controls in column 3 of Table 5. Standard errors are clustered by country in the panel regressions. The RS and OPS variables are instrumented using instruments that, for each country, exclude the data from this country and its neighbors. The China's neighboring countries are excluded from the sample in all the regressions. In columns 2 and 4, we also exclude from the sample the oil countries and those countries for which exports of natural resources represent more than 35% of their total exports. Significance levels: *** 1%, ** 5%, * 10%.

4 Export relocation and export upgrading

Standard trade theory shows that if a country loses comparative advantage in a particular product, then it will gain comparative advantage in other products and reallocate its resources accordingly. Hence if some products in a country's initial export basket relocate to the South (because comparative advantage changes), then we expect that the country adjusts its export basket to increase the share of products having at the end of the period a higher $AVEX$ than the products that relocated to the South. We now check this hypothesis. In particular, we check if the countries with a more negative RS index conducted a more intense reorganization of their exports by increasing the share of higher–$AVEX$ products.

We define country c's *Export Upgrading* index between time $t-T$ and time t, denoted by $EU_{c,t-T,t}$, as:

$$EU_{c,t-T,t} = \frac{1}{T}\log\frac{\sum_k AVEX_{kt}b_{ckt}}{\sum_k AVEX_{kt}b_{ck,t-T}}.$$

This index delivers a positive value if, on average, a country restructures its export basket between $t-T$ and t towards higher-sophistication products, as measured by the products' end-of-period $AVEX_k$.

Figure 7 show the scatter plots of the RS and EU indices calculated for the whole 1996-2014 period. The figure to the left includes half of the sample of 96 countries with the poorest countries, whereas the figure to the left includes the other half of the sample with the

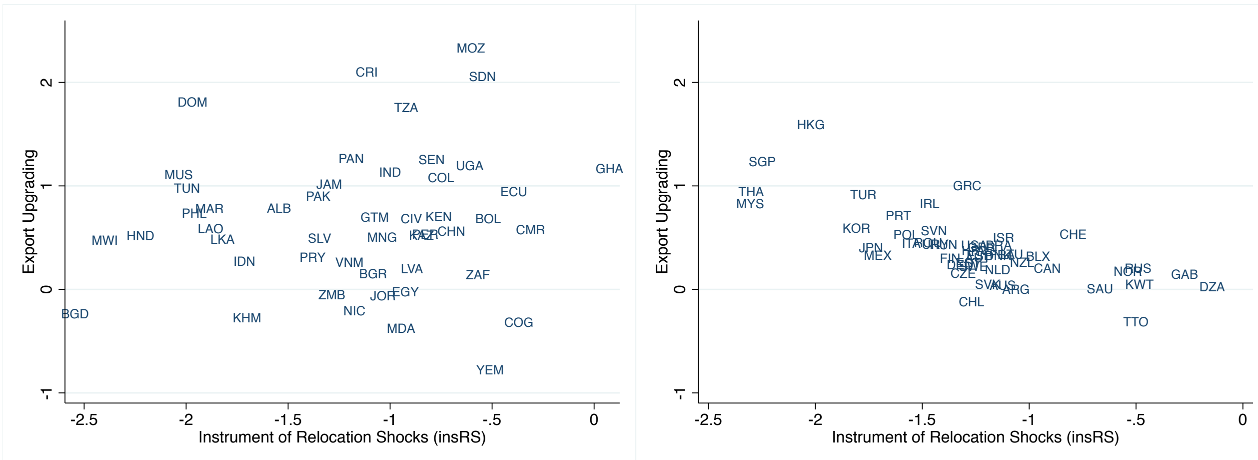

Figure 9: Relocation and export upgrading 1996-2014: poorer (left figure) and richer (right figure) countries

Table 9: Relocation and export upgrading

	(1)	(2)	(3)	(4)	(5)	(6)
Relocation shocks (*RS*)	4.29***	5.12***	4.69***	0.99	2.02**	2.37***
	(1.21)	(1.39)	(1.35)	(0.67)	(0.86)	(0.76)
*RS**log *GDPpc*	-0.50***	-0.60***	-0.54***	-0.15**	-0.27***	-0.31***
	(0.13)	(0.15)	(0.14)	(0.07)	(0.09)	(0.08)
log *GDPpc*	-0.85***	-0.99***	-0.88***	-0.15*	-0.28**	-0.33***
	(0.22)	(0.27)	(0.27)	(0.08)	(0.12)	(0.12)
Observations	96	83	79	192	163	152
R^2	0.34	0.40	0.41	0.24	0.27	0.36

Notes: Results from regressing Export Upgrading on RS, initial GDP per capita, and the interaction between these two variables using 2SLS. Columns 1-3 report results using cross section data with continent dummies for 1996-2006, whereas columns 4-6 report results using panel data with time-continent fixed effects interacted with the continent dummies for the 1996-2006 and 2006-2014 periods. The RS variable is instrumented using the instruments explained in the main text. In columns 2 and 5, we exclude the oil producers from the sample, and in columns 3 and 6, we also exclude the countries for which exports of natural resources represent more than 35% of total exports. Robust standard errors are clustered by country in the panel regressions and are shown in parentheses. Significance levels: *** 1%, ** 5%, * 10%.

richest countries. Relocation shocks and export upgrading are uncorrelated for the poorer countries but negatively correlated for the richer countries. That is, the more-developed economies that were affected by the relocation to the South responded by reshaping and upgrading their export baskets, whereas the less-developed economies did not.[15] To analyze this relationship in more detail, we regress export upgrading (EU) on the RS index interacted with $GDPpc$, using cross-section (columns 1-3) and panel data (columns 4-6), and instrumenting RS and its interaction with $GDPpc$ as in the previous section. The results are reported in Table 9. Except when we include oil and natural resource exporters in the panel regressions,[16] the results confirm that the capacity to reshape and upgrade exports as a result of relocation shocks to the South (i.e., negative RS) increases with the country's $GDPpc$. Figure 10 shows the estimated marginal impact of RS on EU at different levels of $\log(GDPpc)$ with 95% confidence intervals, for the two most different estimations in Table 9: the estimation in column 1 corresponding to the cross-section with all the 96 countries (left figure) and the estimation in column 6 corresponding to panel with 152 observations that exclude the exporters of oil and natural resources (right figure). In all the estimations, there is a statistically significant negative relationship between RS and EU for the relatively richer countries: a more negative RS (i.e., a more intense relocation to the South) leads to a more intense positive revamp and upgrade of the country's export basket. Specifically, this negative relationship is significant at the 5% level for countries with a $GDPpc$ above the 49th percentile of the country income distribution in the case of the estimation in column 1 (left figure in Figure 10) and for countries with a $GDPpc$ above the 27th percentile in the case of the estimation in column 6 (right figure in Figure 10). The relationship is not statistically significant for countries with lower $GDPpc$.

These results help explain the finding in the previous section that the negative growth impact of IPR to the South decreases with income. The richer countries respond to relocations to the South by reshaping and upgrading their export baskets and, thus, it is less likely that IPR has a negative impact on their aggregate growth. The results are also consistent with the evidence showing that firms in advanced economies facing increased Chinese competition intensify innovation and that employment reallocates towards the more technologically advanced firms (Bloom, Draca and Van Reenen 2016).

The presumption that countries respond to changes in comparative advantage and increased competition from the South by reallocating resources to new and more advantageous

[15]Here, we only investigate the reshaping and upgrading of exports as a response to increased competition from the South in terms of changes in specialization across products. However, this response can also take the form of quality upgrading within products (Schott 2004, Khandelwal 2010).

[16]It seems reasonable to expect that natural resource exporters have difficulties in modifying their international specialization as a result of relocation or increased competition from the South.

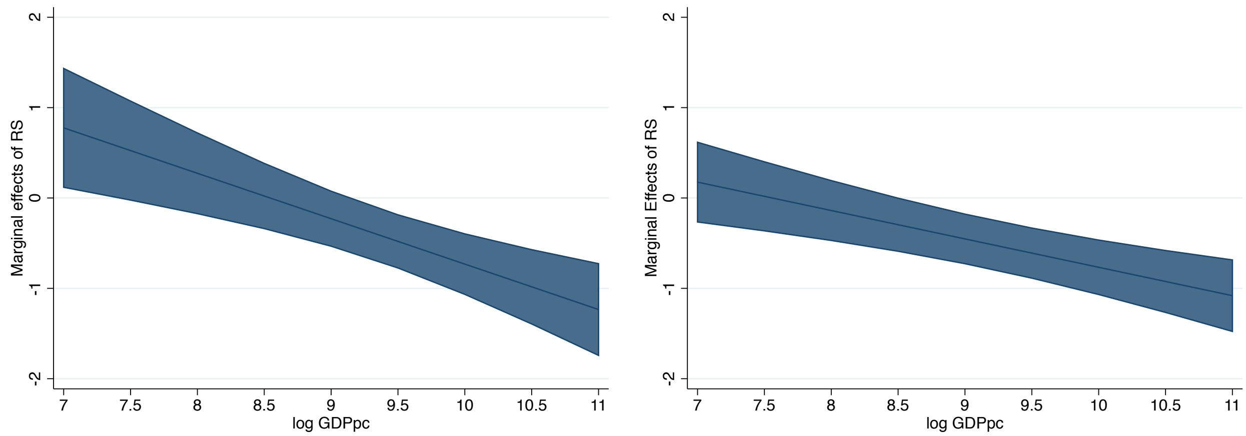

Figure 10: Average marginal effects of Relocation Shocks on Export Upgrading with 95% confidence intervals. They correspond to the estimates in columns 1 (left figure) and 6 (right figure) of Table 9.

exports, appears to hold for the more-developed economies but not so for the less-developed ones. Panel C of Table 3 illustrates the different export upgrade dynamics of developed and developing countries using the country examples already considered in the previous sections. Philippines, Thailand, Malaysia, and especially, Singapore reduced their specialization in electronic products with a low sophistication at the end of the period (e.g., computer data storage units, with a 2014 $AVEX$ of \$24,444) and increased their specialization in products with a currently high $AVEX$, either within the same electronic industry (e.g., non-digital monolithic integrated circuits, with a 2014 $AVEX$ of \$34,920) or in other industries (e.g., petroleum distillates, with a 2014 $AVEX$ of \$38,527). To the contrary, low-income countries such as Bangladesh and Honduras did not upgrade their exports but reinforced their initial specialization in products exhibiting a low $AVEX$ (relative to their average export sophistication, which was \$15,995 and \$20,448, respectively, in 2014). For example, cotton T-shirts knit, with an $AVEX$ of \$15,871.37 in 2014, went from representing 6.5% of Bangladesh's exports and 6.3% of Honduras' exports in 1996 to represent 13.7% and 8.7%, respectively, in 2014. More generally, textiles (HS chapters 61 and 62), which together with electronics was the sector with the most intense relocation to the South, went from representing 63% of Bangladesh's exports in 1996 to 84.8% in 2014.

5 Concluding Comments

Technological change and the emergence of new global players modify comparative advantage across countries and lead to IPR. These shocks appear to have been particularly intense over the last two decades and have led to political turbulences as well as to calls for protectionism in some advanced economies. Besides having distributional consequences within countries, do shocks leading to IPR to the South affect cross-country relative growth? This paper described IPR over the 1996-2014 period and investigated its cross-country growth impact.

The main finding is that, on average, specialization at the beginning of a period in product categories that relocate to the South have a negative growth impact on low-income countries but not on high-income countries. Hence, although globalization and IPR can have an overall positive effect on the world economy, the benefits are significantly smaller in the developing countries whose initial exports are affected by IPR to the South. Meanwhile, advanced economies affected by IPR to the South offset its potential aggregate negative impact by upgrading their export baskets. The presumption that countries adjust to changes in comparative advantage by reallocating their resources to new productions needs to be qualified in connection to the countries' level of development. Advanced economies appear to adjust much more effectively than developing economies.

Calls for a new protectionism appear unjustified on the grounds of the results in this paper. IPR does not have a negative impact on aggregate output in advanced economies and, thus, these economies should have the resources to compensate the workforce groups that were displaced or impoverished by IPR. Less fortunate, low-income exporting economies appear to be vulnerable to increased competition from other developing countries and may not have the resources to compensate the losers. However, they would not benefit either from higher barriers to their economies.

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Appendix A: First-stage regressions

Table 10: First-stage regressions

	Cross-section			*Panel*		
	Relocation shocks (*RS*)	Other Product Shocks (*OPS*)	*RS* * log *GDPpc*	Relocation shocks (*RS*)	Other Product Shocks (*OPS*)	*RS* * log *GDPpc*
	(1)	(2)	(3)	(4)	(5)	(6)
ins_Relocation shocks (ins*RS*)	0.86***	0.18	-0.99	0.80***	0.09	-1.56
	(0.24)	(0.13)	(2.03)	(0.18)	(0.15)	(1.57)
ins_*RS* *log *GDPpc*	0.00	-0.02	1.00***	0.02	-0.02	1.16***
	(0.03)	(0.01)	(0.23)	(0.02)	(0.02)	(0.17)
ins_Other product shocks (ins*OPS*)	0.09	0.94***	0.60	0.05	0.71***	0.52
	(0.14)	(0.07)	(1.18)	(0.09)	(0.12)	(0.79)
log *GDPpc*	-0.02	-0.01	-0.23	0.01	-0.02	0.05
	(0.07)	(0.04)	(0.61)	(0.06)	(0.05)	(0.57)
log human capital (years schooling)	-0.09	0.05*	-0.75	-0.09**	0.07**	-0.77*
	(0.07)	(0.03)	(0.55)	(0.05)	(0.03)	(0.39)
Rule of law	-0.02	0.00	-0.13	-0.02	-0.01	-0.15
	(0.04)	(0.02)	(0.33)	(0.02)	(0.02)	(0.22)
Share of oil exports	-0.01	-0.01	-0.06	-0.18*	-0.17*	-1.35
	(0.15)	(0.11)	(1.31)	(0.10)	(0.10)	(0.86)
log export openness	-0.88*	0.20	-7.67*	-0.57	0.07	-5.07*
	(0.50)	(0.23)	(4.13)	(0.35)	(0.20)	(2.91)
log *GDPpc*	-0.12*	0.04	-0.97*	-0.08*	0.03	-0.70*
	(0.07)	(0.03)	(0.56)	(0.05)	(0.02)	(0.39)
log export openness*log *GDP*	0.03	-0.01	0.27*	0.02	0.00	0.17
	(0.02)	(0.01)	(0.16)	(0.01)	(0.01)	(0.11)
International diversification	-7.82	3.91**	-63.33	-7.78**	4.68**	-66.60**
	(5.16)	(1.83)	(41.91)	(3.81)	(2.30)	(31.97)
International diversification*log *GDPp*	0.71	-0.42**	5.78	0.72**	-0.48**	6.22**
	(0.49)	(0.19)	(4.01)	(0.36)	(0.22)	(3.03)
Economic complexity index (*ECI*)	0.06	0.03	0.64	0.11	0.10	1.27
	(0.23)	(0.15)	(2.00)	(0.23)	(0.11)	(2.04)
ECI *log *GDPpc*	0.00	-0.00	-0.01	-0.01	-0.01	-0.10
	(0.02)	(0.02)	(0.20)	(0.02)	(0.01)	(0.20)
Constant	3.70*	-1.00	31.52*	2.56	-0.43	22.06*
	(2.10)	(0.87)	(17.14)	(1.56)	(0.78)	(12.89)
Observations	96	96	96	192	192	192
R^2	0.93	0.93	0.94	0.94	0.98	0.95
F-test	123.2	113.0	172.2	204.6	1721	251.0

Note: These first-stage regressions correspond to the cross-section estimation of equation (1) in column 1 of Table 5 and to the panel estimation in column 1 of Table 7. Robust standard errors are in parentheses. In the panel regressions (columns 4-6), standard errors are clustered by country. Significance levels: *** 1%, ** 5%, * 10%.

Appendix B: List of countries

Table 11: List of countries

iso3	Country name	iso3	Country name	iso3	Country name
AGO	Angola[a,1,2,*,+]	FRA	France	NER	Niger[b,*,+]
ALB	Albania	GAB	Gabon[1,2,*,+]	NGA	Nigeria[1,2,*,+]
ARE	United Arab Emirates[1,2,*,+]	GBR	United Kingdom	NIC	Nicaragua
ARG	Argentina	GHA	Ghana	NLD	Netherlands
ARM	Armenia[b,*,+]	GIN	Guinea[a,*,+]	NOR	Norway[1,2,*,+]
AUS	Australia[*]	GMB	Gambia[b,*]	NPL	Nepal[b,3]
AUT	Austria	GRC	Greece	NZL	New Zealand
BDI	Burundi[b]	GTM	Guatemala	OMN	Oman[a,1,2,*,+]
BEN	Benin[b]	GUY	Guyana[b,*,+]	PAK	Pakistan[3]
BFA	Burkina Faso[a,b]	HKG	Hong Kong SAR, China[3]	PAN	Panama
BGD	Bangladesh	HND	Honduras	PER	Peru[+]
BGR	Bulgaria	HRV	Croatia	PHL	Philippines
BHR	Bahrain [b,1,2,*,+]	HUN	Hungary	POL	Poland
BIH	Bosnia and Herzegovina[a]	IDN	Indonesia	PRT	Portugal
BLX	Belgium-Luxembourg	IND	India[3]	PRY	Paraguay
BOL	Bolivia[2,*,+]	IRL	Ireland	ROU	Romania
BRA	Brazil	ISR	Israel	RUS	Russian Federation[1,2,3,*,+]
BTN	Bhutan[a,b,3]	ITA	Italy	SAU	Saudi Arabia[1,2,*,+]
CAN	Canada	JAM	Jamaica	SDN	Sudan[2,+]
CHE	Switzerland	JOR	Jordan	SEN	Senegal
CHL	Chile	JPN	Japan	SGP	Singapore
CHN	China	KAZ	Kazakhstan[1,2,3,*,+]	SLE	Sierra Leone[b,*,+]
CIV	Cote d'Ivoire	KEN	Kenya	SLV	El Salvador
CMR	Cameroon[1,2,+]	KHM	Cambodia	SUR	Suriname[a,b]
COD	Dem.Republic of Congo[b,*,+]	KOR	Korea, Rep.	SVK	Slovak Republic
COG	Congo[1,2,*,+]	KWT	Kuwait[1,2,*,+]	SVN	Slovenia
COL	Colombia[2,*,+]	LAO	Lao PDR[3]	SWE	Sweden
COM	Comoros[a,b]	LBN	Lebanon[a]	TCD	Chad[a,b,2,+]
CRI	Costa Rica	LKA	Sri Lanka	TGO	Togo[b,*,+]
CYP	Cyprus[b]	LTU	Lithuania	THA	Thailand
CZE	Czech Republic	LVA	Latvia	TKM	Turkmenistan[a,1,2,*,+]
DEU	Germany	MAR	Morocco	TTO	Trinidad and Tobago[1,2,*,+]
DJI	Djibouti[a,b]	MDA	Moldova	TUN	Tunisia
DNK	Denmark	MDG	Madagascar[a]	TUR	Turkey
DOM	Dominican Republic	MEX	Mexico	TZA	Tanzania[*,+]
DZA	Algeria[1,2,*,+]	MKD	Macedonia, FYR[a]	UGA	Uganda
ECU	Ecuador[1,2,+]	MLI	Mali[b,+]	URY	Uruguay
EGY	Egypt, Arab Rep.[1,2,*,+]	MMR	Myanmar[b,2,3,+]	USA	United States
ESP	Spain	MNG	Mongolia[3,*,+]	UZB	Uzbekistan[a]
EST	Estonia	MOZ	Mozambique	VNM	Vietnam[3]
ETH	Ethiopia[a]	MUS	Mauritius	YEM	Yemen, Rep.[1,2,*,+]
FIN	Finland	MWI	Malawi	ZAF	South Africa[*,+]
FJI	Fiji[b]	MYS	Malaysia	ZMB	Zambia

Note: [a] Countries with no data of human capital; [b] countries with no data of economic complexity; [1] oil exporter in the first period (1996-2006); [2] oil exporter in the second period (2006-2014); [3] China's neighboring countries;* natural resource exporter in the first period; + natural resource exporter in the second period.

Appendix C: Additional robustness checks

Table 12: Relocation and cross-country growth: Additional or alternative controls

	(1)	(2)	(3)	(4)	(5)	(6)
Relocation shocks (*RS*)	7.85***	6.79***	7.83***	6.96***	7.53***	7.65***
	(1.26)	(1.46)	(1.45)	(1.39)	(1.27)	(1.26)
RS *log *GDPpc*	-0.80***	-0.67***	-0.82***	-0.71***	-0.78***	-0.78***
	(0.16)	(0.18)	(0.18)	(0.16)	(0.15)	(0.15)
Other Product Shocks (*OPS*)	4.58***	4.42***	4.40***	4.49***	4.59***	4.62***
	(1.31)	(1.36)	(1.30)	(1.20)	(1.23)	(1.25)
log *GDPpc*	-1.22*	-0.77	-1.47**	-1.05**	-1.14**	-1.10**
	(0.71)	(0.54)	(0.63)	(0.51)	(0.56)	(0.54)
log Human Capital (years schooling)	1.42***			1.44***	1.56***	1.54***
	(0.34)			(0.33)	(0.36)	(0.35)
log Capital Intensity	0.10					
	(0.27)					
Rule of Law	0.25	0.24	0.10			
	(0.31)	(0.32)	(0.32)			
Share of Oil Exports	7.22***	5.99***	7.45***	7.08***	7.32***	7.14***
	(1.68)	(1.59)	(1.67)	(1.47)	(1.60)	(1.53)
log export openness	5.93**	5.54*	8.80***	5.73*	6.09**	6.07**
	(2.93)	(3.19)	(2.92)	(3.02)	(3.01)	(2.98)
log *GDP*	0.42	0.40	0.79**	0.40	0.42	0.44
	(0.30)	(0.32)	(0.31)	(0.30)	(0.30)	(0.30)
log export openness*log *GDP*	-0.23**	-0.21*	-0.34***	-0.23**	-0.24**	-0.24**
	(0.11)	(0.12)	(0.11)	(0.11)	(0.11)	(0.11)
International diversification	63.20***	65.27***	48.06**	61.74***	61.04***	61.90***
	(18.53)	(21.28)	(23.24)	(17.09)	(17.82)	(17.09)
International diversification*log *GDPpc*	-5.78***	-6.04***	-4.35*	-5.66***	-5.56***	-5.65***
	(1.88)	(2.18)	(2.32)	(1.72)	(1.80)	(1.72)
Economic Complexity Index *(ECI)*	-0.63	-0.49	-1.28	-0.37	-0.53	-0.50
	(1.71)	(2.01)	(2.17)	(1.81)	(1.82)	(1.84)
*ECI** log *GDPpc*	0.10	0.08	0.14	0.07	0.09	0.08
	(0.17)	(0.19)	(0.21)	(0.17)	(0.18)	(0.18)
log Human Capital (secondary enrol)		0.56**				
		(0.22)				
log Human Capital (PWT9)			3.22***			
			(0.82)			
Regulatory Quality				0.50*		
				(0.29)		
Governement effectiveness					0.33	
					(0.36)	
Control of Corruption						0.22
						(0.25)
Constant	-13.78	-14.52	-19.63*	-13.04	-13.42	-14.42
	(9.94)	(11.06)	(11.16)	(10.04)	(10.28)	(9.91)
Observations	96	96	99	96	96	96
R^2	0.68	0.64	0.62	0.69	0.68	0.68

Notes: Results from estimating equation (1) using 2SLS with continent dummies and additional controls (capital intensity in column 1), alternative controls for human capital (columns 2 and 3) and alternative controls for institutional quality in columns 4-6 (regulatory quality, government effectiveness, and control of corruption, respectively). The dependent variable is the average growth rate of GDP per capita over the 1996-2006 period in percentage terms. Robust standard errors are in parentheses. The RS and OPS variables are instrumented as in Table 5 (see the main text for details). Significance levels: *** 1%, ** 5%, * 10%.