Measuring subnational trade competitiveness

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Abstract

Much research has tried to measure the competitiveness of territorial units such as countries and subnational regions. We propose new measures of subnational trade competitiveness that reflect the economic focus of regions on their country’s comparative advantage. Our approach starts with data on the revealed comparative advantage of countries at the industry level. We then combine these measures with data on the employment structure of regions to arrive at measures of subnational trade competitiveness. In total, we offer data for 1,212 regions across 62 countries and over a time period of 21 years. In this paper, we introduce our measures and provide descriptive evidence that shows the plausibility of these measures. We also discuss some of the many research questions that these data can be used to address.

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1 Introduction

Ever since Michael Porter published a highly influential study on *The Competitive Advantage of Nations* in 1990 (Porter 1990), much research has analyzed the competitiveness of territorial units. This has led to various rankings of the competitiveness of countries (e.g. Schwab 2019), regions (Annoni and Dijkstra 2019; Huggins et al. 2014), and even cities (Huggins, Thompson, and Prokop 2019). Over time, criticisms of the original efforts (most prominently by Krugman 1994) have led to various improvements in the conceptualization of territorial competitiveness (Berger and Bristow 2009; Birnie et al. 2019; Budd and Hirmis 2004).

We contribute to this large literature by proposing new measures of what we call subnational trade competitiveness. Our measures capture the extent to which a region’s economic structure is aligned with the comparative advantage of the country to which it belongs. The

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resulting data on regions' trade competitiveness is of interest for many research areas across various disciplines. Illustratively, it allows for research on questions as diverse as: does trade integration (for example via trade agreements) affect regions differently depending on their trade competitiveness? Which policies increase or decrease a region's trade competitiveness? To what extent do individuals take into account the economic consequences of trade (which will depend on the trade competitiveness of the region in which they live) when forming their attitudes towards globalization? Does trade competitiveness attract foreign direct investments? Do trade shocks (for example, a sudden surge in imports, which likely affects different regions differently) have an impact on elections? Do legislators consider the economic interests of their electoral districts when casting votes? Does trade competitiveness increase a region's economic growth rate?

The first step in our approach at measuring trade competitiveness is to calculate four different measures of revealed comparative advantage by industry at the national level using disaggregated trade data. In a second step, we then combine these national-level measures with employment data in subnational regions to arrive at measures of subnational trade competitiveness. In total, we present data for 1212 regions in 62 countries and all continents over a 21 year period. We offer each of the four measures at two different aggregation levels, once at the overall and once at the sector level. In terms of sectors, we distinguish between agriculture, mining, manufacturing, and services.

Our approach differs from existing attempts at measuring the competitiveness of territorial units in several important ways. For one, we calculate (trade) competitiveness without recourse to potential drivers of competitiveness. Basically all existing research measures territorial competitiveness relying on input factors such as the number of people with tertiary education or the presence of certain infrastructure. Instead, we try to directly capture the ability of firms from a subnational region to sell on world markets and to compete with imports. Doing so allows for an analysis of the extent to which different factors contribute to a region's trade competitiveness, which would be tautological when the drivers are part of the measure itself. In turn, since our measures heavily rely on trade data, we measure *trade* competitiveness rather than some overall economic competitiveness. Clearly, not all parts of an economy are exposed to international trade, even if indirectly trade matters for a larger part of the economy. Finally, we

also measure trade competitiveness without concern for a region's wealth or income per capita. By definition, all countries – and not only highly developed countries – have a comparative advantage. As a result, in both more or less developed countries, regions can have an economic structure that is aligned with their country's comparative advantage. If trade competitiveness just captured income per capita, there would be no need for such a measure in the first place, as it would just duplicate measures such as Gross National Income.

We focus on trade competitiveness at the subnational level because a measure for the trade competitiveness of a country likely hides much variation across subnational entities. In the United States, for example, the economic structure of California is substantially different from the economic structure of Louisiana, meaning that the two also likely score differently with respect to trade competitiveness. These differences across subnational regions tend to be even more pronounced in emerging economies. What is more, for individuals the trade competitiveness of the region in which they live may be more important than the one of the country as a whole, as it may better reflect their economic reality. For example, a person living in a region with a high value on trade competitiveness may experience globalization very differently from one living in the same country but in a region with low trade competitiveness. This is illustrated by the fact that support for Brexit in the United Kingdom strongly varied across regions ([Carreras, Irepoglu Carreras, and Bowler 2019](#)).

Our study speaks to several strands of literature. Most directly, the paper is relevant for a large literature on territorial and especially regional competitiveness ([Marsh and Tokarick 1996](#); [Huggins et al. 2014](#); [Kitson, Martin, and Tyler 2004](#)). We add new measures of trade competitiveness to this strand of research that complement alternative approaches at measuring regional competitiveness. Moreover, trade competitiveness is key for understanding the political economy of trade ([Baldwin 1996](#)). For example, subnational trade competitiveness may be an explanatory factor in models explaining trade policy attitudes of individuals ([Scheve and Slaughter 2001](#)). Furthermore, for the large literature on the economic and political effects of globalization subnational trade competitiveness can serve as predictor, mediator, or dependent variable. For example, to which extent Greece's entry into the Euro zone affected its economic competitiveness is a pertinent question ([Zemanek 2010](#)). Our measures may show that the effects of the Euro on competitiveness differs across regions.

In the following, we first conceptualise and define the concept of subnational trade competitiveness. Next, we discuss how we measure subnational trade competitiveness by combining four measures of revealed comparative advantage with region-level employment data. In a final part, we provide descriptive evidence, including short case studies of regions in South Korea and Bolivia, that shows the plausibility of the resulting measures of subnational trade competitiveness.

2 Measuring subnational trade competitiveness

2.1 Conceptualizing subnational trade competitiveness

Firm competitiveness refers to firms' ability to sell their goods and services on markets. That is, to be competitive, firms need to produce goods and services that meet consumer demand in the markets they target. Whether a firm is economically competitive matters strongly for its chances of survival in the market. If it is not competitive, it either goes bankrupt or requires government support to survive, for example in the form of subsidies or trade barriers that protect it from more competitive suppliers.

Transferring this logic to territorial units is not straightforward ([Krugman 1996](#); [Aiginger 2006](#)). Most fundamentally, territorial entities do not sell any goods or services on the market; only firms do. Moreover, the survival of a country or any other territorial entity does not depend on its ability to compete on markets. And whereas a firm generally needs to make a surplus, any definition that equates territorial competitiveness with the ability to achieve a balance of trade surplus is correctly criticized as mercantilist.

Building on an intense debate over these issue (e.g. [Krugman 1996](#); [Budd and Hirmis 2004](#); [Berger 2008](#)), we thus conceive of subnational trade competitiveness as the extent to which a subnational region's economic structure is aligned with the comparative advantage of the country to which it belongs. By definition, each country has a comparative advantage in the production of some goods or the provision of some services. Comparative advantage results from differences in the opportunity costs of producing specific commodities across countries, which in turn are largely driven by different factor endowments. Countries that are capital-abundant generally have a comparative advantage in the production of capital-intensive goods and ser-

vices; countries that are labour-abundant have a comparative advantage in the production of labour-intensive goods and services.

Rather than assuming countries' comparative advantage, we use trade data to establish their *revealed* comparative advantage. As doing so is not straightforward, we employ four different approaches at measuring revealed comparative advantage. We then establish to which extent a region's economy produces goods and services for which the country has a comparative advantage. Production generally is not equally distributed across a country because regions differ in natural advantages, infrastructure, and policies. Larger values on the resulting measure of subnational trade competitiveness mean that a region's economic structure is more aligned with the country's revealed comparative advantage; lower values that the region's economy is less well aligned with the country's revealed comparative advantage. What the values thus capture is the ability of a region's firms to exports the goods and services they produce on world markets relative to the ability of firms from other regions in the same country. Moreover, two of the four approaches that we introduce below also capture the ability of a region's firms to withstand international competition in domestic markets relative to firms in other regions.

The values that we get for these measures cannot be easily compared across countries. In some countries, we see much more variation across regions in terms of economic structure. This means that the values for the most trade competitive regions are higher and the values for the least trade competitive region are lower than in more homogenous countries. Nevertheless, the trade competitiveness values can be compared across regions within countries and for the same region over time. These kinds of variation are relevant for many important debates. In fact, subnational trade competitiveness as conceptualized here should both reflect and affect economic and political decisions. For example, foreign firms may be more likely to invest in regions with high values on trade competitiveness. Moreover, politicians and voters in these regions may be more supportive of free trade and globalization than in other parts of the country. In turn, shocks that lead to a decline in a region's trade competitiveness may lead to a decline in the public support that politicians in that entity enjoy. The often cited 'China shock' ([Autor, Dorn, and Hanson 2016](#)) is one prominent example of such shocks. There is no doubt, hence, that subnational trade competitiveness conceived of as a region's alignment with the country's overall comparative advantage is an important social science concept.

Figure 1: Calculation of subnational trade competitiveness

In the following, we discuss how we calculate our measures of subnational trade competitiveness. We do so in two steps: first, we calculate countries' revealed comparative advantage for specific industries; and then we weigh the resulting values at the industry-country level with region-level employment data to arrive at the values for subnational trade competitiveness. Figure 1 provides an illustration of our approach.

This approach rests on the key assumption that if there is a firm from a specific industry located in a specific region, its revealed comparative advantage is the same as that of another firm in the same industry in another region of the same country. This assumption is plausible because trade barriers are largely absent within countries, meaning that more competitive firms should displace less competitive firms in the same country. Of course, our assumption does not mean that there are not more and less competitive regions in a country; it just means that if there are factors that make an industry in a specific region of a country more competitive than in other regions (e.g. because of access to cheaper labour, infrastructure, or natural resources), this industry should concentrate in that region.

2.2 Measuring a country’s (revealed) comparative advantage

Establishing the industry-level comparative advantage of a large number of countries over time is no easy feat. Illustratively, there are simply no data available on the costs of production of different goods (and the provision of different services) for many countries at different times. As a result, [Balassa \(1965\)](#) proposed to use trade data to measure a country’s “revealed comparative advantage” (RCA). Countries’ trade data have the advantage that they are widely available and are harmonized in terms of product classifications. Concretely, Balassa suggested standardizing the share of a specific good in total exports of a country by the given product’s share in world exports. In form of an equation:

$$RCA_{cpt} = \frac{\frac{X_{cpt}}{X_{ct}}}{\frac{X_{rpt}}{X_{rt}}}, \quad (1)$$

where X refers to exports, c to the country, p to the product, t to the year, and r to the reference countries (e.g. the rest of the world minus country c , which we use in this study). Values of RCA_{cpt} above 1 indicate that a country has a comparative advantage in a given product, whereas values below 1 indicate that a country has a comparative disadvantage. This is a measure of *revealed* comparative advantage, as it takes actual trade data (which may be affected by government policies such as tariffs or subsidies) to infer comparative advantage.

Since the publication of Balassa’s paper, many authors have suggested alternative ways of calculating revealed comparative advantage (for an overview, see [Liu and Gao 2019](#)). Among the many measures that have been proposed in this debate, we choose four, all of which have the advantage that they have explicit upper and lower bounds. In fact, all four measures below have a theoretical range from -1 (greatest comparative disadvantage) to +1 (greatest comparative advantage), with a value of 0 indicating that a country has neither a comparative advantage nor a comparative disadvantage in producing a certain good or service. The other measures that have been proposed are either very similar to at least one of the measures considered here or have been shown to have serious problems.

The first RCA measure that we use is a transformation of Balassa’s original measure with the aim of making it symmetric around the neutral state of 0. Concretely, [Laursen \(2015\)](#) proposed the following symmetric RCA (*RCA (symmetric)*):

$$RCA (symmetric)_{cpt} = \frac{RCA_{cpt} - 1}{RCA_{cpt} + 1}, \quad (2)$$

where the letters have the same meaning as in equation 1 above. While the fact that this measure is symmetric around 0 is a nice property of $RCA (symmetric)$, many of the criticisms raised against Balassa's original RCA also apply to this variant. In particular, this measure generally assigns higher than expected values for countries and products that only account for a small share of world exports.

The second RCA measure that we rely on is an additive version of Balassa's original measure that was proposed by [Hoen and Oosterhaven \(2006\)](#). This additive RCA ($RCA (additive)$) is calculated as follows:

$$RCA (additive)_{cpt} = \frac{X_{cpt}}{X_{ct}} - \frac{X_{rpt}}{X_{rt}}, \quad (3)$$

again with the same notation as used before. According to [Hoen and Oosterhaven \(2006\)](#), this RCA measure has the advantage that it has a more stable distribution than the original RCA. Moreover, they criticize the original measure for having a mean above 1, although 1 should indicate the neutral point on the Balassa index. Just as $RCA (symmetric)$, $RCA (additive)$ is symmetric around the neutral value of 0. A weakness of this measure, however, is that it is biased against products that only account for a small share of exports. Larger sectors receive larger values, everything else equal. This makes this measure sensitive to the level of aggregation at which it is calculated.

Because a country's comparative advantage should be visible in both exports and imports, we also consider two RCA measures that take imports into account. Concretely, our third measure is a slight adaptation of an approach originally suggested by [Vollrath \(1991\)](#). Vollrath proposed subtracting a measure equivalent to the original RCA but calculated for imports (so simply substituting imports for exports in equation 1) from the original RCA. We adapt this approach by first applying the RCA transformation suggested by [Laursen \(2015\)](#) and shown in equation 2. In form of an equation, the resulting $RCA (net)$ is calculated as:

$$RCA (net)_{cpt} = \left(\frac{RXA_{cpt} - 1}{RXA_{cpt} + 1} - \frac{RMA_{cpt} - 1}{RMA_{cpt} + 1} \right) / 2, \quad (4)$$

where RXA refers to the RCA calculated in equation 1 and RMA to the equivalent measure calculated for imports. We divide this measure by 2 to give it the same theoretical range as the other three measures have. While taking into account imports can be seen as a strength of this measure, it is at the same time also a weakness. A country may appear to have a comparative advantage for a product only because it imposes high trade barriers that strongly limit imports.

Finally, [UNIDO \(1982: 23\)](#) proposed to use trade balance (which is the difference between domestic production and consumption) as a share of total trade as a measure of a country's RCA. This RCA (*trade balance*) is calculated as follows:

$$RCA (tradebalance)_{cpt} = \frac{X_{cpt} - M_{cpt}}{X_{cpt} + M_{cpt}}, \quad (5)$$

where X are exports and M imports, with the subscripts denoting the same as above. Values larger than 0 and up to 1 on this measure indicate net exports; negative values (with the lowest possible value being -1) net imports. This intuitive interpretation is a key advantage of this measure. Moreover, [Leamer \(1984\)](#) provides a theoretical rationale for its use as a measure of comparative advantage, as trade balance directly reflects the relative factor endowment of a country. Just as RCA (*net*), however, this measure may be strongly affected by trade barriers.

We calculate these four measures relying on data from the United Nation's Comtrade database for trade in goods ([United Nations 2020](#)) and the OECD-WTO's BaTIS database for trade in services ([OECD 2021](#)). The goods trade data are disaggregated at the six digit level of the Harmonised System (HS) in its 2012 version, which contains approximately 5,000 commodity groups. The employment data that we need to calculate subnational trade competitiveness, however, are generally available at the three-digit level of the International Standard Industrial Classification of All Economic Activities (ISIC) maintained by the United Nations ([UNSD 2008](#)). This level of detail is called 'industry groups' in ISIC jargon. Depending on the revision of ISIC (there have been three different revisions in the past decades), ISIC distinguishes between 159 and 238 distinct industry groups (e.g. beverages manufacturing). We use official correspondence tables between ISIC and HS to aggregate the goods trade data to this industry group level before calculating the four measures of revealed comparative advantage. The services trade data contains ten categories. However, we entirely focus on tradeable services, that is financial services, insurance services, and information services, thus reducing this

number to three categories.

All of the four measures aim at capturing the same phenomenon, namely revealed comparative advantage. In fact, the correlation between them for the trade data we use is relatively high, with the partial exception of the RCA (additive). Their high correlation and the distinct strengths and weaknesses of the measures mean that we cannot say that one consistently outperforms the others. Rather, which measure works best likely depends on the question they are used to address.

2.3 Calculating subnational trade competitiveness

To move from the industry-country level data on revealed comparative advantage to a measure of subnational trade competitiveness, we combine them with employment data in subnational regions that allow us to understand where certain industries are located. Concretely, we weight a country's revealed comparative advantage in a specific industry with the number of workers who are employed in this industry in a specific region.

Nearly all countries regularly (quarterly, annually or multi-annually) conduct representative household or labour force surveys that include a question about the main job of the respondent. In countries where these surveys are not available, we used regular census surveys, which are conducted in five- or ten-year intervals and include the same question. As mentioned above, this employment information is generally coded according to the ISIC scheme. In those countries that use their own adaptations of ISIC or have developed unique coding schemes, we use official correspondence tables to transfer this data into an applicable ISIC revision. Additionally, the level of detail varies between surveys: some countries report very specific industries (coded with four or more digits) whilst others only report very broad industry sectors (coded with only two digits). To ensure both comparability and validity, we toss out all surveys that use only two digits and reduce all other data to three digits.¹

We then multiply each workers' survey weight with the revealed comparative advantage data for the industry in which the worker is employed. Finally, we sum up all the products between worker weights and respective RCA values to arrive at our measures of subnational

¹We also exclude regions with fewer than 50 respondents across all tradable sectors because estimates are increasingly unreliable and unstable in smaller samples. In such cases, individual respondents are too influential and changes in competitiveness may simply reflect a marginally different composition of the sample.

trade competitiveness. In summing, we aggregate both to the sector-region level (distinguishing four sectors, namely agriculture, mining, manufacturing, and services) and to the overall region level. In form of an equation:

$$STC_{st} = \sum_{p=1}^N (RCA_{cpt} * ES_{pst}), \quad (6)$$

where STC_{st} is the subnational trade competitiveness value for subnational region s at time t (or a region-sector), p is the industry group, RCA_{cpt} is the value of the specific RCA index (one of equations 2-5) for industry group p in country c at time t , and ES_{pst} is the employment share in the industry group and region in year t .

Given that we have four different ways of calculating RCA (symmetric, additive, net, and trade balance), and that we aggregate these measures to both the region as a whole and the region-sector level (agriculture, manufacturing, mining, and services), we end up with 20 different measures for each region and year. Illustratively, we arrive at values for subnational trade competitiveness based on the symmetric RCA for a region as a whole (STC (*symmetric*)_{OV}) or based on the net RCA for the services sector (STC (*net*)_{SE}). To make their interpretation more intuitive, but without this changing them per se, we subtract the national mean of the respective overall subnational trade competitiveness measure from all measures. Positive values then indicate that a region is more oriented towards the country's comparative advantage than the average region.²

Compared to alternative weights that might be used to aggregate the industry-country RCA data to the subnational level, such as company profits or output, employment data has two crucial advantages. First, the necessary data can be obtained from household and labour force surveys, which are available for a large number of countries in a standardized way. Second, weighting based on employment has conceptual benefits for many applications of this measure in the social sciences that might focus on voting behaviour, political attitudes, or any broader social developments that account for the material situation of people.

Generally, we follow the ISO 3166-2 standard for determining the regions to which we aggregate. In most countries, the ISO 3166-2 standard reflects the first-level administrative

²This means that a dichotomous version of our measures (positive or not) can be compared across countries. The absolute values of the measures, however, are not necessarily comparable across countries. When using the absolute values in cross-national research, we thus strongly recommend using country fixed effects.

divisions of the country. These might be states (e.g. in Brazil, Germany, India, Mexico, and the USA), provinces (e.g. in Argentina, Belgium, Ecuador, and South Africa), or regions (e.g. in Ghana, Namibia, Peru, and Slovakia). However, in some countries, the ISO 3166-2 standard is too detailed for our purposes, which would reduce the number of survey respondents per regions to an unreliably low number. For example, this applies to the counties of Estonia, the departments of France, and the municipalities of the United Kingdom. In these cases, we aggregate to larger statistical regions based on the European Nomenclature of Territorial Units for Statistics (NUTS). Our approach is very flexible in this regard: we could easily calculate the trade competitiveness of larger subdivisions or groupings of regions (such as the nine Census Divisions in the USA instead of the 50 states plus Washington, DC) or that of smaller subdivisions (such as the 107 provinces of Italy instead of its 21 NUTS 2 regions).

The number of regions per country varies from six in Estonia and Rwanda to 81 in the Philippines. The median country has 16 regions. (See Table A1 in the Appendix for more information). In terms of population, the smallest region is Embera Wounaan in Panama with about 12,000 inhabitants, whereas the largest region is Uttar Pradesh in India with nearly 200 million inhabitants. The median region in the sample has about 2 million inhabitants.

We have data for a total of 1,212 regions in 62 countries over a 21 year period (1999-2019). Some of these years have been extra- or interpolated by carrying the employment data backwards and forwards. However, we always use the respective trade data for a year. In other words, even if we impute the distribution of employees in an industry in a year, we use the correct trade data for this year. Figure 2 shows for which country-years we needed to extra- or interpolate data. Our dataset contains labour surveys for dark purple fields. The brighter the field, the larger the distance to the last labour survey. Belgium (BEL) illustrates this neatly. The Belgian Statistical Office only provides labour surveys in sufficient quality since 2013. Thus, the competitiveness estimate for 2010 uses the 2010 trade data and merges it with the first observation carried backwards, that is the 2013 employment data. For countries like Germany (DEU), we obtained data every three years. The 2016 employment data is thus a linear approximation from 2015 to 2018. Again, we use the 2016 trade data. Our sample of countries represents all areas of the world. For example, we are able to capture subnational trade competitiveness for large parts of the Americas and Europe, but also for several African,

Figure 2: Data availability

Asian and Arab countries.

3 Illustrating the plausibility of the measures

In this section, we first show that the various measures of subnational trade competitiveness (for the region overall) are highly positively correlated with each other and discuss to which extent subnational trade competitiveness varies within countries. Second, we provide several tests of the data's face validity. Finally, we provide two brief case studies of South Korea and Bolivia that help better understand the dynamics. Further analysis of the data for all measures,

regions, years, and sectors is possible via the following Shiny app:

https://subnationaltradecompetitiveness.shinyapps.io/Comp_Shiny/.

3.1 Descriptive evidence

We first present correlations between the measures of subnational trade competitiveness (as calculated for the region as a whole). The results suggest that all measures, with the partial exception of $STC (additive)_{OV}$, are highly correlated. Particularly the measures based on the net and trade balance approaches behave very similarly. In fact, the correlations between $STC (symmetric)_{OV}$, $STC (net)_{OV}$, and $STC (trade balance)_{OV}$ are all above 0.82 (also see Figure A7 in the Appendix). The reason why $STC (additive)_{OV}$ differs a bit more from the other measures may be that it systematically punishes small sectors, whereas the other measures potentially punish larger sectors. Nonetheless, the three correlations with $STC (additive)_{OV}$ are all above 0.46, indicating that all measure tap into the same latent concept (that is subnational trade competitiveness).

Next we analyse to which extent subnational trade competitiveness varies *within* countries. Figure 3 shows the ranges across regions within each country. In other words, each bar shows the difference in subnational trade competitiveness between the region with the lowest and the region with the highest value on subnational trade competitiveness in a country. The colours indicate the different measures. The horizontal, dashed lines indicate the average range across all countries in our sample.

The figure shows that the within country variation that we find is substantial. All variables theoretically range from ± 2 .³ Against this theoretical range of 4, the within country range is large. For example, the mean range for the $STC (symmetric)_{OV}$ measure is around 0.8; and hence about 20 percent of the maximum possible range. We find similar variation for the $STC (net)_{OV}$ and $STC (tradebalance)_{OV}$ measures. Only the $STC (additive)_{OV}$ operates on a more restricted part of the theoretical range.

Zooming in to individual countries, across all measures we find that the countries with relatively little heterogeneity tend to be highly developed, whereas the lower income countries tend to exhibit more variation across regions. Austrian and German federal districts, for example,

³They are standardised between ± 1 . Since we subtract the country mean, theoretically it could take values in the range ± 2 .

Figure 3: Within-country range of subnational trade competitiveness

Note: Bars are sorted by the sum of ranges across all measures.

are similar in their employment structure, thus their level of within-country variation is rather small. On the other end of the extreme, we observe lower income countries that tend to have one political and economic center and several more rural regions. A country such as Argentina that has several highly industrialised (e.g. Buenos Aires) and other more rural regions (e.g. La Pampa and Tierra del Fuego) is placed somewhere in the middle of the distribution. Again, the additive measure ($STC (additive)_{OV}$) behaves slightly different from the other measures, as it produces some extreme outliers (Benin and Cambodia have five times the average range). Nevertheless, even for this measure we find the difference between more and less highly developed countries discussed before.

3.2 Relationship between competitiveness and GNI

Since by definition all countries have a comparative advantage in the production of some goods or the provision of some services, we should see regions with relatively high and regions with relatively low values on subnational trade competitiveness in each country. As a result, our

measures cannot simply reflect cross-country differences in levels of development. Nevertheless, at the subnational level, trade competitiveness and level of development may correlate. It could be that within countries, the regions with the highest level of development also receive the highest scores on subnational trade competitiveness. If so, our measures could simply be substituted with a measure of regional GDP per capita.

As outlined in the introduction, there are theoretical reasons to believe this is not the case. Nevertheless, in this subsection we analyze this correlation empirically. Figure 4 shows correlations between region's trade competitiveness and Gross National Income per capita by country. Bars (which indicate the correlation) are sorted by the countries' average GNI per capita over our 21-year observational period. The correlations between the two variables vary widely from quite negative to quite positive, which demonstrates that they measure different attributes of these regions. In Guinea, for example, three of four measures have a negative correlation with GNI per capita of -0.85 or below. In contrast, in Great Britain all four measures show a correlation of 0.84 or higher.

Nevertheless, we observe at least a weak pattern, as indicated by the black line that summarizes the correlations via a LOESS regression. The correlation is on average positive for the more developed countries in the sample and negative for the less developed countries. This suggests that in less developed countries, poorer subnational entities are more focused on the comparative advantage of the country, which might be explained by lower production costs (mainly wages) in these regions. In more developed countries the relationship is reversed and richer regions are more in line with the comparative advantage of the country. This might be a result of the availability of high skilled workers in wealthy districts. Overall this pattern suggests that the underlying factors that determine whether a region is oriented towards a country's comparative advantage or not are different at different levels of development.

Figure 4: Correlation between regional GNI per capita and subnational trade competitiveness

Note: Bars are sorted by country GNI per capita.

3.3 Case studies: South Korea and Bolivia

We conclude our empirical investigation by providing two brief case studies of South Korea and Bolivia. These two cases, chosen to include a more developed and a less developed country, allow us to convey the intuition behind our measures.

3.3.1 South Korea

South Korea has a mix of highly industrialized and rural regions. On the one hand, some regions are home to a large electronics industry led by Samsung and LG. In addition, they host the Hyundai Kia Automotive Group, which is one of the world's largest automobile producers. Hyundai Heavy Industries, Samsung Heavy Industries, and others also account for a large share of global shipbuilding.⁴ These regions should score highly on subnational trade competitiveness,

⁴<https://www.statista.com/statistics/263895/shipbuilding-nations-worldwide-by-cgt/>.

as their economies are in line with South Korea’s comparative advantage. On the other hand, some regions are mainly characterized by agricultural production. These regions should get low values on our measures, as overall South Korea is not particularly competitive in agriculture.

Indeed, we find considerable variation in trade competitiveness across regions. In Figure 5, the city-province of Ulsan (circle with plus) consistently scores highest on trade competitiveness, across all four measures. Ulsan is home to one of the most important harbours in South Korea. It also hosts the Ulsan industrial zone in which Hyundai has its headquarters and most of its production. Hence, it is clearly oriented towards South Korea’s comparative advantage in manufacturing. In fact, almost a third of all employees in Ulsan work in the manufacturing sector. Another region that scores highly on subnational trade competitiveness is Gyeongsangnam-do (South Gyeongsang; purple star). This region’s economy is characterized by large shipbuilding and chemical industries. Again, these are industries that form part of South Korea’s comparative advantage.

The country’s capital, Seoul, used to be South Korea’s industrial centre after World War II. Decentralisation, however, led to substantial relocation of industry to other regions. Thus, while large corporations continue to have their headquarters in the capital, their production moved to other provinces. Not surprisingly, Seoul does not score very high on subnational trade competitiveness, taking a place in the middle to lower end of the distribution. The region that consistently scores lowest (North Jeolla), finally, has a relatively small manufacturing sector. In combination with the relatively large agricultural sector, which is rather uncompetitive in South Korea, this means that North Jeolla’s economy is not in line with the country’s comparative advantage. Figure A8 in the Appendix provides more detailed evidence on these four regions that is further indication of the plausibility of our measures.

Figure 5: Subnational trade competitiveness of South Korean regions over time

Note: The dashed line between years 2008 and 2009 represents a change in ISIC coding scheme from ISIC rev 3 to ISIC rev 4.

3.3.2 Bolivia

In the second case study, we look at Bolivia. Bolivia's comparative advantage lies in agriculture and the mining of silver. We thus expect regions with silver mines and strong agricultural production to score highly on subnational trade competitiveness. Regions with a strong manufacturing sector, by contrast, should receive low values on subnational trade competitiveness.

In fact, this is what we find (see Figure 6). The region of Potosí is not only Bolivia's mining centre, as it contains the world's largest silver deposits. It also has a large agricultural sector. Overall, therefore, Potosí's economy is focused on the country's comparative advantage. It is no wonder then that this region scores highly on subnational trade competitiveness across all four measures.

Figure 6: Sectoral subnational trade competitiveness in Bolivia (2018)

In contrast, La Paz has a quite different economic structure. It also has a relatively large agricultural sector, but a substantial part of employment is engaged in manufacturing. Moreover, the mining sector in La Paz is not only smaller than the one in Potosí, but also does not focus on the mining of silver. In La Paz, 60 percent of employees in the mining sector are in the ISIC rev. 4 group 081 ‘Quarrying of stone, sand and clay’. The RCA values for this industry group indicate that it is not part of Bolivia’s comparative advantage. Overall, therefore, we find that La Paz’s subnational trade competitiveness is only average. The same applies to the region of Cochabamba, which is the industrial hub of Bolivia. Of the four regions shown in Figure 6, Santa Cruz scores lowest on subnational trade competitiveness, as it has the largest manufacturing sector, in combination with a smaller agricultural sector and only very limited mining activity.

While this between-region variation is interesting, we also observe variation over time. For this, we focus on one of the most competitive regions, Oruro (see Figure 7). Similar to Potosí, this region has traditionally been characterized by highly competitive mining. From 2004 to 2008, however, we observe a decline in its overall subnational trade competitiveness (see first dots for each year). As illustrated by the estimates for each year, while the competitiveness of individual sectors hardly changed, the region’s employment structure changed substantially. The percentage of employees working in mining decreased from more than 11.6 percent in 2004 to 2.9 percent four years later. To some extent, this can be explained by debates about the ownership of different mines, resulting in protests and eventually the closing of some mines.⁵ Thus, while mining remains fairly competitive, Oruro’s mining sector shrunk and as a result its overall trade competitiveness decreased.

⁵<https://www.internationaltin.org/confrontation-at-huanuni-mine-escalates/>.

Figure 7: Sectoral subnational trade competitiveness in Oruro over time

4 Conclusion

We have presented new measures of subnational economic competitiveness. Descriptive evidence on these measures suggests that they plausibly capture regions' orientation towards the country's comparative advantage. Moreover, this evidence has provided a rationale for our effort in that it reveals much variation in subnational trade competitiveness within countries, which is largely independent of the region's level of development.

We expect that these data are useful for scholarly inquiries across various social science disciplines. For one, it would be interesting to investigate whether changes in subnational trade

competitiveness matter for election outcomes. Do voters punish incumbents when the trade competitiveness of a region declines? Data on subnational trade competitiveness may also help better understand public opinion towards globalization. The economic effects of globalization should be quite different in regions that score high on trade competitiveness than in regions that score low on trade competitiveness. Moreover, using our measures as dependent variable, it would be interesting to study how (economic) policies affect subnational trade competitiveness. Our measures of subnational trade competitiveness could also allow new insights for research on foreign direct investments. Do multinational companies prefer to invest in regions with high trade competitiveness? Alternatively, does an inflow of foreign investments lead to an improvement in a region's trade competitiveness? Finally, for economic geographers, it might be interesting to investigate to which extent physical characteristics of regions correlate with trade competitiveness, especially also at the sectoral level. Overall, we are confident that our dataset will prove useful for a large number of researchers.

In future research, it would be interesting to improve our dataset in various ways. For one, it would of course be good to have data beyond the 62 countries included in this first version of the dataset. Unfortunately, for many countries it is very difficult to get a hold of household or labour surveys. Partly, this has to do with data protection laws that make it impossible for statistical offices to release the kind of disaggregated data we need here. Partly, it is also simply difficult to interact with statistical offices in some countries. In addition, and this could also be a partial solution to the issue just mentioned, it would be interesting to calculate our measures of subnational trade competitiveness not with employment data but with production data. Some countries indeed provide data on the share of gross regional income contributed by different industries. Alternatively, it may be possible to approximate these shares using firm-level data. At least for some countries, such firm-level data may even allow for a calculation of our measures at an even more fine-grained level than the industry groups used here. Linking our data with firm-level data would anyhow be a worthwhile undertaking. In short, while already in their present format our data should be highly useful, future research could push this research agenda even further.

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6 Appendix

6.1 Available countries and years

Country	Years	Regions	Coding scheme	Survey type	Source
Argentina	17	24 provinces and districts	CAES	Household	INDEC (2021)
Armenia	1	11 regions and cities	ISIC adapted	Census	NSS (2011)
Australia	3	8 states and territories	ANZSIC	Census	ABS (2021)
Austria	17	9 states	NACE adapted	Household	StatAustria (2020)
Belgium	7	11 provinces and districts	NACE	Labor	StatBel (2020)
Benin	1	12 departments	ISIC adapted	Census	INSAE (2013)
Bolivia	15	9 departments	ISIC	Household	INE (2021a)
Botswana	2	10 districts	ISIC adapted	Census	StatsBots (2011)
Brazil	13	27 states and districts	CNAE	Household	IBGE (2021)
Cambodia	10	25 provinces and cities	ISIC	Household	NIS (2020)
Cameroon	1	10 regions	national	Census	BUCREP (2005)
Canada	20	10 provinces	NAICS	Labor	StatsCAN (2021)
Chile	8	16 regions	ISIC	Household	MDSF (2021)
Colombia	13	24 departments and districts	ISIC adapted	Household	DANE (2021)
Costa Rica	10	6 socioeconomic regions	ISIC	Labor	INEC (2021a)
Czechia	20	14 regions and districts	NACE	Labor	CSO (2021)
Dominican Republic	3	10 regions	ISIC	Household	ONE (2021)
Ecuador	13	24 provinces	ISIC	Labor	INEC (2021b)
Egypt	12	29 governorates	ISIC	Labor	CAPMAS (2017)
El Salvador	9	14 departments	ISIC	Household	DIGESTYC (2021)
Estonia	20	5 NUTS-3 regions	NACE	Labor	StatEst (2020)
France	20	26 NUTS-2 regions	NACE	Labor	INSEE (2020)
Germany	7	16 states	NACE	Household	DESTATIS (2020)
Ghana	3	10 regions	ISIC	Household	GSS (2021)
Greece	2	13 regions	NACE adapted	Census	ELSTAT (2021)
Guinea	1	8 regions and governorates	ISIC adapted	Census	INS (2014)
Haiti	1	10 departments	ISIC	Census	IHSI (2003)
India	7	35 states and territories	ISIC	Labor	MoSPI (2021)
Indonesia	14	33 provinces and districts	KBLI	Labor	BPS (2020)
Iran	2	31 NUTS-2 regions	ISIC adapted	Census	SCI (2011)
Italy	6	21 NUTS-2 regions	NACE	Labor	ISTAT (2019)
Jamaica	1	14 parishes	ISIC adapted	Census	STATIN (2001)
Jordan	12	12 governorates	ISIC	Labor	DOS (2016)
Kyrgyzstan	2	9 regions and cities	ISIC adapted	Census	NSC (2009)
Laos	1	18 provinces and prefectures	ISIC adapted	Census	LSB (2005)
Malaysia	1	15 states and territories	ISIC	Census	DOSM (2000)
Mexico	15	32 states and districts	SCIAN	Labor	INEGI (2021)
Mongolia	13	22 provinces and districts	ISIC	Labor	NSO (2021)
Namibia	2	15 regions	ISIC	Labor	NSA (2021)
Nicaragua	3	17 departments and regions	ISIC	Household	INIDE (2021)
Palestinian Territories	1	16 governorates	ISIC	Labor	PCBS (2008)
Panama	2	13 provinces and regions	ISIC adapted	Labor	INEC (2021c)
Papua New Guinea	1	20 provinces, districts and regions	ISIC adapted	Census	NSO (2000b)
Peru	16	25 regions	ISIC	Household	INEI (2021)
Philippines	1	80 provinces	ISIC adapted	Census	PSA (2010)
Portugal	2	7 regions	NACE	Census	INE (2011)
Rwanda	2	5 provinces and cities	ISIC	Census	NISR (2012)
Senegal	1	14 regions	ISIC adapted	Census	ANSD (2013)
Slovakia	17	8 regions	NACE	Labor	StatSVK (2020)
South Africa	20	9 provinces	SIC	Labor	Stats SA (2021)
South Korea	19	17 provinces and cities	KSIC	Labor	KLI (2019)
Spain	7	19 communities and cities	NACE	Labor	INE (2020)
Switzerland	15	26 cantons	NACE	Labor	BFS (2020)
Tanzania	2	25 regions	ISIC	Labor	NBS (2021)
Thailand	1	76 provinces and cities	ISIC	Census	NSO (2000a)
Togo	1	6 regions	ISIC adapted	Census	INSEED (2010)
United Kingdom	20	12 NUTS-1 regions	NACE	Labor	ONS (2021)
United States	19	51 states and districts	US Census	Household	USCB (2018)
Uruguay	14	19 departments	ISIC	Household	INE (2021b)
Venezuela	1	24 states and districts	ISIC	Census	INE (2001)
Vietnam	2	64 provinces and municipalities	ISIC adapted	Census	GSO (2009)
Zambia	1	10 provinces	ISIC adapted	Census	ZamStats (2010)

Table A1: Summary of available countries

The surveys for Armenia, Benin, Botswana, Cameroon, Guinea, Haiti, Iran, Italy, Kyrgyzstan, Laos, Malaysia, Papua New Guinea, the Philippines, Portugal, Rwanda, Senegal, Thailand,

Figure A1: Available countries

Togo, the USA, Venezuela, Vietnam, and Zambia were provided by the [Minnesota Population Center \(2019\)](#). The surveys for Egypt, Jordan, and the Palestinian Territories were provided by the [Economic Research Forum \(2020\)](#).

6.2 Data quality checks

This section provides some quality checks of the labour and household surveys that we use to assess the regional distribution of industries within a country. These checks demonstrate that overall the data quality of the labor and household surveys is very good and suited for our purposes. We perform the following five tests:

- Figure A2: Does the aggregated data yield the correct industry sector shares of employment on the national level? This ensures that no industry sector is over- or underrepresented. We compare our data to the estimates of sector employment of the International Labour Organization (ILO) ([ILO 2020](#)).
- Figure A3: Does the aggregated data yield the correct population shares for each region within the country? This ensures that no region is over- or underrepresented. We compare our data to population data of the Subnational Human Development Index (SHDI) ([Smits and Permanyer 2019](#)).
- Figure A4: Is the original data coded correctly? This ensures that we do not use incorrectly coded data or data that uses a different coding scheme than assumed. We compare our data to the coding schemes of the International Standard Industrial Classification (ISIC) ([UNSD 2008](#)).
- Figure A5: Is transferring the original coding scheme into the corresponding ISIC scheme causing too much duplication? When the original coding scheme is not as detailed as the ISIC scheme, some respondents are attributed to more than one ISIC category. This duplication should be kept to a minimum.
- Figure A6: Is the aggregated data based on enough respondents? This ensures that our data is robust.

Figure A2: Employment shares by national industry sector

Ideally, the shares should match exactly. In some countries such as Laos and Tanzania, subsistence pastoral farmers are not included in the labour surveys, which explains the large difference to the ILO data.

Figure A3: Population shares by region

Ideally, the shares should match exactly. For most regions, the shares we have closely resemble the population shares calculated from the SHDI dataset.

Figure A4: Share of incorrect industry codes

Ideally, there should be no incorrect ISIC codes. However, some countries use special categories that cannot be transferred into standard ISIC schemes. An example is Bolivia, which has a unique code for professional football players. Other countries suppress the codes of certain respondents. We treat these codes as NAs.

Figure A5: Ratio of duplicated respondents

When the original coding scheme is different than the standard ISIC schemes, we use official correspondence tables. Sometimes, these original coding schemes are not as detailed as the corresponding ISIC scheme, which causes the duplication of respondents (who will be attributed more than one ISIC category). The ratio should ideally be 1, which means that there are no duplicates. In Australia, Belgium, Canada, Germany, and Estonia, the calculation of duplicates is not possible due to technical reasons. However, the ratio of duplicates is close to 1 in these countries.

Figure A6: Share of regions with few workers

Ideally, the survey would include a large number of workers for each region. However, this is not the case in countries with many first level administrative divisions relative to their population such as Switzerland or Cambodia. In Korea, the labor survey is a panel survey with a low number of respondents. We drop regions if we have fewer than 50 workers to calculate the competitiveness measures.

6.3 Additional Evidence

Figure A7: Correlation between the four measures

Figure A8: Sectoral competitiveness by region in South Korea

Note: Data for the year 2018.

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