

ORIGINAL ARTICLE

Globalization and comparative compositional inequality

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Abstract

Globalization has been one of the biggest driving forces of the last half century. There has been substantial disagreement about the impact that increased international integration has on income inequality. Though most agree that globalization positively affects economic output, it is no surprise that it leads to relative winners and losers within nations. The question that remains is where in the income distribution are these relative gains and losses occurring? We offer a broader picture of globalization's effects on inequality by using a dynamic compositional approach to test the impact of globalization and relative factor endowments on the composition of income. Using data from four countries, we model the effects of globalization on quantiles of the income distribution. Our findings suggest that globalization has substantial (and divergent) effects across income strata, and that these effects differ across nations based on relative factor endowments.

Keywords: Comparative political economy; globalization; inequality; time series

Globalization has been a major force of change in the last half-century. The rapidly increasing development of digital, transportation, and communication technology has culminated in a level of international political and economic integration never before experienced in human history. Globalization's proponents have argued that it has brought about an unprecedented level of prosperity that far outweighs the costs incurred. Its critics have questioned whether its positive impact is as large as the costs it has imposed. Political economy scholars agree that globalization has given rise to an overall increase in general standards of living, but they also recognize that it is not cost-free (Feenstra and Hanson, 1997; Stiglitz, 2002; Beramendi and Anderson, 2008).

While globalization has been touted as a force that has helped lift billions out of poverty, it also has the potential to alter the relative shares of income of groups within national economies, thus contributing to inequality. Rising inequality has been associated with several undesirable outcomes, such as decreased democratic representation, social welfare, and economic growth (Beramendi and Anderson, 2008; Rigby and Wright, 2013). Most studies that have examined the impact of globalization on inequality have utilized summary measures of inequality, such as the Gini index or the share of income for the wealthiest quantile. Moreover, analyses have mostly focused on developed economies. This leaves open questions about the impact of globalization on the overall composition of incomes within nations, and whether or not this impact differs across developed and developing nations.

In this paper, we offer a broader picture of globalization's effects on inequality by using a new empirical approach to test the impact of globalization and relative factor endowments on the composition of income. We argue that the impact of globalization on the national distribution of income depends on a country's relative factor endowments. We test our expectations using

a new modeling strategy that allows us to evaluate the dynamic effect that globalization has on quantiles of the income distribution within nations over time.

In the sections that follow, we begin with an overview of the existing literature on the link between globalization and inequality. Next, we present our theory and data. We then test our theoretical expectations with models of the trajectory of income compositions across four countries. We conclude by discussing our results and some possible directions for future research.

1. Globalization and inequality

Globalization—or the increased interaction and interdependence between different geographical areas around the globe—has created large secular changes in many economies (Stiglitz, 2002). Comparative advantage has led to gains from trade across countries (Feenstra and Hanson, 1997; Feenstra, 2015), although recent studies have found that such gains have not been reallocated homogeneously across the income distribution (Hays, 2009; Rodrik, 2011). Globalization has also been associated with a number of other outcomes, such as a reduction in global poverty (Ravallion, 2003), decreased cost of goods and services, and increased democratization (Schwartzman, 1998).

There is a considerable body of literature on the relationship between globalization and inequality. Though globalization may lower absolute poverty through rising incomes (Ravallion, 2003), there is a growing consensus that some individuals are likely to experience relatively greater gains than others (Alderson and Nielsen, 2002; Stiglitz, 2002). While scholars present a variety of causes for economic inequality—ranging from land ownership (Miller, 2011), inherited wealth (Boserup *et al.*, 2016), intellectual ability (Huggett *et al.*, 2011), and individual risk aversion (Azzimonti *et al.*, 2014)—many works point to political and economic globalization as a major determinant of inequality (c.f., Stiglitz, 2002). Garicano and Rossi-Hansberg (2005), for example, show that lowering the costs of communication and technological change affect wage inequality. Beckfield (2006) finds that economic and political “regional integration explains nearly half of the increase in income inequality” in Western Europe (p. 964). In a cross-country analysis, Lundberg and Squire (2003) find a positive relationship between economic openness and inequality.

Scholars suggest several reasons why globalization may exacerbate inequality. Piketty (2014) stresses that, overall, inequality is intrinsic to market economies. He also claims that the gap between the rate of return on capital and economic growth explains extreme income inequality until World War I, while political and institutional shocks as well as the supply of and demand for skills account for it thereafter (Piketty, 2015). Other scholars have proposed that increased international trade has exacerbated inequality—most noticeably in the developed world—due to decreasing returns to unskilled labor and diverging levels of human capital across different nations (Wood, 1995; Corak, 2013).

Globalization may also have non-uniform effects across income distributions based on the level of economic development. Advanced industrialized economies, in particular, have seen a resurgence in inequality after a period of consistent decrease in their disparity of wealth (Alderson and Nielsen, 2002).¹ In these countries, comparative trade advantages in capital-intensive industries have caused relative declines in the return to unskilled labor. As a result, highly-skilled, better-educated workers typically have benefited from increased economic integration. Such “college earnings premiums” have been associated with decreased income mobility for unskilled workers (Corak, 2013). Developed countries may also exacerbate inequality by failing to adequately redistribute the gains from trade. For instance, low levels of redistribution, inadequate trade adjustment assistance, or policies that favor skilled workers exposed to trade at

¹This phenomenon has been labeled “the Kuznetsian pattern” in the literature (Alderson and Nielsen, 2002, p. 1246).

the cost of others, might also lead to increased economic inequality (Hays, 2009; Rodrik, 2011; Acemoglu *et al.*, 2013).²

Empirical evidence suggests that in OECD countries, globalization has increased inequality (Dreher and Gaston, 2008). Examining 27 EU countries, Asteriou *et al.* (2014) find an increase in inequality since 1995, mostly attributable to financial globalization stemming from foreign direct investment. Schneider and Soskice (2009) emphasize the influence of distinct political institutions on within-country inequality across the developed world. Smeeding (2002) observes that, although rich countries have experienced a rise in inequality, these trends have been driven by increasing income shares to the top income brackets, not necessarily a decrease to lower quantiles of the distribution. However, Luttmer (2004) suggests that this is exactly the type of relative difference that individuals care about when making well-being assessments. Thus, even though an entire society may be better off in terms of real inter-temporal comparisons, rising inequality may have serious political and social consequences.

In developing countries, in contrast, globalization might have an entirely different effect on inequality. The poorest 80 percent of individuals on earth have experienced large increases in real incomes over the past 30 years, while those in the next 15 percent have seen very little (The Economist).³ Thus, at first glance globalization appears to be helping out the very bottom of the income distribution in developing countries. At its most simple, comparative advantage suggests that low-skilled, labor-intensive industries will flourish.⁴ Therefore, we might expect that lower incomes will experience relative gains, while the highest incomes—typically taking advantage of capital rather than labor—will experience relative decreases. However, few studies have examined this relationship in the developing context. Those that have generally found mixed results (e.g., Wood, 1997). For instance, Dreher and Gaston (2008) do not find evidence of a globalization-inequality effect in developing countries.

2. Theory

As outlined in the previous section, there is abundant evidence that inequality has increased in developed nations during the recent periods of rapid globalization, with the highest earning segments of such societies experiencing substantial relative gains. However, it is not clear which income segments are losing out as the top makes relative gains. The same trends are not apparent in less developed nations where the empirical evidence on the impact of globalization on inequality has been somewhat mixed.

We argue that to better focus our thinking about the impact of globalization on relative income shares in a nation, we first need to think about the income composition as a whole, and the likely consequences of globalization on different segments of society within that composition. To do this, we turn to figures developed by Boix (1998) for depicting the relative skill and income distribution in a hypothetical society. As per Boix, we begin with Figure 1, in which we depict the levels of skills and wages on the vertical axis, and the rank distribution thereof on the horizontal axis. The s-shaped curve in Figure 1 reflects the initial distribution of wages and skills before an increase in globalization.

Figure 1 can be connected to theoretical models of trade by recognizing that individuals who gain most of their livelihood from labor will be clustered in the lower-left quadrant of this figure,

²In contrast, some have argued that welfare state expansion has nothing to do with the pressures of globalization (Iversen and Cusack, 2000).

³“Shooting an Elephant” <http://www.economist.com/node/21707219/print>. Accessed 12/14/2016. The very highest incomes have also experienced large gains, which is why the figure has become known as the “elephant chart”.

⁴However, even jobs considered low-skilled in richer countries may still attract high-skilled workers in poorer countries. As The Economist puts it, “the typical call-center employee in India has a bachelor’s degree” (Revisiting Ricardo, <http://www.economist.com/node/21613280/print>. Accessed 12/14/2016.). This might result in no change in inequality if globalization facilitates easier linkages between highly-skilled workers in poor countries and firms in rich countries.

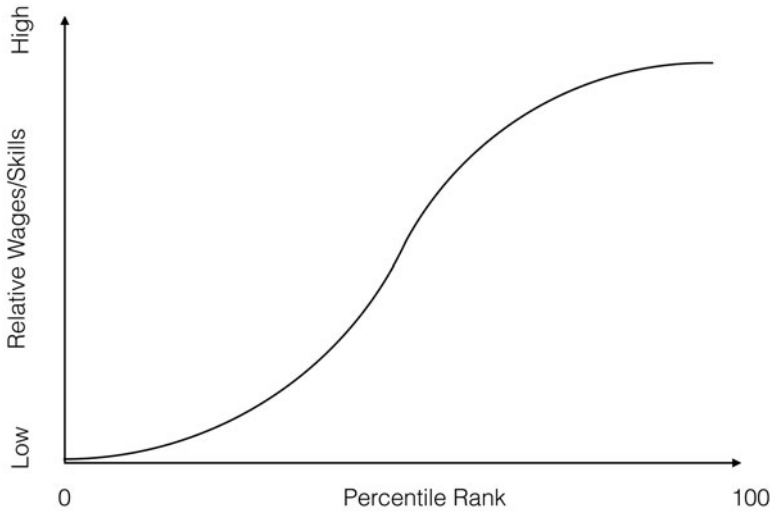


Figure 1. Wages and skills by percentile rank.

while individuals who gain most of their livelihood from capital will be clustered in the upper-right. A key insight from economic models of trade (e.g., Heckscher and Ohlin, 1991) is that a country's imports and exports will be determined by their factor endowments relative to the rest of the world. Essentially, exports will come from sources of relative abundance and advantage while imports will be driven by sources of relative scarcity and disadvantage.

We recognize that the connection between international trade and a society's relative economic development is more complicated than this. For one, low skilled labor in one country might not be perfectly substitutable for low skilled labor in a different country. In other words, there are legitimate differences in factor endowment *levels* across (and within) countries. Reinert (2007) points out that, for these very reasons, factor price equalization has failed to materialize with the advent of modern globalized trade. Reinert argues that countries that have advanced their economies have done so through *emulation* rather than comparative advantage. While these arguments are certainly reasonable, addressing the effects of globalization on economic development and global poverty is beyond the scope of this paper. Instead, we focus on different aspects of the income distribution, assuming that in a country that employs more capital relative to labor, capital-rich products are more likely to be exported (to the benefit of individuals who employ capital). Similarly, in a country that employs more labor relative to capital, labor-rich products are more likely to be exported (benefiting those who employ greater amounts of labor relative to capital). We contend that, depending on the level of factor endowments in a nation, globalization is likely to affect *relative* gains and losses differently across the income distribution.

To convey our logic, in Figure 2 we present a hypothetical scenario in which two countries, one capital-rich (dark lines) and one labor-rich (grey lines), are both exposed to an increase in globalization. In both countries, we focus on the top and bottom income quantiles, with the solid lines representing the pre-globalization absolute real incomes, and the dashed lines representing the post-globalization absolute incomes of the four groups. As we show in Figure 2, we expect the absolute real income in all income groups in this scenario to increase from gains from trade—more specifically, all groups can be expected to benefit from lower prices for consumer goods. But, as this figure displays, we do not expect all groups in this scenario to gain equally.

In particular, we expect the top income group in the capital-rich country and the bottom income group in the labor-rich country to gain the most from this increase in globalization.

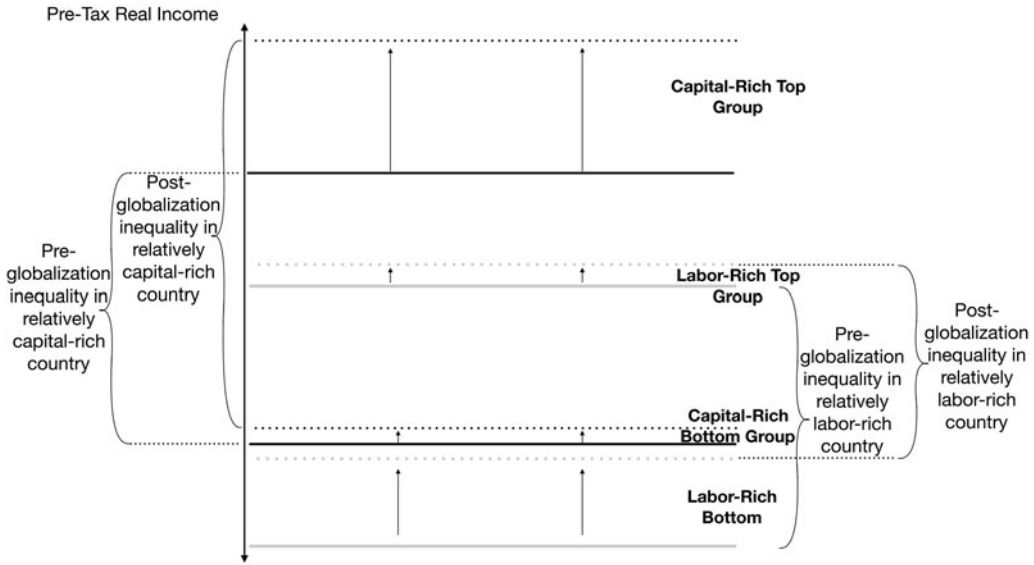


Figure 2. Pre- and post-globalization absolute income shifts among top and bottom groups in relatively labor-rich and relatively capital-rich countries.

The top income group in the capital-rich country will benefit the most because they now have a wider range of investment opportunities and they have the capital needed to take advantage of these opportunities. The wealthiest income quantile in the labor-rich country will also benefit, but their gains will be considerably more modest. We expect this to be the case because, although they have greater investment opportunities, they now face competition from the top income group in the capital-rich country as they pursue these opportunities. As we mentioned above, all groups will benefit from lower prices for consumer goods. This drives the absolute real income of all groups up but has a particularly strong effect on the two bottom income groups in this scenario. The bottom income group in the capital-rich country will also experience an increase in competition from the lower paid labor in the labor-rich country. Thus their absolute gains from this increase in globalization will be somewhat modest. In contrast, the bottom income group in the labor-rich country will benefit a lot in absolute terms because they will simultaneously experience increased demand for their labor and lower prices for consumer goods.

As can be seen in Figure 2, these gains in absolute income across all four groups translate into relative gains and losses across the two groups within each country. We can see this from the brackets on the outside of this figure depicting the gap between the top and bottom groups in each country before and after the increase in globalization. The brackets on the left, for the capital-rich country, show that the top quantile gains relative to the bottom quantile. The brackets on the right, for the labor-rich country, show that the bottom quantile gains relative to the top quantile. Although absolute real incomes have increased across all strata within each nation, the relative measure of within-country inequality has moved in opposite directions. In the labor-rich country, globalization has led to a shrinking of the income gap between the top and bottom income groups. In the capital-rich country, globalization has led to a larger income gap between the top and bottom income groups.

If we return to the Boix-style figures like Figure 1, we expect that the impact of an increase in international trade on the relative income distribution in a society depends on its relative factor endowments. These expectations are reflected in Figures 3(a) and 3(b). In Figure 3(a), we depict the expected changes from an increase in trade openness on a nation with a relative abundance of

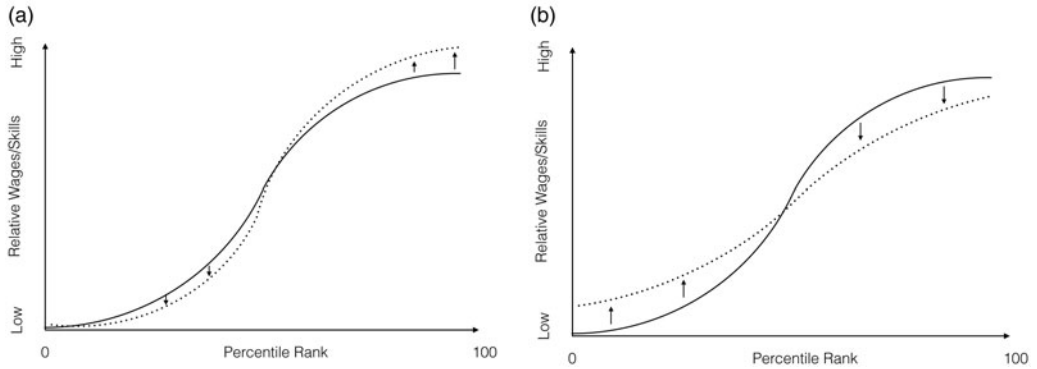


Figure 3. Expected impact of an increase in globalization on the relative income distribution. (a) Nation with large capital endowment. (b) Nation with large labor endowment.

capital. Given this abundance, we expect gains from international trade to disproportionately benefit upper income groups relative to the lower income groups. In a nation with a relative abundance of labor, our expectations are the opposite; as depicted in Figure 3(b), we expect relative increases on the lower end of the income distribution and relative declines at the upper end. Therefore, we expect that inequality will decrease in countries with a relatively abundant supply of labor.

The combined effects of relative factor endowments and trade patterns are likely to shape national income distributions in several ways, as shown in Figures 3(a) and 3(b). In Table 1, we show theoretical expectations for the effect of globalization on the composition of income. For simplicity of exposition, we split income categories into top, middle, and bottom.⁵ As shown in Table 1, we expect that in countries with high capital endowments, holding other relevant factors constant, increased economic openness increases the proportion of income for the highest earners and decreases the proportion of income for the lowest earners. While we expect the middle group to experience relative decreases in income shares as well, we expect that this decline is not as large as the decrease for the bottom income group. In contrast, in countries with high labor endowments, our expectation is that, holding all else constant, increased economic openness increases the proportion of income for the lowest and middle earners, while decreasing the proportion of income for the highest earners. We expect this increase to be largest for the bottom group.

In Table 1, we also display our theoretical expectations for the effects of increases in the other relevant variables. We have mixed expectations about the relative impact of economic growth. On the one hand, similar to our expectations for an increase in globalization, it seems reasonable to expect that increased economic growth will benefit whichever factor a country has relatively more of. For instance, in Brazil, increased economic growth would benefit the poor relative to the rich. On the other hand, we might expect that economic growth disproportionately benefits the lower and middle strata of the income distribution relative to the top. In line with the argument of Bonica *et al.* (2013), we expect that increased political polarization will lead to partisan gridlock, which may slow passage of regulatory laws in the legislature. This is expected to increase the share of the income distribution for the top income groups at the expense of the middle and, especially, the bottom. Similarly, we expect the effects of increased political constraints to benefit the top

⁵In the empirical analyses below, we split income into six different quantiles for each nation studied, thus our expectations for the top correspond to the top two categories, middle for the middle two categories, and bottom for the lowest two categories.

Table 1. Expected effects on income composition

Increase in:	Income categories		
	Top	Middle	Bottom
Globalization (high relative capital)	+ +	–	– –
Globalization (high relative labor)	–	+	+ +
Economic growth (high relative capital)	+	mixed	–
Economic growth (high relative labor)	–	mixed	+
Political polarization	+	–	– –
Political constraints	+	–	– –
Left government ideology	–	mixed	+
Age dependency ratio	mixed	mixed	mixed

Note: Each income category column shows the relative gains and losses in income shares in response to an increase in the independent variables shown on the left. ++: strong relative increase, +: weak relative increase, –: weak relative decrease, ––: strong relative decrease.

income groups at the expense of the middle and bottom groups. Although our theoretical ideas are about relative income shares before taxes and redistribution, we still expect other policies of governments on the ideological left to increase the relative share of bottom income groups at the expense of the top. We do not have specific expectations about the impact of the age dependency ratio; we include it in our models as a control for the possible effects of demographic change on relative income shares.

In this paper, we are interested in understanding the short- and long-term trade-offs between different layers of the income distribution—including the poor, the lower middle class, the upper middle class, the rich, and the super rich. We believe that globalization affects each of these groups differently over time. Yet, by virtue of being compositions of the same income distribution—the remaining error terms are correlated across each of these groups. Furthermore, we suspect that the relationship in question varies based on relative capital intensity. We are unaware of other academic articles that measure these complex relationships dynamically treating income as a compositional dependent variable.

In order to test the theoretical expectations laid out in Table 1, we need data on the relative income shares of all quantiles within each country-year as well as a measure of each control variable. Because all of the relative variables are likely to be fluctuating over time, we need annual, or more finely-grained temporal data. Given the high persistence in income composition data over time, a good model for testing our theoretical propositions would be

$$\text{Income Composition}_{it} = f(\text{Income Composition}_{it-1} + \text{Globalization}_{it} \times \text{High Relative Capital}_i + \text{Controls}_{it}) \tag{1}$$

where High Relative Capital_{*i*} is a dummy variable identifying countries with relatively high levels of capital endowments.

3. Data and research design

While summary measures of inequality such as the Gini coefficient are available for a wide number of countries over a long period of time (Solt, 2016), data that disaggregate the income distribution into quantiles are more rare and often incomplete in terms of annual coverage. As such, we are severely limited in the cases we can analyze. Since we are interested in understanding how all quantiles of the income distribution are affected by changes in economic globalization over time, we cannot utilize common measures such as Piketty’s (2014) top income shares, or the Luxembourg Income Study’s (LIS) reported household income information. The former only includes information on top income quantiles, while the latter has substantial breaks in the series

that eliminates the possibility of using a time series model.⁶ Given our data requirements, we were able to obtain income data for four country-cases: the United States, Canada, Sweden, and Brazil.⁷ Although a larger multi-country analysis would be ideal, as Figure 4 shows, these four countries provide us with three cases that have high relative capital endowments (Canada, Sweden, United States) and one case (Brazil) that has a high relative endowment of labor over the period for which we have appropriate data on income quantiles.⁸ As we can see from Figure 4, most of the variation in relative factor endowments for our cases is between the high labor case and the three high capital cases rather than over time for the individual country time series.

Despite the similarity of Canada, Sweden, and the United States in terms of relative factor endowments, there are major differences across these nations in terms of other relevant characteristics. For instance, it is well known that, by most measures, Sweden has more generous social welfare provisions than Canada and that Canada is more generous than the United States. To the extent possible, we have tried to remove these types of issues by using pre-tax measures of income as the basis for our dependent variable (more on this below). Despite this, there are doubtless other differences between these nations that persist. Given these, rather than estimate a pooled model such as that specified in Equation 1, we instead estimate a series of single-country equations, each specified as

$$\text{Income Composition}_t = f(\text{Income Composition}_{t-1} + \text{Globalization}_t + \text{Controls}_t). \quad (2)$$

We then compare the results from the three countries with relatively high capital endowments with the results from our one country with a relatively high labor endowment. Although this approach does not allow for formal hypothesis tests of the interaction between globalization and high relative capital, it does provide estimates of the effects of globalization at the two different values of the conditioning variable (relative capital), and it avoids the pooling assumptions imposed in typical time series cross sectional models.⁹

Before discussing the technical details of our model estimation, we provide a brief discussion of the measure of our dependent variable for each country as well as the operationalization of our independent variables.

3.1. Dependent variable

United States: Income distribution data for the United States were obtained from the US Census Bureau (2017) Current Population survey, and are available between 1947 and 2013. These data represent the share of all pre-tax taxable household income held by each of the five income quintiles as well as the top 5 percent.¹⁰ Due to additional available data, we were able to disaggregate

⁶See Section 3 of the Supplemental Appendix for discussion of this issue and a matrix plot visually comparing available data from our dataset to that of the LIS.

⁷As we discuss in Section 8 of the Supplemental Appendix, we were able to obtain annual income quantile data for a fifth case, Uruguay, but these data were post-tax and thus not appropriately comparable with the pre-tax data that we were able to obtain on the other four nations. In Section 8 of the Supplemental Appendix we show the results from our analyses of Uruguay.

⁸Note that the vertical axis in Figure 4 has a large scale because capital is measured as the capital stock in a given country-year (in millions of 2011 US dollars), divided by the number of employed workers (in millions). See Caselli (2005) for further details on this measure.

⁹Kam and Franzese (2007) provide an excellent discussion of these trade-offs in a section that they label “Separate-Sample versus Pooled-Sample Estimation of Interactive effects” (pp. 103–111).

¹⁰As is true in our other three country-cases, our measure of the share of income held by different quantiles of the income distribution is pre-tax but post-transfers. This implies that these data are not “government-free,” yet, we believe they are still appropriate for this analysis. Since relatively capital-rich countries generally have more robust and more reliable welfare systems than relatively labor-rich countries, the use of these data should provide a more difficult test of our theoretical expectations. We claim that with the advent of trade openness, the upper echelons of the income distribution stand to lose relative to lower quantiles in relatively capital-rich countries. If this relationship holds in spite of government transfers that likely

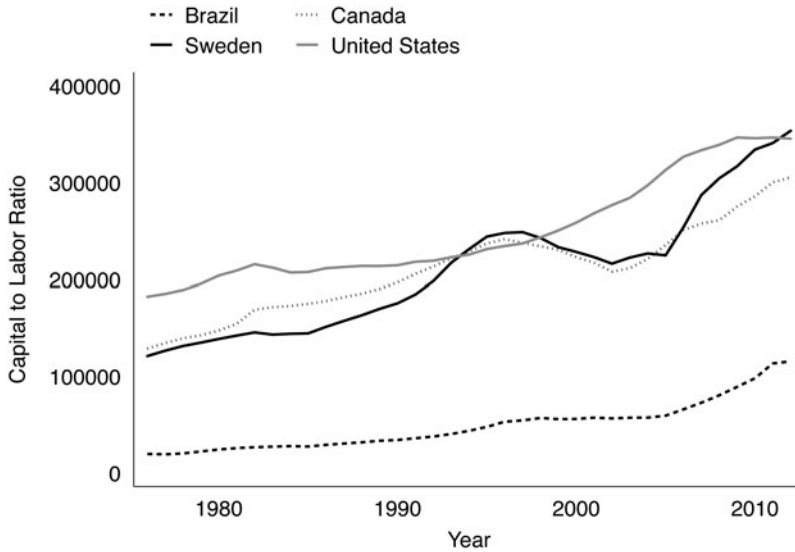


Figure 4. Capital to labor ratio, 1976–2012.

the top quintile into two categories, the top 80–94th percentile as well as the top 5 percent, for a total of six income categories.

Canada: Income distribution data for Canada were obtained from the Income Statistics Division (N.d.) of Statistics Canada. These data include pre-tax household income shares of the bottom four income quintiles as well as the top 80–90th percentiles and the top 10 percent between 1976 and 2015. These estimates are based on numerous household surveys including the Survey of Consumer Finances, Survey of Labor and Income Dynamics, and the Canadian Income Survey. The measure of income in question encompasses all market income such as wages, net investments, and rental earnings in addition to government transfers, such as social assistance, less income taxes.

Sweden: Swedish income distribution data were obtained from Hicks *et al.* (2016) who acquired the original data from Statistics Sweden. These data include total disposable pre-tax income shares of the bottom four income quintiles, as well as the top 80–90th percentiles and the top 10 percent between 1975 and 2011. Documentation from Statistics Sweden defines disposable income as earnings from factor income (wages and capital) as well as government transfers.¹¹

Brazil: Our inequality data for Brazil comes from the Institute of Applied Economic Research (Instituto de Pesquisa Econômica Aplicada – IPEA, N.d.), a government agency associated with the Brazilian Ministry for Planning, Development and Management. Income shares were calculated from annual national household survey responses (Pesquisa Nacional por Amostra de Domicílios Contínua – PNAD, N.d) conducted by the country’s federal statistical agency, IBGE, from 1976 through 2014 (excepting 1980, 1991, 1994, 2000, and 2010).¹² The PNAD questionnaire requests gross income information for retirement, pensions, social assistance, rental

overwhelmingly benefit lower quantiles of the distribution, then we should be even more confident about our conclusions. Similarly, since labor-rich countries are less likely to have particularly generous and robust welfare systems compared to their capital-rich counterparts, government transfers should lead to fewer relative gains to the bottom quantiles than to the rich in these countries. Ultimately, we believe that the comparisons we make between relatively labor-rich and relatively capital-rich countries with these data are fair comparisons.

¹¹(see *Disposable Income in the National Accounts and in the Income Statistics*, N.d.).

¹²Missing values of the dependent variable were linearly interpolated.

properties, donations, investments, and wages from each household member for the reference month. The data we utilize include the bottom four income quintiles, the top 80–99th percentiles, as well as the top 1 percent of Brazilian households.

Figure 5 illustrates the advantages of a compositional approach compared to examining only the trajectory of the top income group. In the left panel in Figure 5, we show the relative share of the top 1 percent over the time period for which we have data. This is the type of dependent variable typically analyzed in studies of inequality. The conclusions from this approach are that income inequality declined slowly across the depicted time period. The general assumption from such a figure would be that this decline, in turn, benefited the rest of the distribution. In the right panel, however, we can see that this was not the case; there was also a decline in the relative income share of the top 80–99th percentiles (the top line in the right panel of Figure 5 depicted with patterning of four dots and a dash). Moreover, we can see that while the relative shares of the remaining quantiles all went up across this period, they did so on fairly different trajectories.

3.2. Independent variables

For our main independent variable, globalization, we use the World Bank’s measure of trade openness. It is calculated as the sum of exports and imports of goods and services as a percentage of a country’s gross domestic product. This indicator is consistent with our theoretical expectations of *trade* being the primary driver of the effect of globalization on income inequality.¹³ For economic growth, we use the percentage of growth in purchasing power parity GDP per capita in constant 2011 US dollars as reported by the Penn World Tables. For our measures of political polarization and government ideology, we utilize Philip Keefer’s (2013) “Database for Political Institutions” issued by the World Bank Development Research Group (Beck *et al.*, 2001; Keefer and Stasavage, 2003; Keefer, 2013). For political constraints, we use Henisz’s (2002) measure of “feasibility of policy change.” For age dependency ratio we use the measure provided by the World Bank Development Indicators.

4. Modeling strategy

Using the recommendations of Philips *et al.* (2015, 2016a,b), we model the relative effects of globalization across income quantiles using a dynamic pie modeling strategy. Such an approach closely mirrors our theoretical expectations about how different income categories respond to increasing globalization. Our strategy for modeling the J income categories measured over t time points, y_{tj} , is as follows. Since we cannot estimate all J income categories simultaneously (if we did, one of the categories would fall out of the equation, since it would be perfectly predicted by the other income categories), we instead select one category of the compositional dependent variable (say, y_{t1}), and divide all of the other categories by it.¹⁴ We then take the natural log of each resulting ratio, thus creating $J-1$ logged compositions:

$$s_{tj} = \ln\left(\frac{y_{tj}}{y_{t1}}\right) \forall j \neq 1 \quad (3)$$

this has the advantage of “unbounding” the series from a compositional space; now, instead of ranging from zero to one (as y_{tj} does by definition), s_{tj} can take on any range of possible values.

¹³There are several alternative measures of globalization available. As we show in Section 2 of the Supplemental Appendix, these measures are fairly highly correlated with each other, though some of them are invariant for the country years of our study. In Section 4 of the Supplemental Appendix, we provide results from models using each of the alternatives for which there was variation for each country. Our main findings are robust to these alternative choices of measures of globalization.

¹⁴Philips *et al.* (2016a) point out that it does not matter which income category is selected as the “baseline.”

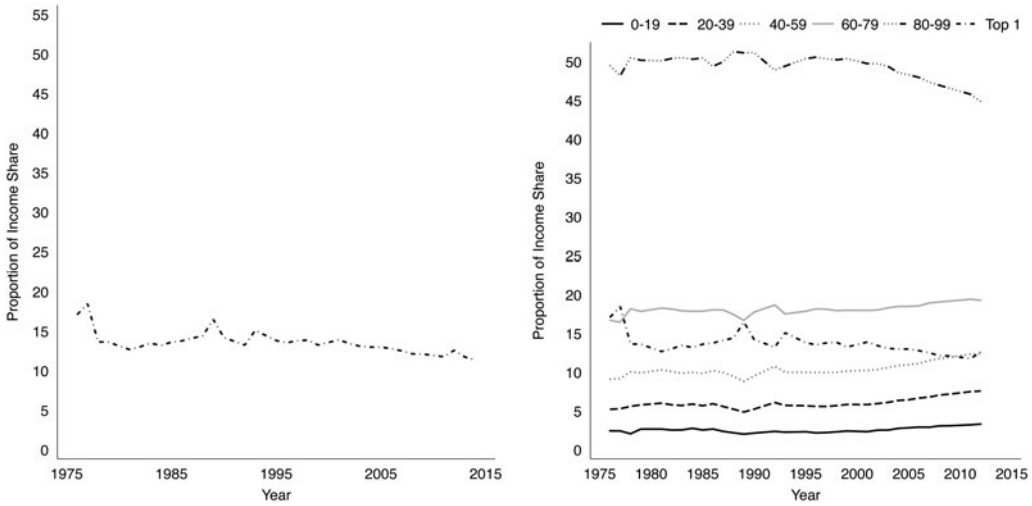


Figure 5. Brazil (1976–2014) comparison between standard measures and a compositional approach.

Thus, standard multivariate approaches may be used to estimate models of s_{ij} (Katz and King, 1999; Tomz *et al.*, 2002).

Next, we estimate $J-1$ error correction models (ECMs) for each of the s_{ij} income compositions. These are estimated simultaneously using a seemingly unrelated regression approach which increases the efficiency of estimates by allowing for correlated errors across equations. These equations are specified as

$$\Delta s_{ij} = \beta_{0j} - \alpha_j s_{jt-1} + \beta_{Lj} x_{t-1} + \beta_{Sj} \Delta x_t + \epsilon_{jt} \tag{4}$$

where:

- Δs_{ij} is the change in the logged ratio of dependent variable category “ j ” for $j > 1$ to baseline category $j = 1$ from time “ $t-1$ ” to time “ t ”,
- β_{0j} is a constant term,
- x_t is a vector of independent variable values at time “ t ”,
- $-\alpha_j$ is a vector of adjustment parameters that measure the long-run error correction processes,
- β_{Sj} is a vector of short-run effects,
- β_{Lj} is a vector of parameters that can be combined with $-\alpha_j$ to calculate estimated long-run effects of changes in each independent variable¹⁵,
- and ϵ_{jt} is a stochastic disturbance term that may be correlated across the “ j ” equations.

When working with time series data, the potential for non-stationary series prompts one to question whether the relationships we observe may be a product of spurious inferences. Recent work has advocated for checking first for non-stationary series, then performing multiple cointegration testing procedures (Philips, 2018). Several unit root tests produced strong evidence that all series in our analyses contain unit roots. We also found evidence of cointegration using a

¹⁵These long-run effects are calculated by dividing the coefficient on the lagged independent variable by the negative of the adjustment parameter (which is also negative, so they cancel out), β_{Lj}/α_j .

variety of approaches.¹⁶ We tested for autocorrelation using the Harvey test for global autocorrelation and were unable to reject the null hypothesis that no autocorrelation remains in our system for each of the countries analyzed.¹⁷

Instead of presenting a sizable table of regression results of categories of a dependent variable in logged ratios, we use the Stata program `dynsimpie` to produce expected values of the proportion of income across all categories in response to a counterfactual increase in globalization (Philips *et al.*, 2016b). A stylized version of this approach is shown in Figure 6. The program first creates 1000 parameter estimates using Clarify (Tomz *et al.*, 2003), which come from the coefficients and covariance matrix from the estimated model. At $t = 1$, it then sets all lagged dependent variables to their sample means, the first difference and lag of globalization, x_{t-1}^* , to zero and its sample means, respectively; the same is done for the control variables. Then the program generates expected values, which become the new value of the lagged dependent variable for $t = 2$ and $t = 3$. At time $t = 4$, the program introduces a counterfactual one-period shock into the system through variable x_t^* (globalization in our example). The lag of all other control variables remain at their sample means, and their first-differences at zero, effectively rendering them “all else equal”. The counterfactual shock first appears in the first difference of x_t^* , then the lag of x_t^* when $t = 5$. The resulting predictions are then “untransformed” and plotted as short- and long-run changes from starting values (i.e., analogous to marginal effects in standard regression models). Tables of the parameter estimates from these models are included in Section 7 of the Supplemental Appendix.

5. Results

5.1. United States–globalization

In panel a of Figure 7 we plot the results of a globalization shock on the composition of income by simulating a one standard deviation increase in economic openness. The horizontal axis is the expected change in income compositions for each quantile of the income distribution (expressed as a change in the proportion of total income from the sample means scenario). The short-run effects are the instantaneous expected change in the composition of incomes in response to an increase in economic openness. The long-run effects show the accumulated change in each category over time. In other words, they show the estimated total effect of a one standard deviation increase in economic openness on income compositions. Each effect is displayed with a 95 percent confidence interval. Although there are no statistically significant short-run changes as a result of increased economic openness in the US, in the long-run, substantial gains (about 3 percentage points more of the income distribution) accrue to the top 5 percent. These gains do not come at the expense of the 80–94th percentiles, nor—interestingly—very much from the very bottom quintile; instead, the middle income groups (20–79th percentiles) experience the largest

¹⁶We tested for cointegration in each country using the Engle–Granger method, the Johansen test, and the Bounds test approach. Results obtained using the Engle–Granger method and the Johansen test report statistically significant cointegrating relationships, primarily when using US and Swedish data. Though fewer statistically significant relationships, Brazilian data have also provided evidence of cointegration through the Engle–Granger and Johansen methods. Canadian data have not led to strong support for cointegrating relationships. Utilizing the Bounds test provides limited evidence of cointegration for all four countries. Although it is not a formal test for cointegration, a statistically significant negative α parameter is often seen as evidence supporting the use of an error correction model. Across all of our equations from the seemingly unrelated regression estimations, $\hat{\alpha}$ is statistically significant and negative. These results are available in Section 7 of the Supplemental Appendix.

¹⁷For more details on this test, see Judge *et al.* (1985). It is a Lagrange multiplier test calculated as *Harvey LM* = $T \sum_{j=1}^s \hat{\rho}_{jj}^2$, with a test statistic that is asymptotically distributed χ^2 with s degrees of freedom (where s is the number of equations estimated in the seemingly unrelated regression). The test examines the joint hypothesis of whether residual temporal autocorrelation exists in the system (H_0 = no overall system autocorrelation). Results for these tests were as follows: United States $\chi^2(5) = 2.16$, $p = 0.83$; Canada $\chi^2(5) = 4.76$, $p = 0.45$; Sweden $\chi^2(5) = 0.61$, $p = 0.99$; Brazil $\chi^2(5) = 0.90$, $p = 0.97$.

$$\Delta \hat{s}_{ij} = \hat{\beta}_{0j} - \hat{\alpha}_j s_{jt-1} + \hat{\beta}_{1j} x_{i-1}^* + \hat{\beta}_{2j} \Delta x_i^* + \hat{\beta}_{Lj} \mathbf{x}_{t-1} + \hat{\beta}_{Sj} \Delta \mathbf{x}_t + \hat{\epsilon}_{ij}$$

$t = 1$	\bar{s}_j	\bar{x}^*	0	$\bar{\mathbf{x}}$	0
$t = 2$	s_{j1}	\bar{x}^*	0	$\bar{\mathbf{x}}$	0
$t = 3$	s_{j2}	\bar{x}^*	0	$\bar{\mathbf{x}}$	0
$t = 4$	s_{j3}	\bar{x}^*	<i>shock</i>	$\bar{\mathbf{x}}$	0
$t = 5$	s_{j4}	$\bar{x}^* + shock$	0	$\bar{\mathbf{x}}$	0
\vdots					

Figure 6. Dynamically simulating the effect of globalization on income compositions; x_i^* represents globalization at time t .

relative declines in income share. Note that we would be unable to see this non-uniform decrease in the other income categories if using standard approaches to analyzing inequality, such as the Gini coefficient or income share of the top percentiles.

5.2. Canada-globalization

We present a simulation of the same counterfactual one standard deviation increase in economic openness for Canada in panel b of Figure 7. Contrary to our findings for the United States, with the results for Canada we do see some significant short-run changes. It is worth noting, however, that the overall pattern in the long-run responses are very similar to those found in the United States. In response to increased globalization, the top 1 percent experience a substantial increase (about 1.75 percentage points) over the long-run. As with the US, this comes mostly at the expense of the middle income groups.

5.3. Sweden-globalization

The results from Sweden, shown in panel c of Figure 7, have some similarities and some differences with both the results for the US and Canada. Similar to the results from the other capital-rich countries, the top 1 percent receives a greater share of the income distribution as a result of increased globalization (a gain of about 3 percentage points of total income). However, unlike the US and Canada, this appears to come from the bottom two quintiles. The results from Sweden are thus closest to our expectations presented at the top of Table 1.

5.4. Brazil-globalization

Finally, we present the results from Brazil, our one labor-rich country example, in panel d of Figure 7. As expected, globalization has nearly the opposite effect in this labor-rich nation; the 0–59th percentiles all experience increases in their proportion of the income distribution as a result of increased economic openness. This comes at the expense of the top quintile (80–99th), though the estimated losses for the top 1 percent are not statistically significant. Given that the average income distribution in Brazil during the period covered by this study is highly unequal, such a gain in the share of income is substantial for these income groups.¹⁸

¹⁸This is evident in Figure 5; the bottom, second lowest, and third lowest quintiles comprise approximately 3, 5, and 10 percent of the income distribution across the period studied

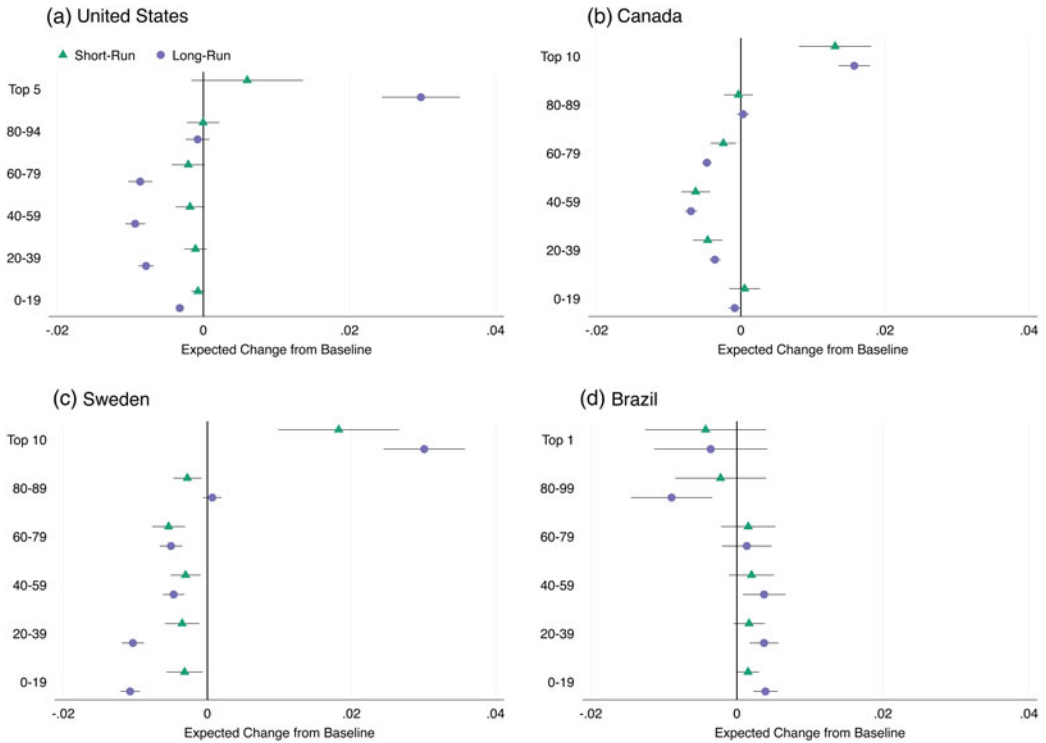


Figure 7. Effects of an increase in globalization on relative pre-tax income shares in (a) the US, (b) Canada, (c) Sweden, and (d) Brazil.

5.5. Summary of globalization results

Overall, the results across the four different country models support our theory that the relationship between globalization and inequality is shaped by a country’s relative factor endowments. We found that in countries with relatively high levels of capital, increased globalization exacerbates inequality by increasing the share of national income going to the wealthiest citizens. This result is consistent with the extant literature.

One of the advantages of the dynamic pie modeling strategy is that we are able not only to test whether the rich get richer, but also to model which groups experience relative declines in their shares of the national income. Our expectation was that such losses would come disproportionately from those citizens with the lowest incomes. While this was clearly the case in Sweden, it was not the case in the United States and Canada, where losses came disproportionately from the middle-income groups. Another interesting finding across the three capital-rich cases is that the relative income share for the next highest income groups (80th–99th percentile in Canada and Sweden and 80th to 95th percentile in the United States) were not affected by an increase in globalization. Of course, while these three countries share similar endowments of capital relative to labor, other factors may be contributing to these differences such as automatic stabilizers. Exploration of this and other contributing factors would be possible if, for a future study, we were able to obtain appropriate data from more nations.

As expected, results for our one labor-rich country, Brazil, run in the opposite direction. As globalization increases, the share of the top income groups declines while the shares of national income for the bottom groups increases. Obviously we should not make too much of the results from only one nation, but these findings do comport with our theoretical expectations.

Table 2. Summary of long-run effects for control variables

	United States	Canada	Sweden	Brazil
Economic growth	+, -, -, -, ,, +	-, -, +, +, +, +	,, ,, ,, ,, +	,, -, +, +, +, +
Political polarization	,, -, ,, +, +, .	-, ,, +, +, ,, .	,, ,, ,, ,, -	,, +, -, -, -, -
Political constraints	+, ,, -, -, -, -	,, ,, ,, ,, -	+, -, -, -, -, -	,, ,, ,, ,, .
Left government ideology	,, ,, ,, ,, .	,, ,, ,, ,, .	,, ,, ,, ,, .	,, ,, ,, ,, .
Age dependency ratio	,, ,, ,, ,, .	,, ,, ,, ,, .	,, ,, ,, ,, .	,, ,, ,, ,, .

Note: Each cell presents the estimated long-run effects of an increase in that particular independent variable on the the relative income distribution in a particular country. Results are displayed from left to right, where the leftmost entry indicates the effect for the top income group and the rightmost entry indicates the effect for the bottom group. Effects are separated by commas with “+” indicating a statistically significant positive effect ($p < 0.05$), “.” indicating a statistically insignificant effect, and “-” indicating a statistically significant negative effect ($p < 0.05$).

5.6. Summary of results for control variables

The results for our control variables were either statistically insignificant or mostly consistent with the expectations laid out in Table 1 and our discussion thereof. Table 2 presents a summary of our results for each of our control variables. Figures showing these results are in Section 6 of our Supplemental Appendix.

As we explained above, we had competing expectations for the effects of economic growth. On the one hand, we expected these effects to vary across relative factor endowments in a fashion similar to our expectations for globalization. On the other hand, we had a competing expectation that economic growth would raise the relative income share of the lowest groups at the expense of the top regardless of relative factor endowments. Our results for the United States were contrary to both sets of expectations, with statistically significant relative increases to the top and bottom groups at the expense of all others. Results for Canada and Brazil all support the latter expectations with statistically significant relative increases for the bottom income groups at the expense of the top. Results for growth in Sweden also supported these expectations in that the estimated effect is positive and statistically significant for the bottom group but no other long-term effects were statistically significant. Results for political polarization were contrary to expectations in the United States and Canada with statistically significant negative effects for one top group in each and statistically significant positive effects for lower income groups; but results for Sweden and Brazil were more in line with expectations for this variable. Results for political constraints were consistent with expectations in the United States, Canada, and Sweden but statistically insignificant across the board for Brazil. Finally, results for government ideology and age dependency ratio were not statistically significant across the board for all four countries.¹⁹

6. Conclusion

While globalization has improved the lives of many, recent evidence suggests that globalization may exacerbate income inequality within a country. In this paper we have proposed a new way of testing the impact of globalization on income inequality within nations depending on their relative factor endowments. We have found that countries that employ more capital relative to labor experience increased inequality as a result of globalization, while countries that employ more labor relative to capital experience a decrease in income inequality in response to globalization. Our findings provide empirical support for our argument that relative factor endowments interact with globalization to affect income inequality.²⁰

¹⁹It is worth noting our results are nearly identical when we control only for economic growth. We present these results in Section 5 of the Supplemental Appendix.

²⁰We caution readers against interpreting our findings as evidence of development, poverty, or absolute economic gains and losses. Our claims are specific to the effect of globalization on relative changes across the income distribution.

We also argued that the best way to test our theoretical argument about the effects of globalization is to study multiple components of the income distribution. While existing work typically relies on summary statistics (i.e., Gini coefficient), or the incomes of the very top of the income distribution, we have shown that by considering all segments of the income distribution, we gain a better picture of how globalization *shapes* inequality. The use of dynamic compositional methods shows promise for future studies of income inequality. This approach allows us to see not only which income segments gain as a result of globalization, but where these relative gains are coming from in the form of relative losses for other income segments. Future studies should gather data on a larger set of countries with greater variation in relative factor endowments and other factors that are likely to shape relative income shares.

Supplementary Material. The supplementary material for this article can be found at <https://doi.org/10.1017/psrm.2019.25>

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