'Export-led Growth': The Trade-Technology Relation in Small and Poor Economies

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Abstract

This paper analyzes the impact on aggregate economic performance of trade and technology in a world where poor nations are cheap. The paper builds on Ricardo Hausmann's "Export-led Growth", but departs in two ways: First, this paper shows empirically that small nations are economically surprisingly successful. This finding contradicts the implications of theoretical models where aggregate economic performance draws on diversity, complexity, or increasing returns to scale. For small states to succeed relative to those economies that are larger but otherwise comparable, trade matters importantly. Second, the paper argues that in a world where poor nations are cheap, the effects of technological improvement and trade openness are not monotone, but vary with the wage-price characteristics of those sectors where technology pulls ahead and where trade impacts. That complexity correlates with advanced technology is important on average, but less so among the most extreme of national economic successes.

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1 Introduction

This paper analyzes the impact of trade and technology on aggregate economic performance in a global economy where nations that are poor are also cheap. The paper builds on the ideas in "Export-Led Growth" (Hausmann, 2023) but departs in two ways: First, its shows empirically that small economies are surprisingly successful. Their per capita incomes are unusually high, relative to counterparts that are larger but otherwise similar. This finding runs counter to the implications of theoretical growth models that draw on the advantages of diversity, scale economies, and complexity and experimentation. This is not to say that all small states are rich; indeed, many small states are poor. Instead, the finding says the inverse, almost all rich states happen to be small. Smallness is not sufficient but is (close to) necessary for economic success. Moreover, aggregate economic success is not just the preserve of one or two small states, but is seen in a good number of them, each with apparently different circumstances.[1] Singapore is a tiny sovereign nation with population only 5.6mn and a land area of 734 sq km. It is smaller than New York City or urban London. Yet its per capita income, as an average since 2013, makes Singapore the world's sixth-richest nation in World Bank accounts. The obviously largest nation among the top nine is the US, ranked eighth. This might make it seem that Singapore is an outlier, rich only because of exogenous circumstances unique to it. However, the average population among the nine richest nations, taking out the US, is only 4.2mn, i.e., less than Singapore's. The largest nation in the group, excluding the US, is Switzerland with population (averaged since 2013) only 8.5mn. Among rich nations, small states are not the exception; they are the norm.

Second, this paper argues that what matter critically for aggregate economic performance are (a) not just trade but exports; and (b) not just technological progress but complexity in output. This paper contends that, on both analytical and empirical grounds, the conclusions in Hausmann (2023) are overly strong. Instead, taking into account why poor nations are cheap

[1] The analysis in this paper is of "aggregate economic performance", in the understanding that that is actually what many observers have in mind when they speak of economic growth. For policymakers, growth rates—the first-differences of log incomes, typically analyzed in regressions—are meaningful not for their actual absolute value but for the endpoint to which they draw the economy.

suggests that it is a price effect that crucially underpins the acceptability and thus the growth impact of changes in and interactions between trade and techology. Such price effect can have multiple drivers, not just exports and not just complexity.

The line of attack developed in this paper begins from seeking the potential population responses to changing patterns of trade and technology. Standard understanding is that trade is good for all; so too productivity-enhancing advances in technology. In that conventional approach, the analysis can proceed directly to structural mechanism. In this paper's approach, however, political consensus from the nation's population matters. Hence, while popular endorsement might indeed be what aggregate welfare-enhancement predicts, this paper adopts a different framework. It assumes that what a population responds to is not official accounts of aggregate quantity changes—more goods available ever more readily—but instead that population's lived experience, i.e., the impact on prices of what different segments of the population buy and sell.

Thus, this paper develops a simple analysis of wage-price dynamic responses to trade and technology. It uses the mechanism underlying the cheapness of poor nations to explore the domestic political acceptability of technological advances and of national engagement with the global economy. This last is not just a matter of export-import statistics but relates to the geopolitical framing of cross-nation interaction.[2]

The remainder of this paper is organized as follows. Section 2 explains how poor nations being cheap matters for trade and technology's impact on aggregate economic performance. Section 3 analyses the cross-section distribution of per capita GDP to assess the empirical validity of the preceding analysis. The key finding of this section is the surprising economic success of small states. Section 4 concludes.

2 Poor Cheap Countries in the Global Economy

A touchstone guide for nations operating in the global economy for the past four decades has been the Washington Consensus.[3] While its author

[2] Armstrong and Quah (2023) and Quah (2024a) analyse this interaction between geopolitical and economic considerations.

[3] See Rodrik (2006); Spence (2021); Williamson (2002). Quah (2024b) develops further the relation between the trade and technology themes in this current paper, small state

reported "there are people who cannot utter the term without foaming at the mouth" (Williamson, 2002), the Washington Consensus can be uncontroversially viewed to provide three broad groupings of guiding principles: first, property rights, privatisation, and liberalisation; second, monetary and fiscal policy; and third, trade and foreign investment.

Spence (2021) compared the Washington Consensus with aggregate economic success both in Asia and across the world more generally, and concluded that two priorities are key: knowledge transfer and engagement with the global economy. He suggested that these are not dramatically at odds with the principal ideas in the Washington Consensus. High incomes come from high productivity and advanced technology: the fastest, most efficient way to advance techology levels in an economy is through knowledge transfer with the rest of the world. And, all economies, especially poorer emerging ones, are dwarfed in trade and investment opportunities compared to the global economy.

However, the Washington Consensus as typically understood is also associated with the Latin American growth experience and with traditional growth theory. Here, disagreement appears more readily.

On this last point, two key assertions in Hausmann (2023) are important to highlight. First is that the Washington Consensus doesn't work: Latin American countries that followed Washington Consensus policy recommendations have not been as successful as Asian ones that did not. Second is that traditional growth models also don't work: Demographic-transition explanatory variables—life expectancy, fertility, employment per capita, and female labour force participation—and neoclassical growth factors—workers per capita, capital per worker, education, and urbanization—have all converged across nations. However, per capita incomes remain widely dispersed in the cross section of nations.

Why, if countries have grown so similar in essential economic characteristics, are some nations still so much richer and others so much poorer? The leading explanation for this failure to converge economically is that countries have differential levels of technology: rich countries have more advanced technologies than do poor nations.

Sharper insight is available drawing on the widely-noted observation that poor countries are cheap.[4] The informal understanding on this is that

success, and the Washington Consensus.

[4]This is also known as the Balassa-Samuelson effect after the economists who early on

poor countries use older technology that is cheap. The cheapness of poor economies therefore must confirm the hypothesis that economies are poor because they use less advanced technology.

But experience in less advanced economies suggests that that informal understanding is far from obviously correct. As just one example, recall that in the early 2000s, many poor countries did not have widely available high-speed, broadband WiFi Internet service. Instead, users there had to get by with relatively costly, slow wired Internet cafes. Those last were far from state of the art. In this situation, less advanced technology did not make Internet use cheap. Instead, the opposite: Users in poor countries had to make do with costlier Internet use, not cheaper.

As a second example, consider farming. Traditional agricultural methods that reduce technological input and raise labour intensity are of course appropriate for nations with plentiful cheap labour. But if this makes agricultural output cheap in poor countries, it is because workers there are paid low wages, not because agriculture uses less advanced technology. To see this, note that as wages rise, staying with low-technology agriculture quickly results in unreliable and expensive agricultural output. It is not less advanced technology that makes a poor country cheap. Instead, it is low wages.

While the most obvious explanations don't work, as an empirical regularity, poor countries are indeed cheap. Hausmann (2023, Fig. 1) documents this, as do others, using PPP Purchasing Power Parity adjustment factors. But unless one knows what convention is being used for numerator and denominator in the definition of a PPP adjustment factor, it will be unclear how exactly a downward-sloping line in Hausman's Fig. 1 shows what it intends. (Does a high adjustment factor mean the country is poor? Or expensive? What is the direction of the adjustment?) Since "poor countries are cheap" will be central to the reasoning that follows, it is helpful to be clear how exactly the empirical regularity is understood.

Define the real price of the economy R as the ratio of the number of local currency units (LCUs) needed to purchase what 1 international dollar can buy, divided by the market exchange rate (in LCUs per international dollar). This measure is dimensionless. It is low—the economy is cheap—when fewer LCUs are needed to buy a required amount than market exchange

proposed explanations for it.

rates.[5]

This reasoning explains why the empirical analysis in this paper uses incomes measured at market exchange rates, rather than correcting for a poor economy's cheapness (i.e., using incomes PPP-corrected). Doing the latter makes a poor economy seem larger and more significant in the global economy. While correcting for purchasing power is appropriate for understanding the well-being of a nation's people, it is inappropriate for assessing that nation's international standing and its role in the global economy: jet fighters and Apple iPhones are purchased not with PPP-corrected dollars but with dollars bought at market exchange rates.

In the empirical analysis to follow I present snapshots at the beginning and the end of the available timesample, where beginning means taking the timeseries average over the decade 1980-1989 and end means the timeseries average over the decade since 2013.

Fig. 1 graphs on the vertical axis the real price of the economy R against per capita GDP on the horizontal axis. Each panel shows the OLS straight line and a nonparametrically-fitted trend line, together with 95% confidence interval. The World Bank's international dollar is close to but not identical with the US dollar, so the US appears near but not on the value 1 on the vertical axis.

On average poor countries are indeed cheap: in both panels the best-fitting lines slope upwards.[6] However, there is considerable variation in datapoints around the positively-sloped lines. Where the bulk of the cross-section distribution rests, the loess line is firmly positive with confidence interval tightly around the estimate. It is striking, however, in that mid-range there are significant outliers both upwards and downwards. Singapore, for one, has been consistently cheap relative to what its high per capita GDP would predict; in the cross-section Singapore is balanced by others more expensive: Switzerland, Norway, Iceland, and Denmark.

[5]The variable R is available as `PA.NUS.PPPC.RF` from the World Bank's World Developments Indicators database.

[6]The nonparametric loess line begins to turn around for the very richest countries but that negative slope is not significant and is pretty much due to just Luxembourg, the richest nation in the sample. Note that the 95% confidence interval around the loess line does not have to include within it 95% of the datapoints. The confidence interval denotes how precise the sample estimate is, not sample coverage. The empirical evidence presented in this paper will all take this same format, so the Figures below will not repeat the details as here.

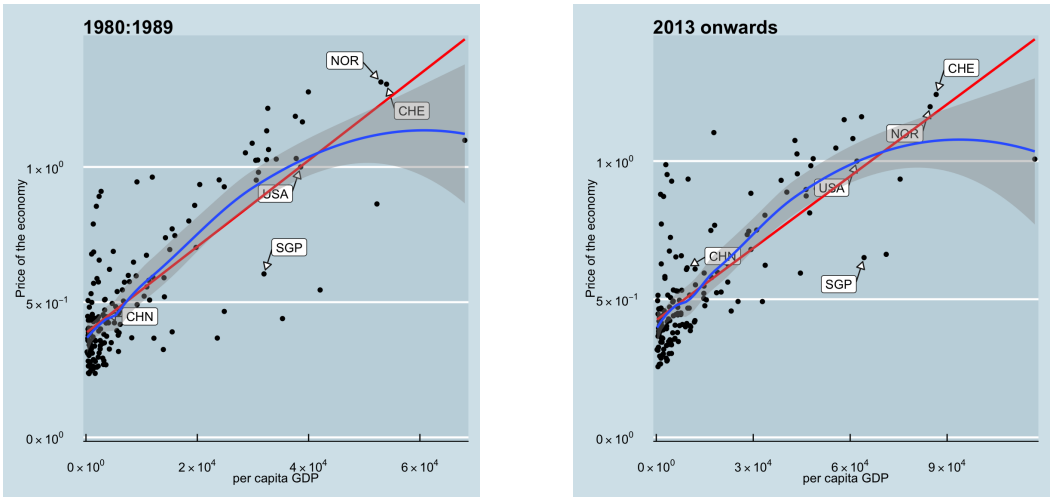

Figure 1: Poor countries are cheap. The left panel shows the 1980s; the right, since 2013. The vertical axis is the real price of the economy, or R in the discussion in the text; it is the reciprocal of cheapness. The horizontal axis is per capita GDP. The datapoints are all the national economies in the World Bank's World Development Indicators database. Each graph displays OLS and nonparametric loess (locally estimated scatterplot smoothed) lines, the latter together with its 95% confidence interval. The panels also explicitly indicate Switzerland, Norway, Singapore, the US, and China—useful to calibrate the reader's intuition on what the figures show, and to which the analysis will return subsequently. All regions, countries, and territories are named according to their ISO 3166-1 alpha-3 designation.

Next, to see how the cheapness of poor nations bears on technology and economic success, consider the simplest possible relationship between wages w, prices p, and productivity θ:

$$w = \mathrm{p} \times \theta. \tag{1}$$

Interpreting θ as the physical marginal product of labour, this equation just says that businesses pay a wage rate equal to labour's value marginal product. Since technological advance makes labour more productive, equation (1) adopts the shortcut of referring to technology and labour's marginal product interchangeably.

To understand the situation previously described, where less advanced technology makes an economy more expensive, consider when wage w is sticky or pre-determined (or causally prior, in the language of Quah (2024b)). Then equation (1) predicts exactly that downgraded technology drives up price. In such a situation, the opposite, technological advance lowers price and makes the economy cheaper.

In contrast, if price p is sticky or pre-determined, the equation implies that technological advance raises wages.

Putting these two scenarios together, suppose that the economy has both a tradeables and a nontradeables sector, and that a version of equation (1) applies to each. In the tradeables sector, output price p is pre-determined by global competition; in the nontradeables sector, wage w is pre-determined by competition for labour with the tradeables sector. Then technological advance in the nontradeables sector lowers price, i.e., technical progress in nontradeables hurts businesses in the economy. On the other hand, if technology in the tradeables sector is less advanced, then wages are lower, with competition then driving down nontradeables price.

Thus, businesses want technology to improve in tradeables but not in nontradeables itself, as, paradoxically, technical progress in nontradeables hurts businesses in that sector. Paradoxically, businesses in the nontradeables sector are against technical progress in their own sector. Technological advance in nontradeables lowers price and damages profitability, thus increasing the risk of layoffs and unemployment.

If there is to be trade, businesses want that to occur only for the sectors with advanced technology. In contrast, trade that comes to sectors with less advanced technology lowers wages, hurts workers throughout the economy, and lowers price and profitability in nontradeables. The same ripple effects

emerge again for businesses and workers if trade is with a more productive foreign economy as that too ends up lowering the price of tradeables.[7]

In summary, understanding why poor economies are cheap, and examining price effects, gives insight on why trade and technology are not unambiguously accepted by the population in a given economy.

The analysis in this paper is silent on how technology improves. Hausmann (2023) proposes that it is through the economy making more complex products. Other researchers say that progress comes from domestic R&D. Yet others will point to how both these channels are slow compared to knowledge transfer from the global economy. As long as some engineering accelerates tradables technology improvement, it does not matter what form exactly that engineering takes.

A natural interpretation of why an economy prefers the price of tradeables to rise is that it allows domestic producers to sell at higher prices. Going outside the model that is used here, selling to larger markets allows leveraging scale economies in production. This is the reasoning that underlies the emphasis on export-led growth in Hausmann (2023). However, in the analysis of the current paper, it is not the volume of exports that is critical, but instead price in the tradeables sector that drives incomes and wages. It is natural that exports raise the price of tradeables and that imports do the reverse. But other factors might increase or decrease the relevant price, and policymakers need to be mindful of these more general circumstances. High prices in the tradeables sector might emerge because of, say, government support for domestic industry. If such support does not drain government resources, then that elevated price serves exactly the same function for economic growth as would an increase in exports. In this regard, the emphasis on trade in the Washington Consensus does not have to be replaced entirely by an emphasis on exports. Indeed, overly emphasising exports for growth can easily veer into mercantilism.

Policymakers have a range of options for trade and technology that will raise economic performance, increase growth, and also be politically acceptable. What does not work, however, is to simply boost technology or seek greater trade openness, without working through their impact on wages and prices.

[7] In the language of Great Power rivalry this is what happened with "The China Shock" (Quah, 2024a). While the economy can always then choose to disrupt trade, the sensible way to combat this deterioration is to improve technology in the tradeables sector.

3 The Global Distribution of Economic Success

This section quantifies the significance of trade and technology in the cross-section distribution of aggregate economic performance across nations. This is to help assess the export and complexity channels for economic growth proposed in Hausmann (2023). The key finding, however, will be that small nations are surprisingly successful economically. This casts doubt on the idea that complexity and scale are the critical drivers for aggregate economic performance. More directly, this section will also document how the effects of technological improvement are not monotone, Thus, the section will show that complexity correlates importantly with advanced technology on average, but less so among the most extreme of national economic successes.

To anticipate some of the key results to follow and so as not to present redundant information, the analysis here is in per capita terms—as it had been earlier in Fig. 1, except when obviously it doesn't make sense (e.g., for the real price of economies R and Hausmann's Economic Complexity Index). Because business cycle fluctuations will distort underlying, longer-run features of the data, I take 10-year averages and present results for just the beginning (1980-1989) and end (2013-2022) of the data sample. All data are from the World Bank's World Development Indicator's database or Ricardo Hausmann and Cesar Hidalgo's *Atlas of Economic Complexity* website.

First, consider the distinction between trade in general and exports in particular. Do exports need to be highlighted as the engine of growth and prosperity? Or will total trade—the sum of exports and imports—in general suffice?

Fig. 2 shows how tightly these two variables are related in the cross section of nations, once business cycle variations have been removed. Over the longer-term, total trade just equals twice exports. The slope of the OLS line equals exactly that ratio with deviations from the line too small to be visible to the human eye.

The lesson from this is that it will be not possible to tell if it is exports that drive growth, as suggested in Hausmann (2023), or whether it is more generally trade that does so. But then, given how these variables covary across nations, it might not be meaningful in any case to seek that distinction.

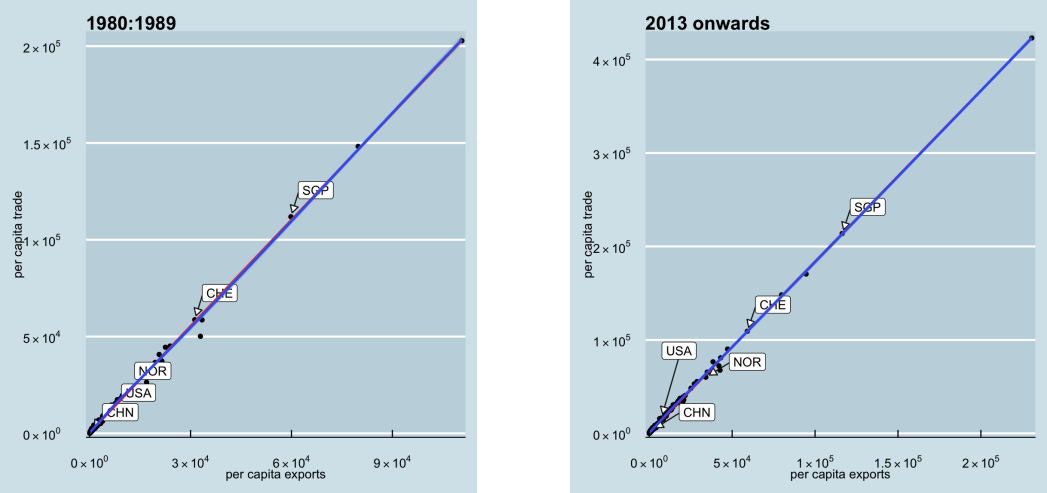

Figure 2: Modulo a proportionality constant, trade and exports are indistinguishable.

Next, consider the hypothesis that engagement with the global economy encourages technological advance and thus increases growth and raises economic performance more generally.

Fig. 3 shows that for both beginning and end of the datasample, income and trade are indeed strongly positively related. Economies are richer, the greater their openness. This positive relationship has a relatively narrow confidence interval around it. At the same time, however, the data show significant outliers. Singapore is one. Conditional on its trade patterns, Singapore's per capita GDP is unexpectedly low. Two other outliers, but now in the opposite direction, are Norway and the US: these two nations are unexpectedly rich given the amount of trade they do.

One of the most interesting features of Fig. 3 is how China's position in the Figure is strikingly unremarkable. For all the attention China attracts in its being nearly every other nation's leading trading partner, in reality, China undertakes relatively little trade per person. Many other nations do much more. Singapore, for one, does about fifty times the trade that China does, per capita. In the world, China's trade is notable primarily because its population is so large. In terms of trade per capita, China is unremarkable.

This empirical regularity on trade and size is sometimes dismissed with the suggestion that arithmetic alone mechanically and misleadingly makes

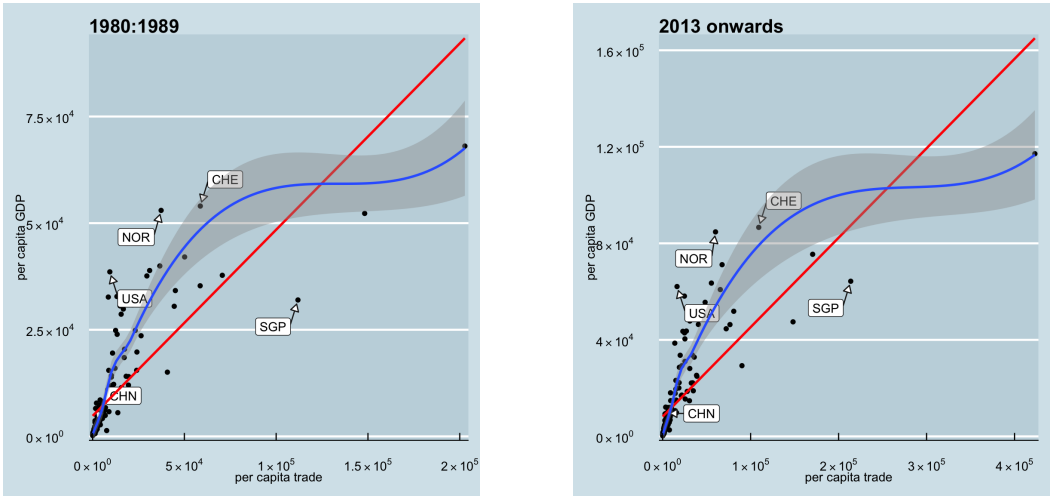

Figure 3: Incomes and trade are positively related. The vertical axis is per capita GDP; the horizontal axis, per capita total trade. The positive relationship has a relatively narrow 95% confidence interval, but with significant outliers. Singapore, conditional on how much it trades, has relatively low per capita income. Norway and the US, on the other hand, deviate in the opposite direction. Relative to how much they trade, those two nations are unexpectedly rich. Finally, given its very large population, China's pattern of trade and income is unremarkable.

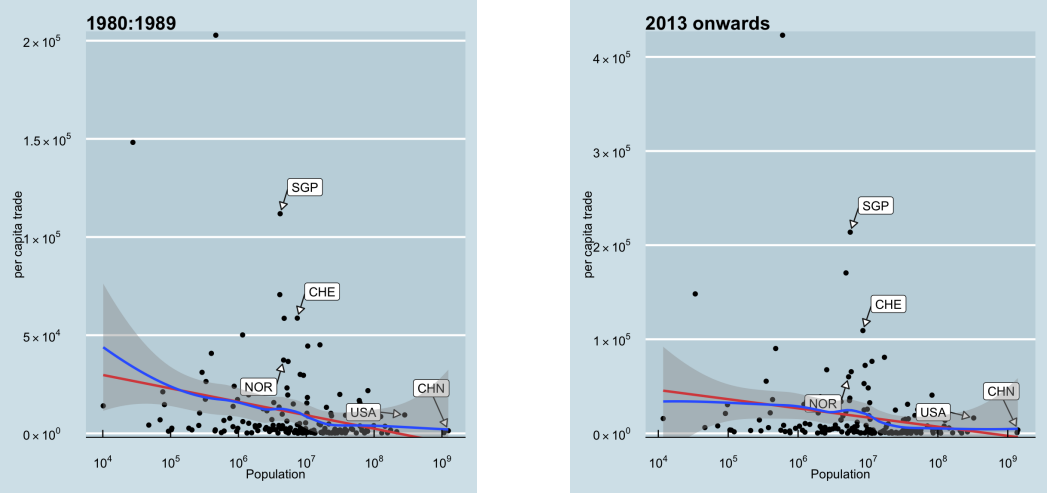

Figure 4: On average, per capita, small states do not trade significantly more than large economies. The vertical axis is trade per capita; the horizontal axis is population, measured on a log (base 10) scale. The most striking feature is how nations, like Singapore and Switzerland, consistently trade orders of magnitude more than world average.

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small states appear to trade more. However, Fig. 4 shows that that is not the reality. Many small states do as little trade per capita as do large nations. Some big states trade hardly at all; others, considerably more. Nations exercise considerable agency in how much they choose to trade. On average the relationship between trade and size is negative, but only slightly so. Instead, the most outstanding empirical feature in Fig. 4 is how the successful nations, such as Singapore and Switzerland, consistently trade orders of magnitude more than world average. It is not that small nations trade a lot. Instead, it is that successful nations who trade a lot happen to be small.

That last point needs to be clarified. Fig. 5 graphs the relationship between per capita income and population. The Figure shows small states succeed at economics.

Over 2013-2022, of the nine richest nations on Earth, only the US had population greater than 10mn. With a population over 300mn, the US was obviously an outlier. Singapore's population, by contrast, was only 5.6mn. Even more remarkably, the average population of the nine richest states, excluding the US outlier, only came to 4.2mn. The largest of these

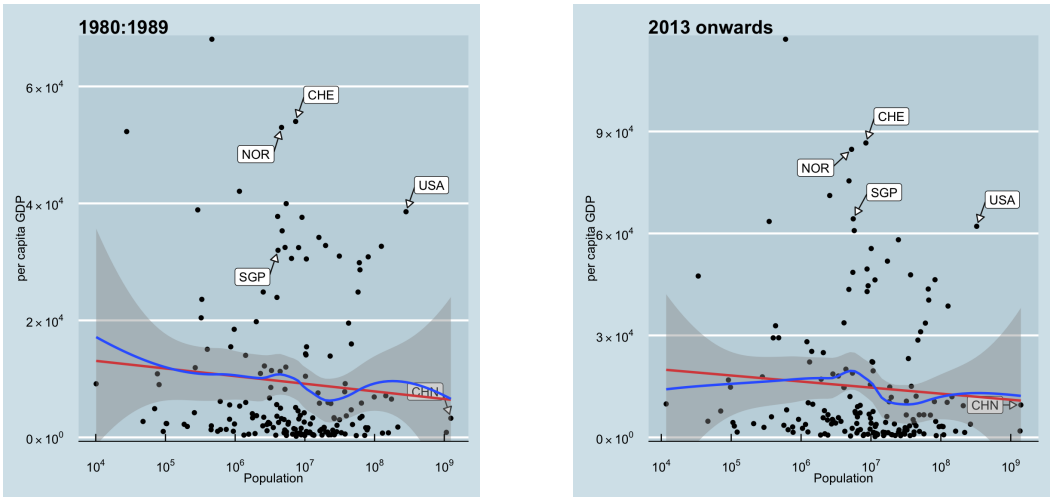

Figure 5: Small states are the richest nations on the planet. Since 2013, of the nine richest nations only the US had a large population, exceeding 300mn. Singapore's population then was 5.6mn. But, more striking, the average population of the nine richest states, excluding the US, was only 4.2mn, with the largest, Switzerland, having population just 8.5mn. Obviously, many small nations are poor. Successful nations happen to be small; but not all small states succeed.

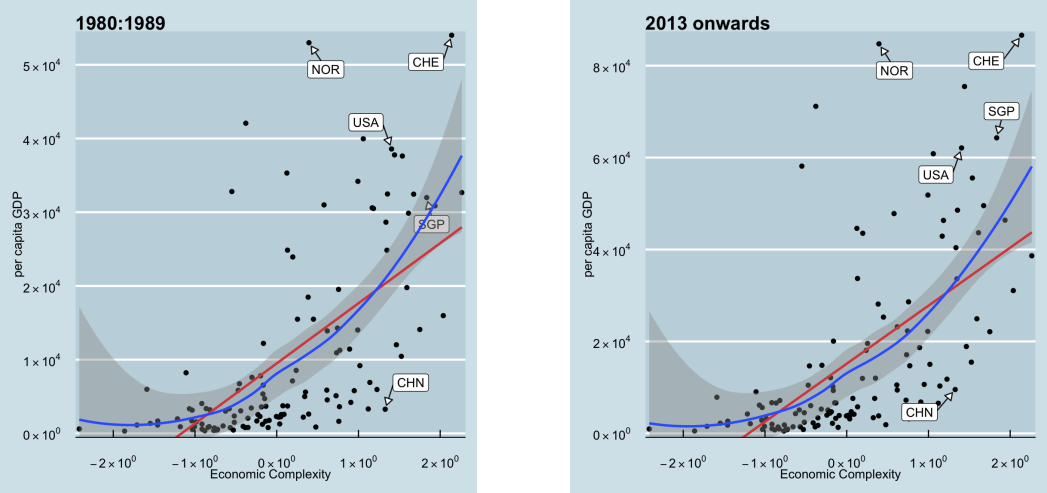

Figure 6: Incomes and high-complexity production are strongly positively related; at the same time, however, complexity cannot account for the performance of the small-state, successful economies. The Figure graphs per capita GDP on the vertical axis and the Hausmann-Hidalgo index of production complexity on the horizontal axis.

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eight, Switzerland, had population only 8.5mn. To be clear, Fig. 5 is not a statement that small states always succeed. The Figure shows many small nations are poor. Instead, the lesson in Fig. 5 is that successful nations are small, not that small states succeed.

Finally, and most critical for the analysis in Hausmann (2023), we turn to complexity and economic performance. Does complexity account for the the greatest economic successes? Is complexity the best, fastest way to improve the level of technology in the price-prior T sector and to maintain it at a high level? Is complexity the best way to raise the price-prior p_T and thus allow incomes, wages, and prices to rise without mass opposition?

Fig. 6 shows the relation between incomes and complexity is strongly positive. However, the most successful economies are distinct upwards outliers relative to that relationship. By contrast, those nations that do not outperform the positive relationship are many and hew close to the OLS and loess lines. Complexity accounts well for average economic performance, but not for successes.

This pattern of outliers is predicted from the earlier finding that small states are surprisingly successful. By logic, small states do not have the size

to have the wide diversity of skills and insights that create complex products. When they succeed, therefore, they escape in an upwards direction the predicted average relation between incomes and complexity. This reasoning helps explain Fig. 6. It leaves open, however, the reasons underlying the success of those small states that do succeed.

Small states will, naturally, tend to make too much of what its people can, and too little of what its people want. It is trade—both exports and imports together—that overcomes these bottlenecks. Both the empirical evidence of this Section and the theoretical reasoning of the previous Section 2 support the relevance of this mechanism.

4 Conclusion

This paper has developed a simple analysis of the effects of trade and technology on aggregate economic performance, with a focus on why mass opposition might emerge in opposition to those different effects. The mechanism is through wage-price dynamics in a global economy where poor nations are cheap.

The paper drew extensively on Hausmann (2023), but departed from that work in two important conclusions: (1) what matters is trade generally, not exports in particular; (2) what matters is technological progress generally, not complexity in particular. It is important, however, that those sectors where technological advancement occurs and trade impacts are ones with particular wage-price patterns. Empirically, for average nations, technological advancement through complexity matters; for extreme successes, it is trade that matters.

The paper's key empirical findings, however, concern the economic performance of small states. An economy that is small, all else equal, will tend to produce too much of what its people can and too little of what its people want. Small states cannot match the scale, variety, or complexity on which bigger economies can draw. They face significant obstacles for growth and economic success. Yet, small states are the most successful economies on the planet.

Small nations, provided they remain open to the global economy, can draw importantly on different channels of knowledge transfer. Advanced technology levels are indeed critical for prosperity and aggregate economic

performance—but they can come through multiple pathways, not only homegrown research and domestic-economy complexity. Thus, trade helps small states overcome their natural bottlenecks.

Trade with the global economy is essential for small states whereas larger nations can afford autarky. Thus, although a more elaborate analysis is not given in the current paper, a simple conjecture is natural on the role small states can play in the international system. All else equal, small states have the most to gain from an open global trading system. It follows that it is they who will show greatest commitment to such an international order (Quah, 2024a).

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