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Winners and losers in the commodity lottery: The impact of terms of trade growth and volatility in the Periphery 1870–1939

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Abstract

Most countries in the periphery specialized in the export of just a handful of primary products for most of their history. Some of these commodities have been more price volatile than others, and those with more volatility have grown much more slowly relative to the industrial leaders and to other primary product exporters. This fact helps explain the growth puzzle noted by Easterly, Kremer, Pritchett and Summers more than a decade ago: that the contending fundamental determinants of growth — institutions, geography and culture — exhibit far more persistence than do the growth rates they are supposed to explain. Using a new panel database for 35 countries, this paper estimates the impact of terms of trade volatility and secular change on country performance between 1870 and 1939. Volatility was much more important for growth than was secular change and accounts for a substantial degree of the divergence in incomes within the sample of small, commodity-dependent 'Periphery' nations as well as under-performance of the Periphery as a whole relative to such nations as the US and Western Europe, or 'Core'. One channel of impact seems to be the adverse effect of volatility on foreign investment. It appears that the terms of trade effects were asymmetric between Core and Periphery.

JEL classification: F1; N10; O1
Keywords: Terms of trade; Growth; Volatility; Periphery

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1. Introduction

This essay explores an underappreciated aspect of long term growth: differences in price trends and volatility across primary commodities explain much of the global income divergence observed in the last century and a half. We show that most countries outside Western Europe and the US have been specialized in the export of the same handful of primary commodities for most of their history. Moreover, some commodity prices have proven more volatile than others, and some have enjoyed better secular growth. A look at commodity dependent price-taking economies (the *Periphery*) yields two main results. First, those countries with more volatile primary product prices grew more slowly relative to other primary product exporters as well as to the industrial leaders (or *Core*). Second, after controlling for volatility, rising terms of trade are associated with higher growth in Core countries, but not so in the price-taking Periphery.

We establish these facts using a new database of commodities, prices, and incomes for 35 countries over eight decades—a coverage of more than 85% of the world population and nearly all of world GDP in 1914. Fig. 1 illustrates the simple bivariate relationship between income and terms of trade volatility over the entire period, 1870 to 1939. Examining the price-taking Periphery, simple OLS estimates will suggest that a one standard deviation increase in terms of trade volatility was associated with a 0.4 percentage point decrease in the rate of income growth per annum—a 40% decrease from the mean. This estimate seems to be a lower bound, with the upper bound a 66% decrease from the mean of income growth. Our results are extremely robust to alternative time periods, definitions of volatility, and exclusion of larger exporters where one might fear the terms of trade are less likely to be exogenous. Meanwhile, Fig. 2 illustrates the bivariate relation between income and terms of trade growth, suggesting a mild positive correlation. A multivariate treatment will show that after controlling for volatility income growth is in fact not robustly related to secular terms of trade changes in the Periphery.

We investigate one prime channel through which volatility could have impacted growth—foreign investment. Eichengreen (1996) argues that in much of the Periphery capital inflows

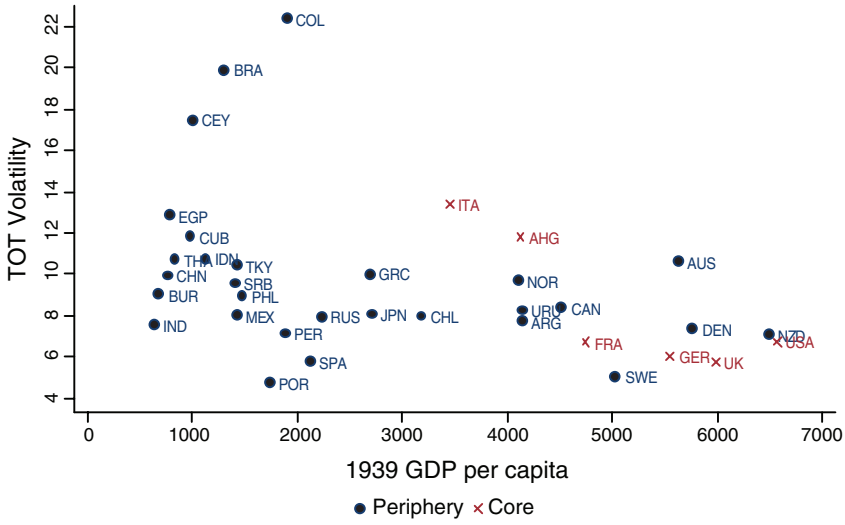


Fig. 1. 1939 GDP per capita and terms of trade volatility 1870–1939.

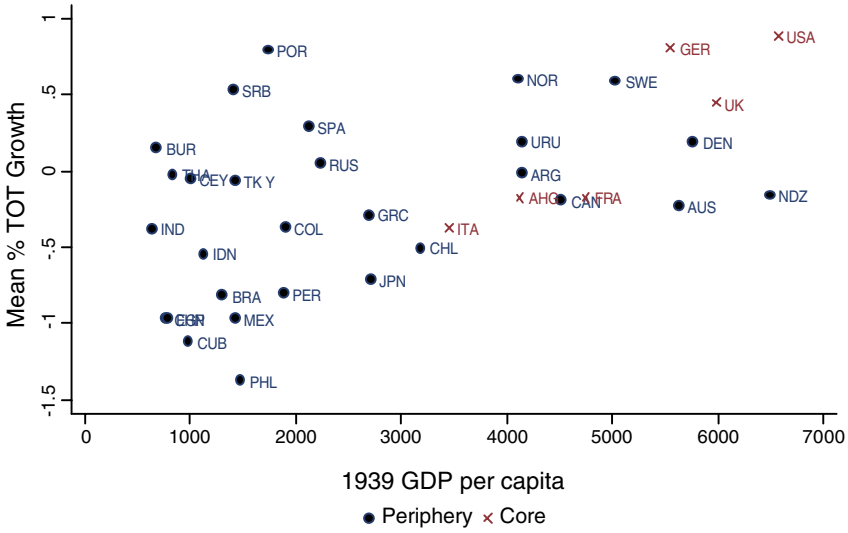


Fig. 2. 1939 GDP per capita and mean terms of trade growth 1870–1939.

shrank as price shocks reduced the attractiveness of investment. We attempt to quantify this response using the only source of investment data for the period in question—British capital flows from 1870 to 1913. While we do not find evidence that changes in terms of trade trends influenced capital flows, we do find evidence that volatility mattered. Fig. 3 illustrates this bivariate relationship graphically. In OLS regressions we find that a one standard deviation increase in terms of trade volatility was associated with a 33% to 58% decrease in average capital flows to the Periphery (although the results are not as robust as in the case of the income

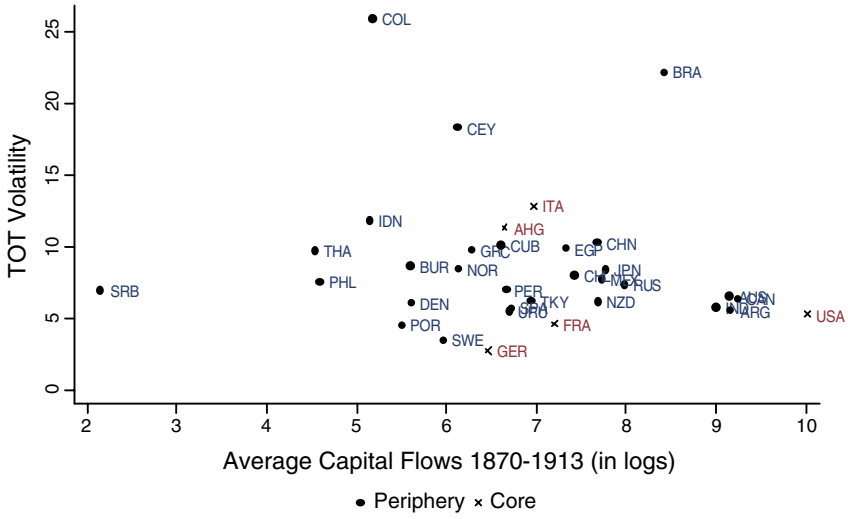


Fig. 3. Capital flows and terms of trade volatility.

Table 1
Ratio of within-country variance to total variance for typical explanatory variables in growth regressions

Variable	1870–1909	1960–1999
Growth of GDP per capita	0.85	0.73
Terms of trade growth	0.96	0.90
Population growth	0.37	0.29
Investment	0.31	0.28
Level of primary education	0.05	0.09
Primary products in exports	0.02	n.a.
Number of countries	35	125

Data for 1960–1999 come from the Penn World Tables v6.1 (for GDP, population, and the investment rate), the Barro–Lee Data Set of International Measures of Schooling Years and Schooling Quality (for education), and the World Bank's 2004 World Development Indicators (for the terms of trade). Countries with fewer than 20 annual observations (or 4 quinquennial ones) were dropped from the analysis. Data for 1870–1939 are discussed in the data appendix. The investment figure is not investment rates (as in 1960–99) but rather is capital flows from the UK to the receiving country.

growth effects). While this impact is substantial, foreign investment flows were small relative to output in most countries, so it is perhaps only one of many channels of impact. If one assumes that domestic savings and investment respond in similar fashion to volatility, however, the investment channel would appear to be an important one.

Finally, our results are consistent with asymmetry between the Core and Periphery. In contrast to the Periphery results reported here, elsewhere we show that income growth in Core countries bears little relationship to the volatility of the terms of trade, but is positively correlated with secular terms of trade growth (Blattman et al., 2004). We believe that the source of the asymmetry is diversification and industrialization in the Core. Countries with a broader base of exports, especially manufactures rising in value over time, can be expected to grow faster and be better insured against price fluctuations in individual commodities. Similarly, countries having governments with a broader tax base are less vulnerable to terms of trade, tariff revenue and project volatility, thus are capable of faster growth.

Our results speak to three longstanding puzzles in the economic growth literature. First, although specialization in the production and export of primary commodities has proven to be one of the most robust determinants of poor economic growth, economists have yet to account fully for the power of commodity-specialization in predicting economic performance.[1] We suggest that commodity price volatility is one reason why. Second, in spite of the explanatory power of commodity specialization, economic performance among the resource-rich before 1940 varied enormously. Some grew remarkably fast (e.g., Canada and Norway), some grew very slowly (e.g., Colombia and India), while some lay in between (e.g., Turkey and Brazil). We explain the variation by noting that all primary products were not created equal. Third, we seek to explain the volatility of growth rates over time using an equally volatile variable, commodity prices. As argued by Easterly, Kremer, Pritchett, and Summers (1993), the usual determinants of income growth—institutions, geography and culture—exhibit far more persistence than do the growth rates they are supposed to explain. In Table 1 we look at two time periods and compare the fraction of within-country variation to total variation for GDP growth and its common determinants. As noted by Pritchett (2000), growth within a country over time varies more than between countries, while the opposite is true of most explanatory variables. Therefore

[1] See Sala-i-Matin (1997) and Sachs and Warner (2001).

growth determinants that change over time, like commodity prices, are both intuitively and econometrically more satisfying.

We conclude that two important determinants of growth — commodity price volatility and secular growth — have been overlooked in the contest between constitutions, cultures and coastlines. Our findings are reminiscent of what Carlos Diaz-Alejandro (1984) called the "commodity lottery." Each country's exportable resources, he explained, were determined in large part by geography and chance, and differences in later economic development were a consequence of the economic, political and institutional attributes of each commodity. Differences in the secular growth of each primary product's relative price mattered, but not, as we shall see, in the way Prebisch and Singer saw it. Furthermore, the exogenous price volatility of each primary product mattered even more by generating internal instability, reduced investment, and diminished economic growth.

2. Theory and evidence on the terms of trade and development

A large literature has considered the consequences of movements in the terms of trade. One view has it that improving terms of trade raises GDP. A secular rise in the terms of trade over a long period is of course akin to technological progress and results in improved productivity, faster accumulation and growth. The favorable impact on investment is one channel. Another might be that the increase in the purchasing power of exports encourages the purchase of productivity-enhancing intermediate goods and equipment that often must be imported by developing countries. Basu and McLeod (1992) model this effect and find supportive evidence for twelve developing countries, mostly in Latin America. Similarly, Deaton and Miller (1996) and Deaton (1999) find that a sharp increase in commodity prices in Africa is associated with increases in both the level and growth rate of per capita income.

An influential dissenting view has been termed "the resource curse." According to this view, resource abundance hurts long run growth. Sachs and Warner (1995, 2001), for example, have observed that resource-rich countries tend to grow more slowly than resource-poor countries. A popular explanation, due to Prebisch (1950), Singer (1950) and others, is that the pattern of comparative advantage forces resource-rich countries to specialize in sectors with falling global demand or little potential for learning and productivity improvement. An alternative story is that resource sectors are inherently more vulnerable to expropriation and thus that their expansion leads to poor growth. Krueger (1974), for example, famously argued that resource-owning elites may suppress growth through rent-seeking in poor and resource-abundant countries. Empirical support for the resource curse view is found in Hadass and Williamson (2003) who find that between 1870 and World War I, positive terms of trade movements reduced growth in a sample of commodity exporters. Their sample, however, covers few of the developing countries that remained poor up to WW II and they did not explore the impact of volatility. We improve on their work by constructing a larger sample and focusing on volatility.

How volatility affects growth has been a topic of recent research, spurred by the work of Ramey and Ramey (1995) who found that countries with large fluctuations in growth rates tended to have lower average growth rates. One explanation for this finding is that risk-averse households save less when returns to capital are volatile (e.g., Rosenwzeig and Wolpin, 1993). Another is that poor governments under-invest in public goods when beset with revenue instability, especially given that they are more likely to face borrowing constraints on world markets. Ramey and Ramey indeed find that government spending fluctuations and macroeconomic volatility are closely related, and that this volatility is associated with lower

growth.[2] A particularly important source of such volatility might be short-run movements in the terms of trade. Eichengreen (1996) argues that both negative trends and volatility in the terms of trade depressed export revenues and capital inflows for many developing countries, creating a reinforcing cycle of current and capital account shocks which led to financial crises and poor growth. Mendoza (1997) formalizes the intuition that terms of trade volatility should discourage saving by assuming that households consume imported goods and save in order to be able to consume in the future, which implies that fluctuations in the terms of trade translate directly into fluctuations in the returns to saving. The assumptions of sufficient risk-aversion and closed capital markets produce the result that countries with higher terms of trade volatility grow more slowly than countries with more stability. A rising trend in the terms of trade also has the expected stimulating effect on investment and growth while a negative movement has the opposite effect. In a sample of 40 industrial and developing countries for 1970–1991, Mendoza confirms the predicted positive relationship between terms of trade trends and growth, and the negative relationship between terms of trade volatility and growth. Other studies have corroborated these findings. In a sample of 14 sub-Saharan countries between 1980 and 1995, Bleaney and Greenway (2001) find that terms of trade volatility had a significant negative impact on the level of investment and growth rate of output. For a sample of 61 developing countries between 1975 and 1992, Turnovsky and Chattopadhyay (2003) find that an increase in the growth rate of the terms of trade has a weak positive effect on the mean growth rate of output while an increase in volatility has a strong negative effect on output growth.

There is notable consistency in these results, especially considering the different time periods, county samples and volatility measures used. However, all of these studies are limited to the 20 or 25 years after 1970 and therefore cannot really speak to the long run. Short time periods also constrain their ability to isolate volatility from trend. We believe our much longer historical sample makes the decomposition of the terms of trade series more reliable, and the tests of impact more robust.

3. Discussion of the data and sample

Our analysis stretches over three twenty year periods — the rapid expansion of global markets from 1870 to 1889, their maturation from 1890 to 1909, and the tumultuous interwar years from 1920 to 1939. These periods were chosen because they represent episodes of global integration and disintegration, inducing large terms of trade changes and economy-wide responses. The two war decades are excluded due to the absence of data and to the gross distortions to trade and prices attributable to war demands, blockades and skyrocketing transport costs.[3] The years 1950 to 2000 are also excluded because they have been explored elsewhere, and because radical changes in the composition of production and trade in the periphery make the use of a continuous terms of trade series less meaningful.

We collected new terms of data for 35 countries. Table 2 lists our sample, with summaries of incomes, exports, and terms of trade. We divide our sample into Core and Periphery nations, an

[2] While greater volatility increases the need for international borrowing to help smooth domestic consumption, Catão and Kapur (2004) have shown recently that volatility constrained the ability to borrow between 1970 and 2001.

[3] We stop at 1909, not 1913, because the trend and volatility data for are only comparable if they are based on a full decade.

Table 2
Summary statistics

	GDP per capita			Exports			Terms of trade		
	1870	1939	Avg. growth	Value (′ 000s)	% Primary products		Avg. growth	Avg. volatility	Exogeneity
					1870	1939			
Core									
Austria	974	4123	2.03	1918	28	36	−0.18	9.70	*
France	1858	4748	1.77	7000	44	41	−0.18	5.67	*
Germany	1913	5549	2.17	5017	38	18	0.85	4.76	*
Italy	1467	3444	1.18	1096	88	45	−0.39	13.19	*
United States	2457	6568	1.46	4488	86	48	0.88	5.84	*
United Kingdom	3263	5979	0.91	11,811	11	24	0.43	4.83	*
Periphery									
European Periphery									
Denmark	1927	5766	1.74	355	96	85	0.20	7.24	
Greece	1295	2687	0.94	84	94	94	−0.29	7.38	
Norway	1303	4108	1.62	217	97	58	0.58	8.81	
Portugal	1085	1739	0.73	183	96	61	1.20	8.02	
Russia	1023	2237	1.27	2456	98	82	0.04	7.36	†
Sweden	1664	5029	1.95	411	91	56	0.57	4.09	
Serbia	822	1412	0.83	59	96	86	0.54	9.26	
Spain	1376	2127	0.73	796	71	84	−0.16	6.72	
European Offshoots									
Australia	3801	5631	0.84	861	97	95	−0.25	9.47	†
Canada	1620	4518	1.66	588	95	74	−0.20	7.84	‡
New Zealand	3115	6492	0.80	116	100	99	−0.17	6.82	
Latin America									
Argentina	1311	4148	2.15	302	100	97	−0.01	7.20	‡
Brazil	740	1307	0.82	1,055	100	100	0.82	17.52	†
Chile	927	3178	2.21	292	99	100	−0.49	7.74	†
Colombia	1183	1905	0.65	69	97	98	−0.37	19.05	
Cuba	1568	978	−1.08	967	80	97	−1.15	10.62	
Mexico	710	1428	1.07	225	100	98	−1.00	7.82	
Peru	389	1884	2.15	296	99	100	−0.83	7.06	
Uruguay	1311	4148	2.15	101	100	100	0.19	7.66	
Asia and Middle East									
Burma	602	681	−0.20	154	93	98	0.12	8.08	
Ceylon	769	1011	0.47	206	98	99	−0.03	14.93	
China	523	763	0.54	1116	99	82	−0.99	6.75	†
Egypt	271	787	1.77	442	93	95	−1.00	11.51	
India	558	643	0.20	2108	93	72	−0.40	6.76	†
Indonesia	657	1124	0.52	309	98	98	−0.55	9.70	
Japan	741	2709	1.60	164	71	23	−0.73	6.79	‡
Philippines	912	1476	0.58	291	99	94	−1.38	8.30	†
Thailand	717	833	0.27	61	99	99	−0.05	9.17	
Turkey	508	1430	1.61	1022	100	94	−0.11	7.63	

* Initially industrialized countries; low initial commodity dependence; high degree of market power. 1870–1939.
† Produce more than 1/3 of global share of exports in any commodity and/or >5% of global exports.
‡ Produce between 1/3 and 1/4 of global share of exports in any commodity.

allocation based on the initial size of the economy, initial size of the manufacturing sector, and the share of the country in the world market for its exports. The names Core and Periphery are primarily a rhetorical device; our primary objective is to obtain the largest sample possible where

terms of trade may be considered exogenous, and then examine more and more conservative assumptions about who in the Periphery is truly a price-taker. We include six industrial leaders in a parsimonious definition of the Core: Austria–Hungary, France, Germany, Italy, the UK, and the USA. In 1870 these countries were already wealthy, industrialized, and major exporters of both primary commodities and manufactures, and therefore cannot comfortably be considered price-takers on world markets. Our Periphery, on the other hand, was mostly poor, commodity-dependent, and highly concentrated in one or two export products. There are eight in the European Periphery (Denmark, Greece, Norway, Portugal, Serbia, Spain, Sweden, and Russia), eight in Latin America (Argentina, Brazil, Colombia, Chile, Cuba, Mexico, Peru, and Uruguay), ten in Asia and the Middle East (Burma, Ceylon, China, Egypt, India, Indonesia, Japan, the Philippines, Siam, and Turkey), and three European Offshoots (Australia, Canada, and New Zealand). Of course, some of these countries were large economies, and some exported manufactures—all of which might call into question the price-taking assumption. Table 2 highlights those countries where the exogeneity of the terms of trade is suspect. We will see their exclusion does not affect our conclusions.

The terms of trade is the ratio of export to import prices. The Core has excellent existing data, and we construct new terms of trade series for the Periphery. Detailed sources and methods of construction are discussed in a previous working paper.[4] In the numerator we employ country-specific commodity weights and global commodity prices from US and UK markets. Global prices have the advantage of greater accuracy and availability, and most importantly can be considered exogenous by individual countries that produce a relatively small share of that commodity (a definition that we will see captures most of our Periphery exporters). The denominator is a price index for extensively traded US manufactured goods.[5] As constructed, the index measures the purchasing power of a country's principal primary commodity exports in terms of a common, constant basket of manufactures.[6]

For most countries in our sample, the primary source of GDP per capita estimates (in 1990 $US) is Maddison (1995). Since the sample's GDP estimates often begin only with 1900 or even 1913, earlier years are obtained from supplementary sources, in particular back-casting from Maddison using estimates of real wage or output growth constructed by Jeffrey Williamson. The poor quality of income growth estimates for some countries, especially for the late nineteenth century, implies that measured changes in GDP per capita over a decade or more are almost certainly more reliable than annual ones. They will also give a better fix on long run effects.[7] As long as the measurement errors are random, they should not, of course, bias our econometric estimates, but rather only raise standard errors.

[4] See Blattman, Hwang, and Williamson (2004).

[5] The import index in the denominator is a weighted sum of the prices of textiles (55%), metals (15%), machinery (15%), building materials (7.5%), and chemicals/pharmaceuticals (7.5%) from the US Dept. of Commerce *Historical Statistics*. The same import price index has been used for all countries since reliable country-specific import mix data are not available for all before World War I. What data do exist, however, suggest that the assumption closely approximates reality.

[6] Kose and Riezman (1998) suggest that the use of such a price index is superior to an import index when examining the effects of trade shocks, and that such an index exhibits similar levels of volatility compared with a pure terms of trade measure.

[7] Decades were chosen to be the main unit of analysis in part to reduce measurement error in the dependent variable, in part to have a sufficient span of time over which to measure terms of trade trend and volatility, and to ensure there were sufficient observations to give the econometric tests power.

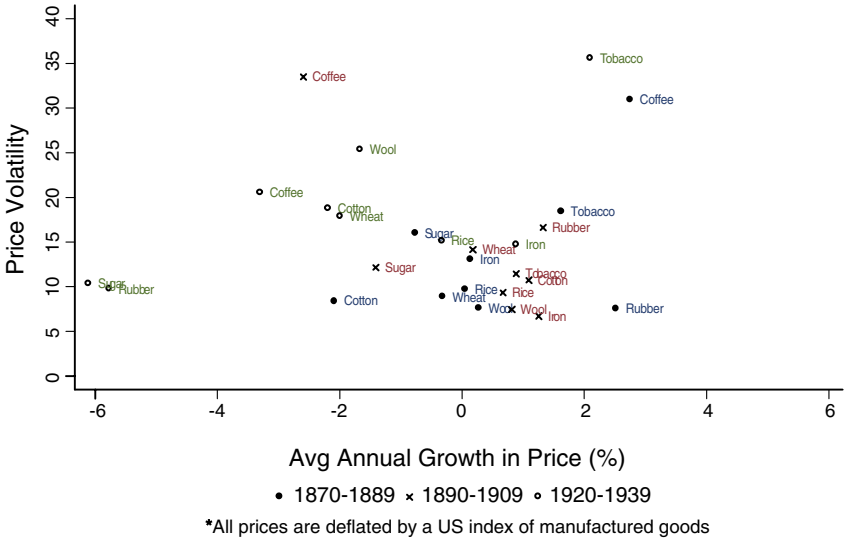


Fig. 4. Commodity price volatility and growth for select commodities.

Our capital flow data are measured with more precision.[8] They refer to UK capital exports for the period 1870 to 1913, and our country sample received 92% of it. We choose UK capital exports as a measure of international capital flows because it is available, and because the UK was then the world's leading capital exporter, far exceeding the combined capital exports of its nearest competitors, France and Germany. Thus, UK capital was the dominant source of international capital for more than forty years.

Our control variables come from a historical database constructed by Jeffrey Williamson and others, as described in Clemens and Williamson (2004a,b). Export share is calculated as the ratio of exports to national income. The share of exports in primary products follows a definition similar to that in Sachs and Warner (1997) and is the ratio of all exports except manufactured products and specie to total exports. Population growth rates are straight-forward. Schooling reflects estimates of primary school enrollment rates for those of school age, and is calculated by dividing reports of per capita primary enrollment rates by the fraction of the population under the age of 14.

3.1. Behavior of the new commodity and terms of trade data

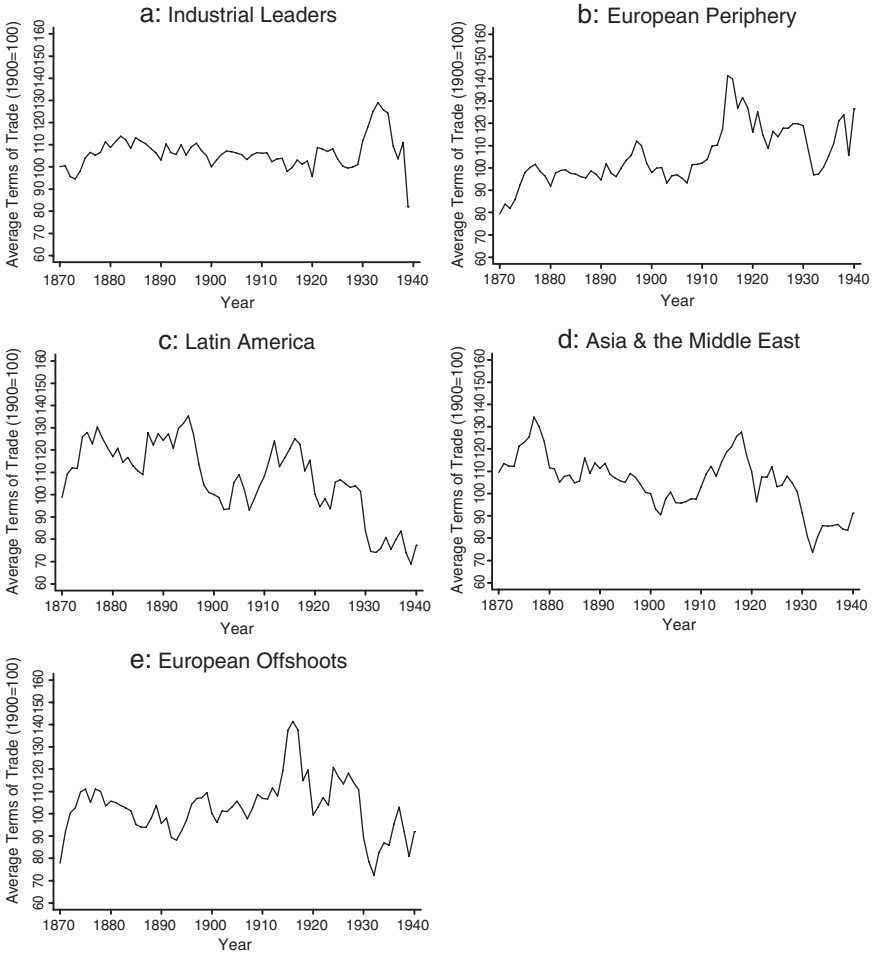
The most important feature of commodity prices is not their long-term drift,[9] but rather their volatility. Fig. 4 depicts trend growth and volatility in the prices of 9 of our 42 primary products over the three twenty-year periods. Commodity prices experienced the highest average growth and lowest volatility from 1890 to 1909, and the highest volatility and slowest growth during the interwar years. Within each period, however, some primary products were very

[8] The data were originally collected by Leland Jenks and Matthew Simon, and then reported by Stone (1999). They were cleaned recently by Clemens and Williamson (2004b).

[9] This statement was true after the 1870s or 1890s. However, the terms of trade facing commodity exporters in the Periphery rose dramatically over the seven decades before the 1870s (Williamson, in press).

volatile (such as coffee and tobacco), while others were relatively stable (like wheat and iron). Note that volatility between commodities often differed by a factor of two or three, and in some cases by a factor of six or seven. What's more, while some commodity prices rose (such as tobacco and wool), others suffered sharp reversals (such as rubber, which was supplanted by cheaper synthetics in the interwar period). Since most countries specialized in a handful of commodities, such differences in price behavior translated into diverse country experiences—a true commodity lottery.

Fig. 5 displays the paths of the terms of trade by region, 1870 to 1939. Looking backwards from their vantage point shortly after WW II, Prebisch and Singer were right to argue a secular decline in the Periphery's terms of trade. Thus, over our seven decades there seems to be an



** Unweighted average of terms of trade across groups of countries:*
Industrial Leaders (Core): Austria-Hungary, France, Germany, Italy, UK, USA
European Periphery: Denmark, Greece, Norway, Portugal, Serbia, Spain, Sweden, Russia
Latin America: Argentina, Brazil, Colombia, Chile, Cuba, Mexico, Peru, Uruguay
Asia and the Middle East: Burma, Ceylon, China, Egypt, India, Indonesia, Japan, Philippines, Siam, Turkey:
European Offshoots: Australia, Canada, New Zealand

Fig. 5. Terms of trade by country groups.

upward drift for the Industrial Leaders and the European Industrial Latecomers, and a downward drift for Latin America, Asia and the Middle East. Their conclusion regarding the full twentieth century was, however, premature. First, as Spraos (1980) noted, such a trend is very sensitive to the choice of time period, and when the series is extended beyond 1950 the downward trend in the Periphery's terms of trade disappears. Second, downward drift is not itself evidence of a trend even over our seven decades. Consistent with much of the literature,[10] time series tests (not shown) fail to find evidence of a secular trend. We cannot reject the presence of a unit root in two-thirds of the countries and, in countries where trends appear, they are generally small and certainly not universal to all primary product producers.

In short, our country terms of trade exhibit considerable year-to-year fluctuations, as well as short term trend movements or cycles, but little long-term trend-bolstering our prior conjecture that terms of trade volatility mattered far more after the 1870s than did long run trend.

3.2. Decomposition of terms of trade fluctuations

There are several options for decomposing terms of trade movements into trend and volatility. Mendoza employs the terms of trade growth rate and the standard deviation of the growth rate. There are three potential drawbacks to this approach. First, the growth rate of the terms of trade over a period of time (such as a decade) will be overstated if there is a positive shock in the tenth year, and understated if there is a negative shock. More volatile countries will thus be measured with less accuracy, leading to systematic measurement error. Second, a structural break or a discrete change in the rate of growth will register as both a change in trend *and* a change in volatility, potentially confusing the effects. Third, persistent shocks away from trend will result in a lower measure of volatility than a shock that returns to trend the following year. Shocks that persist for more than a year before returning to trend will register as volatility, since they remain deviations from measured trend. The standard deviation of the growth rate of the terms of trade, on the other hand, will instead register only the initial shock and its eventual return to trend as volatility. The more gradual and consistent the return to trend, the lower the volatility measure, and so shocks that die out slowly will register as less volatile, even though the distortion may be greater.

We prefer measures of trend and volatility that do not relate in a systematic way to one another and that minimize the measurement error in the trend. A practical solution is to use a filter that produces a smooth trend and stationary deviations. The Hodrick-Prescott (HP) filter is a common choice, used by Basu and McLeod (1992) among others, and we employ it here.[11] Over the 10-year intervals used in our analysis, the HP data filter and Mendoza's method generate very similar results. The correlations of growth rates and volatility produced by the two methods are .85 and .86, respectively, and our findings are robust to both.

4. Empirical strategy

We are principally interested in explaining the diversity in economic performance among primary product exporters. Our first reason is relevance—there is a tremendous divergence in

[10] See Grilli and Yang (1988) or Bleaney and Greenaway (1993) for a review of the literature on declining terms of trade.

[11] We set the smoothing parameter in the HP filter at 300, which implies a relatively slow-changing trend. A more quickly changing trend (such as that achieved with a smoothing parameter of 100 or lower) does not materially affect our results.

incomes within the commodity-dependent sample, variation that is at least as interesting and meaningful as that between industrial Europe and the Periphery. A second reason is that of heterogeneity—the relationship between the terms of trade and income growth may be fundamentally different in large, diverse industrial nations than it is in the commodity-dependent. For instance, if, as is commonly believed, industrialization is important for growth, and positive terms of trade movements reinforce global patterns of trade, then positive secular change in the terms of trade may be beneficial for growth in the Core but less so, or even damaging in the Periphery. The third reason is the potential for simultaneity bias in the Core where countries were more likely to exercise price-setting power over their exports.

Elsewhere, we also investigated the relationship between terms of trade and economic performance in the Core as well as the Periphery (Blattman et al., 2004). Our reasons were relevance and heterogeneity. Evidence of a different structural relationship between the terms of trade and economic performance in the Core versus the Periphery bolstered our decision to examine them separately and provide insight into the unique consequences of commodity specialization. Here, however, we are more cautious given the potential for endogeneity bias for the Core. Thus, we only report results for the Periphery.

We will pay equally close attention to the potential for bias in the Periphery. Consistent identification of the impact of terms or trade fluctuations on incomes requires that terms of trade movements are exogenous, and that there is no source of simultaneity bias. These concerns are addressed in this section.

The basic empirical specification is a regression of the average annual growth rate, GR, on measures of the growth and volatility in the terms of trade, TOTG and TOTV:

$$\mathrm{GR}_{it} = \beta_0 + \beta_1 \mathrm{TOTG}_{it} + \beta_2 \mathrm{TOTV}_{it} + \boldsymbol{Z}_{it}\boldsymbol{\Phi} + \mu_i + \nu_t + \varepsilon_{it} \quad (1)$$

for country i and time period t, a vector of controls, $\boldsymbol{Z}$, country and time period dummies, μ and ν, and residuals ε. Deaton and Laroque (1992) find that the persistence of commodity shocks is fairly high, and therefore a decade seems like a reasonable unit of observation (although our results hold if we analyze the data in 5-year increments instead). Thus, the dependent variable is the average annual growth of GDP per capita over some decade. All of our specifications include country and decade fixed effects in order to control for unobserved fundamentals that were also determining growth performance, fundamentals that are not the focus on this paper. Finally, all standard errors are heteroskedasticity-robust.

Our terms of trade growth measure is the percent change in the trend in the terms of trade over the decade, while volatility is measured by the standard deviation of departures from this trend. As discussed in the previous section, we choose an HP filter to decompose the fluctuations into trend and volatility, although we will see that our results are robust to alternate decompositions. This marks a departure from much of the cross-country growth literature, which typically estimates the following equation:

$$\mathrm{GR}_{it} = \beta_0 + \beta_1 \mathrm{TOTS}_{it} + \boldsymbol{Z}_{it}\boldsymbol{\Phi} + \mu_i + \nu_t + \varepsilon_{it} \quad (1')$$

where TOTS (terms of trade shock) is simply the log difference of ending and beginning terms of trade levels. The decomposition of the terms of trade shock is critical, however. When measuring the impact of terms of trade changes over a period of time, such as a decade, failure to decompose the shock results in systematic measurement error and biased coefficients. Consider two countries: in one there is a mild, steady improvement in the terms of trade over the period, while in the other the terms of trade are highly volatile, but come out higher at the end of the period than at the beginning. Both would have the same measured terms of trade growth, but

each would have had a sharply different growth experience that decade. In fact, in a regression of decadal growth on the change in the terms of trade, failure to account for volatility will systematically underestimate terms of trade shocks when measured over time, biasing the coefficient on terms of trade growth upwards. Moreover, if commodity price shocks are also skewed, as suggested by Deaton (1999), then the impact of the measurement error on the coefficients becomes difficult to predict. An annual growth regression avoids both difficulties, but will not capture the medium and long term effects of terms of trade growth and volatility on economic development.

Following Mendoza (1997), we could employ a very parsimonious empirical model without controls, regressing average GDP per capita growth rates on average trend growth and volatility in the terms of trade alone.[12] The assumed exogeneity of the terms of trade implies that adding additional control variables should not change the estimated impact of the terms of trade. Even so, the addition of controls will generally reduce standard errors even when the terms of trade are exogenous, and so in general we control for the initial values of income per capita, population growth, and schooling.[13] However, we might expect that the effect of terms of trade shocks on output is conditional on some country characteristic, X, and we can explore this hypothesis with the following specification:

$$\mathrm{GR}_{it} = \beta_0 + \beta_0 \mathrm{TOTG}_{it} + \beta_2 (\mathrm{TOTG}^* X)_{it} + \beta_3 \mathrm{TOTV}_{it} + \beta_4 X_{it} + \boldsymbol{Z}_{it}\boldsymbol{\Phi} + \mu_i + \nu_t + \varepsilon_{it}. \quad (2)$$

Finally, as noted in Sections 1 and 2, terms of trade fluctuations are frequently thought to affect growth through the investment channel. These hypotheses can be tested by estimating Eqs. (1) and (2) using investment levels as the dependent variable. Accordingly, we investigate the impact of terms of trade fluctuations on the only reliable and available investment data for the period in question, the natural log of capital flows from the UK.

4.1. Addressing identification concerns

There are two main sources of concern in our identification assumption: (i) endogeneity of the terms of trade shock in cases where countries are not international price-takers, and (ii) the presence of an invisible third force (such as the quality of political institutions and governance) that result in both poor growth and the choice of export concentration in a commodity with high volatility and poor trends.

The first concern is that some countries in our sample will be large enough producers of a particular commodity to affect the world price. There are two reasons why we do not believe this to be a problem when looking at our Periphery sample. First, we expect violations of this assumption (e.g., Chile with its copper and phosphates) to cause our results to *understate* the predicted positive impact of the terms of trade on growth. For instance, if a negative shock to the supply of copper in Chile caused the world market price to rise just as copper output (and hence

[12] As noted above, Mendoza actually employed per capita consumption growth as a proxy for output growth. We do not have data on consumption, and so follow other authors in analyzing the effects on per capita GDP growth.

[13] Our results will prove robust to the inclusion of openness and institutional variables as well. Conventional growth regressions would also include a measure of physical capital, such as investment share. We do not have such data for our period, but do not feel this to be a problem for two reasons: (i) as discussed, the terms of trade shocks are exogenous and should not be vulnerable to omitted variable bias; and (ii) inclusion of foreign capital flows as a percent of GDP (as a proxy for investment share) does not alter our results, but unfortunately is only available for 1870–1909, so that we cannot use it in our 1870–1939 regressions.

GDP) in Chile fell, there would be a negative correlation between the terms of trade trend and output growth, biasing the coefficient on trend growth downwards. Second, we will show that our results are very robust to the exclusion of Periphery countries that may be suspected of being price-makers rather than price-takers. Table 2 identifies major exporters (those who produce more than five percent of world exports) and countries that have more than a one-third share of global exports in any commodity.[14] According to these criteria, Australia, Brazil, Chile, China, India, the Philippines, and Russia are excluded (representing more than a quarter of our observations).[15] Excluding all countries with more than a quarter share of world exports in a commodity, we would also drop Japan, Canada and Argentina from the panel.[16] We will see that the terms of trade results are highly too robust to these and even more draconian assumptions about exogeneity of the terms of trade. In general, we feel that a one-third export share is a reasonable lower bound on world market share before a country begins to have a significant impact on world price.[17]

The second concern is that a third force, such as the quality of political institutions, is driving both the choice of primary commodity and the pattern and rate of development. It might be suspected, for instance, that countries with particularly poor governance or 'extractive' institutions might systematically choose more volatile commodities, and so volatility would be negatively correlated with growth because it acts as a proxy for poor institutions, rather than for its own sake. There are at least three reasons why this concern does not trouble us. One, to the extent that initial institutional quality influenced the choice of commodity, it should be captured in a regression by country fixed effects. In virtually every Periphery nation in our sample, the choice of commodities was made before 1870 and persisted until the end of our period. Whether we consider Canada or Colombia, each Periphery country's development over the late nineteenth and early twentieth centuries was not one of steady export diversification, but rather expansion in the production of the same handful of two or three commodities. Any impact of institutional quality on commodity choice is therefore largely time-invariant and will be swept out with fixed effects.

Two, the historical and empirical evidence strongly support the "commodity lottery" view — the choice of which commodity to produce and export was not a choice at all, but rather was an outcome determined by geography, factor endowments, and international demand, not institutional quality. In simple regressions of terms of trade trend and volatility on our institutional proxies we do not find any statistically or economically significant relationship.[18] This result is precisely what the historical evidence would lead us to believe: regardless of

[14] Data sources for this classification are listed in Appendix Table 1 of Blattman, Hwang, and Williamson (2004).

[15] We do not have data on world export shares of gold and silver, and in fact several countries (like Mexico) are major producers. These countries need not be dropped, however, because the prices of these precious metals were generally fixed so no feedback effects were possible. The silver price was pegged in world markets by the bi-metallic core Franco-countries during most of our period. As for gold, it too was pegged by the gold standard except for wars and the 1930s.

[16] While we do not have full information on their share in world markets, Canada may have had more than a quarter share of world exports in lumber before 1900, and Argentina may have had more than a quarter share in wool.

[17] Our reasons are threefold: (i) these are export shares only for major exporters, (ii) such measures ignore the importance of local production satisfying local demand (especially in big economies like Russia, the US and China), and (iii) cross-price elasticities between some of these products are high (e.g., hemp versus jute, or cotton versus wool).

[18] Results not shown. A regression of terms of trade volatility on the fraction of the population European in 1800 and initial income gives a coefficient of -0.0002 and a standard error of 0.02. Similarly insignificant results arise from a regression of volatility on the Polity IV measure of democracy. A variety of specifications and controls result in similarly insignificant results.

their institutional makeup, Periphery countries generally exported the product in which they had the greatest natural advantages. A look at the New World provides concrete examples. Where minerals were produced — whether phosphates in Chile or silver in Mexico — the choice of commodity was essentially a function of what was under the soil and not prohibitively far from the coast. The range of agricultural products available to export was likewise a function of the local production advantages and transport costs. The mountainous Andean countries could never compete in wheat production with the Canadian Prairie or the Argentine Pampas — the fertility and lay of the land provided clear cost advantages in production of these goods, and hence Canada remained specialized in wheat (alongside lumber) while Argentina focused on wheat and beef. Aside from any considerations of soil fertility, transport costs alone limited the profitability of many agricultural products in the Andes. In Colombia the cost of road and rail construction over three mountain ranges alone meant that overland transport was almost prohibitively expensive,[19] and was justified only for high value-to-weight export products, such as gold, or relatively lightweight and high value products such as tobacco and coffee.[20]

Three, where institutions and commodity choice are related, such as in the plantation-style production of sugar or cotton, and the associated forced labor, both poor institutions and high price volatility seem to have sprung from the same source—local factor endowments. Engerman and Sokoloff (1997) argue convincingly that the commodity choice, the organization of production, and later institutions in the New World were all functions of factor endowments, including climate and the availability of forced labor. It was not the case that initially poor institutions themselves resulted in the production and export of volatile commodities. As we saw in Fig. 4, while some of these plantation-style products were volatile, many were not. This is not to say that there is no relationship between terms of trade volatility and institutional quality. While institutions might not cause volatility, there may be important interactions. Within the Periphery we might expect countries with better institutions to respond to shocks less severely because of a greater ability to borrow and smooth investment and government finances, or because of a reduced likelihood of civil conflict. Our results, however, do not change when we include institutional proxies in our regressions. Within the Periphery we see virtually no relationship between institutional quality and later volatility, reinforcing our identifying assumption.

5. Discussion of the empirical results

Our results, displayed in Tables 3–5, illustrate an important aspect of long-run growth that has never before received attention: high commodity price volatility does not only explain poor economic performance in the Periphery compared to the Core, but it also explains poor relative

[19] In Columbia, 35 to 60 cents per ton-mile, as compared to 2 to 4 cents in the US over the same period (Safford and Palacios, 2002, p. 34).

[20] The tobacco case is particularly instructive. In the 1870s plantations in Java began producing cheap, high quality tobacco, permanently lowering the world price and shutting Colombia out of the market. Colombia scrounged for new products for several years, cycling through indigo and cinchona bark (for quinine) before eventually finding a profitable niche in the rising world demand for high quality coffee, which their mountains became famously known for cheaply producing. Such a trend was not uncommon in the Periphery; when export products and mixes did change, the pattern was typically one of substitution, not diversification, with any new export product replacing the old. Peru, for instance, focused on cotton and sugar export only after guano and silver stocks depleted. Brazil failed to find a real replacement for natural rubber until almost a generation after the invention of a synthetic substitute that destroyed the market.

Table 3
GDP growth and the terms of trade, 1870–1939

	(1)	(2)	(3)	(4)
	TOT decomposed		TOT not decomposed	
TOT growth[a]	0.05	0.05	0.13	0.13
	[0.124]	[0.119]	[0.090]	[0.084]
TOT volatility[b]	−0.08	−0.08		
	[0.036]**	[0.033]**		
Observations	167	167	167	167
R^2	0.28	0.35	0.28	0.35
Decade dummies	Y	Y	Y	Y
Country dummies	Y	Y	Y	Y
Controls[c]	N	Y	N	Y
Summary statistics:				
GDP growth	1.05	1.05	1.05	1.05
	[1.66]	[1.66]	[1.66]	[1.66]
TOT growth	−0.28	−0.28	−0.45	−0.45
	[1.46]	[1.46]	[2.20]	[2.20]
TOT volatility	8.80	8.80		
	[5.17]	[5.17]		
Impact on GDP growth:[d]				
TOT growth	0.08	0.07	0.28	0.28
TOT volatility	−0.41	−0.39		

Dependent variable: Decadal average GDP per capita growth.
Robust standard errors in brackets; *significant at 10%; ** significant at 5%; *** significant at 1%.
[a] When not decomposed, TOT Growth is the decadal average growth rate in terms of trade. When decomposed into trend and volatility, TOT Growth is the decadal average growth rate of the trend from a Hodrick–Prescott filter.
[b] TOT Volatility is the decadal standard deviation of departures from a Hodrick–Prescott filter trend.
[c] Controls include ln(Initial GDP per capita), lagged population growth, and the fraction of the population with primary schooling.
[d] Calculates the percentage point impact of a one standard deviation change in the TOT variable on annual GDP growth rates.

performance within the commodity-specialized Periphery. After controlling for volatility, trend changes in the terms of trade bear little relationship to patterns of growth and investment. These findings are distinct from the pattern observed in the Core, where volatility matters little and terms of trade growth is associated with rising incomes.

5.1. The terms of trade and growth of per capita income

The results from estimating Eqs. (1) and (1′) by OLS, with and without standard controls, are presented in Table 3. Results are displayed for the full period, 1870 to 1939, omitting the war decade. Here our primary attention is devoted to the full sample of 29 commodity-dependent price-taking Periphery nations. We will examine more conservative definitions of the Periphery in Table 4. The top half of each table reports the point estimates and standard errors for the terms of trade (henceforth TOT) effects. The bottom half reports the quantitative and economic importance of these TOT effects, including sample means and standard deviations of the independent variables, and the impact of a one-standard-deviation increase in TOT growth and volatility.

Table 4
GDP growth and the terms of trade with more conservative periphery subsamples

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	All		Subsample 1		Subsample 2		Subsample 3	
TOT growth[a]	0.05	−0.17	0.04	−0.32	0.01	−0.39	0.00	−0.37
	[0.119]	[0.152]	[0.153]	[0.163]**	[0.178]	[0.179]**	[0.207]	[0.206]*
TOT volatility[a]	−0.08	−0.08	−0.10	−0.09	−0.09	−0.07	−0.09	−0.08
	[0.033]**	[0.032]**	[0.036]**	[0.034]**	[0.042]**	[0.040]*	[0.046]**	[0.045]*
TOT growth × exports/GDP		1.73		2.43		2.50		2.12
		[0.911]*		[0.850]***		[0.869]***		[0.927]**
Exports/GDP		5.82		6.92		5.97		3.30
		[3.628]		[4.084]*		[4.219]		[4.735]
Observations	167	167	125	125	107	107	89	89
R^2	0.35	0.39	0.39	0.45	0.38	0.44	0.42	0.46
Decade dummies	Y	Y	Y	Y	Y	Y	Y	Y
Country dummies	Y	Y	Y	Y	Y	Y	Y	Y
Controls[b]	Y	Y	Y	Y	Y	Y	Y	Y
Summary statistics:								
GDP growth	1.05	1.05	1.10	1.10	0.98	0.98	0.84	0.84
	[1.66]	[1.66]	[1.75]	[1.75]	[1.80]	[1.80]	[1.89]	[1.89]
TOT growth	−0.28	−0.28	−0.17	−0.17	−0.14	−0.14	−0.26	−0.26
	[1.46]	[1.46]	[1.35]	[1.35]	[1.39]	[1.39]	[1.44]	[1.44]
TOT volatility	8.80	8.80	8.69	8.69	8.92	8.92	9.37	9.37
	[5.17]	[5.17]	[5.22]	[5.22]	[5.40]	[5.40]	[5.64]	[5.64]
Exports/GDP	0.13	0.13	0.14	0.14	0.14	0.14	0.14	0.14
	[0.11]	[0.11]	[0.12]	[0.12]	[0.12]	[0.12]	[0.13]	[0.13]
Impact on GDP growth:[c]								
TOT growth	0.07	0.08	0.05	0.02	0.01	−0.04	0.00	−0.11
TOT volatility	−0.39	−0.40	−0.50	−0.45	−0.46	−0.37	−0.52	−0.44

Dependent variable: Decadal average GDP per capita growth.
Robust standard errors in brackets; * significant at 10%; ** significant at 5%; *** significant at 1%.
[a] TOT Growth is the decadal average growth rate of a Hodrick–Prescott trend. TOT volatility is the decadal standard deviation of departures from the trend.
[b] Controls include ln(Initial GDP per capita), lagged population growth, and the fraction of the population with primary schooling.
[c] Calculates the percentage point impact of a one standard deviation change in the TOT variable on annual GDP growth rates.

Looking at the first two columns of Table 3, there is no statistically significant relationship between TOT trend growth and income growth in the commodity-specialized Periphery. As noted in our review of the literature, development economists since Prebisch and Singer have fretted that a declining terms of trade inhibits development. Our evidence suggests their concern was misplaced—the absence of an association in the Periphery (with its exogenous commodity price shifts) suggests that the much-lamented correlation between slow income growth and terms of trade deterioration was probably spurious, at least after 1870. The correlation in the Periphery between the secular terms of trade boom *before* 1870, de-industrialization, and poor income growth may, however, have more to support it (Williamson, in press). Note in Table 3 that there is a large and highly significant negative relationship between volatility and growth. Recall that

Table 5
UK capital exports and the terms of trade, 1870–1939

	(1)	(2)	(3)	(4)
	All	Subsample		
		1	2	3
TOT growth[a]	0.07	0.13	0.17	0.29
	[0.106]	[0.135]	[0.151]	[0.164]*
TOT volatility[a]	−0.06	−0.08	−0.08	−0.10
	[0.031]**	[0.039]*	[0.044]*	[0.049]**
Observations	116	88	76	64
R^2	0.74	0.69	0.67	0.75
Decade dummies	Y	Y	Y	Y
Country dummies	Y	Y	Y	Y
Controls[b]	N	N	N	N
Summary statistics:				
ln(Capital inflow)	6.03	5.63	5.29	5.36
	[2.34]	[2.33]	[2.15]	[2.18]
TOT growth	−0.28	−0.17	−0.14	−0.26
	[1.46]	[1.35]	[1.39]	[1.44]
TOT volatility	8.80	8.69	8.92	9.37
	[5.17]	[5.22]	[5.40]	[5.64]
Impact on capital exports:[c]				
TOT growth	0.10	0.18	0.23	0.42
TOT volatility	−0.33	−0.40	−0.43	−0.58

Dependent variable: Log of decadal average capital flows from the UK.
Robust standard errors in brackets; * significant at 10%; ** significant at 5%; *** significant at 1%.
[a] TOT Growth is the decadal average growth rate of a Hodrick–Prescott trend. TOT volatility is the decadal standard deviation of departures from the trend.
[b] Controls include ln(Initial GDP per capita), lagged population growth, and the fraction of the population with primary schooling.
[c] Calculates the percentage point impact of a one standard deviation change in the TOT variable on UK capital exports.

volatility is measured as the standard deviation of departures from the TOT trend, and we see that in the Periphery the mean volatility is 8.80 (with a standard deviation of 5.17). The marginal effect of an increase in TOT volatility is to decrease income growth by 0.08 percentage points. Furthermore, a country with a one standard deviation greater level of volatility than the mean will grow 0.41 percentage points per annum more slowly than the sample average. Given that the average annual rate of growth in the Periphery was only one percent per year, the volatility effects are extremely economically significant — the marginal effect is roughly 7% of average growth, and the standard deviation change an astonishing 40%. Comparing column 1 to 2, we see that the point estimates for the Periphery are virtually unaffected by the inclusion of controls but standard errors are improved, as predicted.[21] Accordingly, in the remainder of the paper we will focus on results that include the controls unless otherwise specified.

[21] The addition of other controls (including our measures of openness, institutional quality, and capital inflows as a percent of GDP) do not affect the results.

Columns 3 and 4 estimate Eq. (1′) where we do not decompose TOT movements into trend and volatility. We can see that decomposition of the fluctuations is of critical importance. The failure to find robust coefficients on TOT growth has led many empirical studies to discount its importance. As discussed in the previous section, however, the failure to find statistically significant results is largely a consequence of measurement error, a problem that is in large part overcome through the decomposition into trend and volatility.

To forestall concern that commodity price fluctuations are not exogenous in the full sample of commodity-dependent nations, in Table 4 we examine the sensitivity of our results to more and more conservative assumptions about which countries are truly price-takers. Columns 1 and 2 display the results for our broadest Periphery of 29 nations, while Columns 3 to 8 look at three subsamples: Subsample 1 omits the 7 nations that produce more than 5% of all global exports or export more than a third of the global share of any individual commodity (discussed in the previous section); Subsample 2 further omits the 3 nations that export more than a quarter of the global share of any commodity; and finally Subsample 3 omits the 3 Scandinavian nations, which while commodity dependent, one could conceivably fear began the period with a sufficiently large economy, level of development, and domestic industrial output.

All in all, nearly half of our sample can be dropped and our point estimates for TOT volatility go virtually unchanged. Table 4 estimates both Eqs. (1) and (2), where in the latter TOT trend growth is interacted with export share to see whether the terms of trade impact was contingent upon the level of openness and export dependence. OLS results are displayed for the full seven decades, again omitting war years. In the odd-numbered columns, which estimate Eq. (1), the marginal effects of terms of trade trend growth remain negligible. The marginal effects for volatility, meanwhile, range from -0.08 to -0.10 — a statistically indistinguishable change — and remain significant at the 95% level. The impact of a one standard deviation increase in volatility, however, is increasing in the smaller subsamples (largely because the variance of terms of trade volatility is rising). Therefore our lower bound estimate of a standard deviation increase in volatility is a 0.39 percentage point decrease in the rate of growth, and our upper bound is a 0.52 decrease. As a percentage of mean income growth the effect is even more substantial, because the mean growth rate in the smaller, more commodity dependent nation is lower—a one standard deviation increase in volatility reduces mean growth by 63% in the smallest subsample.

The even-numbered columns in Table 4 estimate Eq. (2), where TOT growth is interacted with the share of exports in GDP. It seems reasonable that more export-oriented countries would respond more forcefully to external shocks. Export shares are taken from the first year of the decade to avoid problems of endogeneity. In general the interaction term is positive and significant, suggesting that in the most export-oriented countries an increase in trend terms of trade growth is associated with a rise in incomes. The effects appear very small, however. At the mean level of export share of GDP, the marginal effect of an increase in terms of trade growth is close to zero and not statistically significant.[22] Even the impact of a one standard deviation increase in TOT growth is quite small, especially relative to the impact of changes in volatility. In columns 4 and 6 we note that the inclusion of the interaction reduces the statistical significance of the volatility coefficient from the 95% to the 90% level. Since the point estimates are unchanged and the results are more robust in all other contexts, we remain confident in the reality of the income–volatility relationship.

[22] To obtain the marginal effect, add the coefficient on TOT growth to the coefficient on the interaction term multiplied by the mean of export share. In column 3, $(-0.32)+(2.43*0.14)=0.0167$.

Finally, in our previous working paper (Blattman et al., 2004) we have confirmed the robustness of our results with respect to all of the following: inclusion of the war decade, alternative period lengths, alternative methods of decomposing terms of trade series into trend and fluctuations, alternative definitions of volatility, the dropping of countries and decades with lower quality income data, and alternative functional forms and specifications including additional interactions and controls. As we noted in the previous section, our findings are extremely robust to the inclusion of what institutional quality proxy data exist. Finally, we also examine the effect of terms of trade fluctuations on growth starts and stops. Recently Hausman, Pritchett, and Rodrik (2004) proposed an alternative way to study growth performances. Noting, as we have earlier, that growth rates are volatile over time and therefore significant changes in income occur in spurts during "growth episodes", they identify such episodes and estimate the probability of one occurring conditional on a number of variables, including terms of trade shocks. We have performed a similar analysis and, reassuringly, find results consistent with those presented here—an increase in volatility or a decline in the terms of trade trend reduced the likelihood of growth acceleration and increased the likelihood of a slowdown.

5.2. Terms of trade and foreign capital inflows

What were the channels of terms of trade impact? Here we investigate one possibility, capital accumulation financed by capital inflows. We find that gross capital flows from the UK to Periphery countries were decreasing in TOT volatility. In Table 5 we estimate a version of Eq. (1) where the dependent variable is not income growth, but rather the log of the decadal average capital inflows a country received from the UK between 1870 and 1909.[23] Our key finding is that volatility reduced investment flows to the commodity-dependent, price-taking Periphery, although the relationship is slightly less statistically robust than with income growth.[24]

The first four columns in Table 5 examine the full Periphery and the three subsamples from Table 4. Since the dependent variable is in log form, the interpretation of the coefficients is the percentage change in UK capital flows in response to a marginal change in the independent variable. The point estimates on TOT volatility are all in the range of -0.06 to -0.10, which are statistically indistinguishable from one another. Even so, it is interesting to note that as the nations under consideration become smaller and more and more vulnerable to exogenous commodity price fluctuations, the effect of volatility on investment seems to grow. Thus the marginal effect of an increase in volatility is to decrease UK foreign investment by 6% to 10%. A one standard deviation increase in volatility, meanwhile, is associated with a 33% to 58% decrease in capital inflows, with the larger latter amount applying to the smaller members of the Periphery. The results for the full sample and our smallest subsample are significant at the 95% level, but the results for the two mid-sized subsamples are only significant at the 90% level.

In general, trend growth in the terms of trade does not appear to be robustly related to increases in levels of UK investment, except in column 4. As the sample is reduced further and further, the coefficient on TOT growth increases until it is large enough so that the imprecision with which it is estimated (the standard errors are quite large) is not an impediment to statistical significance. Since the relationship is significant only in the one regression, we should be careful

[23] As noted in the discussion of the data, UK capital flows data were not available for the post-WW I period.

[24] We also look at the effects of TOT fluctuations on capital inflows as a share of GDP, but do not find significant results.

about making any strong conclusions. The evidence, however, is suggestive that TOT trend changes are more influential in smaller exporters.

In the absence of data on capital stocks, we can only conjecture whether the terms of trade impact on domestic capital accumulation was big or small, but assuming a capital-output ratio of roughly 3 : 1 suggests that the impact was only moderate. It seems likely, however, that domestic savings were even more powerfully influenced by terms of trade shocks than were foreign capital flows, a proposition that remains to be investigated.

6. Conclusions

Our analysis suggests that the terms of trade needs to be more central to our thinking about long term development. Commodity choice, dependence and the associated price trends and their volatility were especially powerful determinants of growth in the Periphery up to 1940. In focusing upon the forces that led to industrialization and diversification in Western Europe and the US, scholars may have forgotten that the rest of the world-rich and poor-took a different path. Some of the primary-product producing nations did quite well by this strategy — witness Canada, Australia, or Norway. Some, like India or Colombia, did quite poorly. Others were somewhere in the middle. The commodity-specialized were not uniformly slow-growing and poor. Neither were the prices of their commodities uniformly volatile and decreasing. In reconstructing nearly a century of terms of trade experience from 1870 to 1939 and assessing its impact on economic performance, we see that some commodities proved more volatile in price than others, and that those countries with more volatile terms of trade grew more slowly than other commodity-specialized nations. Countries with just one standard deviation higher volatility, moreover, grew on average more than half a percentage point per annum slower. The same difference in volatility seems to be associated with a third to two-thirds lower capital inflows. While our capital flows results are not large or as robust as our growth results, they still point to an important channel of impact. Other channels are likely to have been important too, such as the effect of terms of trade shocks on the incidence of civil conflict (Rodrik, 1999; Miguel et al., 2004).

The economic effects of our estimates are big. To illustrate the impact, consider an example from the primary product-exporting Periphery. Per capita income in Canada grew faster than in Indonesia by about 1% per annum. The difference in terms of trade volatility between the two countries was just under one half of one standard deviation. Our estimates imply that if, through good fortune, Indonesia had experienced the smaller terms of trade volatility of Canada, then Indonesia would have grown faster by about 0.3 percentage points, reducing the growth rate gap between them by a third.

These magnitudes suggest that terms of trade fluctuations are a major force behind the big divergence in income levels among Periphery nations. Up to now, most development economists would explain the nineteenth and twentieth century take-off of Chile relative to Colombia in terms of geography, institutions, or culture. We argue that commodities probably mattered at least as much. By our estimates, producing and exporting a commodity with half the average level of volatility was associated with an annual increase in the rate of growth of a third to a half of a percentage point — a thirty to fifty percent improvement — as well as an increase in UK capital flows of roughly the same magnitude.

What is also notable about our results is the asymmetry between Core and Periphery. Where terms of trade volatility was present in the Periphery, it created a significant drag on output growth. Elsewhere we show that this was not true of the Core — where it experienced the same

high price volatility, it did not experience the same drag on growth. This asymmetry is consistent with two growth narratives. One, positive price shocks reinforced comparative advantage, and so they induced more industrialization in the Core and less in the Periphery. Two, it may be that rich countries with more sophisticated institutions and markets were better able to insure against price volatility than poor countries, so that terms of trade instability had a far bigger negative impact in the Periphery than in the Core. We await better data on institutional quality to test this hypothesis.

In the meantime, our results are suggestive that terms of trade fluctuations were also a reason for divergence in income levels between the Core and Periphery. Volatility mattered little for the larger, diversified industrial nations, but volatility seems to have impacted the commodity-dependent nations adversely. The gap in growth rates in per capita income between Core and Periphery in our sample is 0.44 percentage points. If the Periphery had experienced the same volatility as the Core, *ceteris paribus*, this would have added 0.2 percentage points to average GDP per capita growth rates in the Periphery. This alone accounts for nearly half of the output per capita growth gap.

Could countries in the Periphery have lessened the impact of volatile prices through judicious use of policy? Questions like this often arise in the resource curse literature. Given the adverse impact of resource-dependence, either through deindustrialization or price volatility, why did these countries not shift resources away from commodity production into something else? While we make no statements about the larger question raised by the resource curse literature, we believe resource-shifting was not really an option as a response to price volatility. As we argued earlier, the choice of commodities was better described as a "lottery" than as a policy choice. Nations seldom 'switched' commodities unless forced to do so. For example, Colombia only began as a producer of coffee in the late nineteenth century once cheap Indonesian exports undermined the Colombian tobacco export trade, forcing it to scramble for a decade to find a new product and a footing in world markets. Even if such a choice was possible, it would have been difficult to predict future price volatility with any degree of accuracy. Hence our finding for the period up to 1940 agrees with a view of the post-war period that good economic performance was as much the result of good luck as it was of good policy. More importantly still, we believe that commodities deserve at least as much attention as the current triumvirate of cultures, coastlines and constitutions.

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