



How industrial development effects the well-being of population: A detailed analysis to reveal the underlying mechanics

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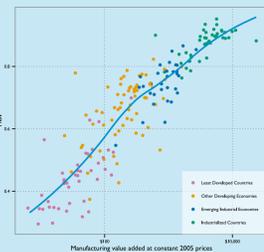
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Industrial Development

effects people's lives in various ways. The level of industrialization, often measured by the manufacturing value added (MVA) per capita, is highly correlated with many social indicators. The higher a country's industrial development, the more resources are available for human development.



But an important question that helps to gain a deeper understanding of the relation and its mechanics, is on the influence of the value added (VA) in different sectors of manufacturing industry – relative to the total MVA – on social indicators.

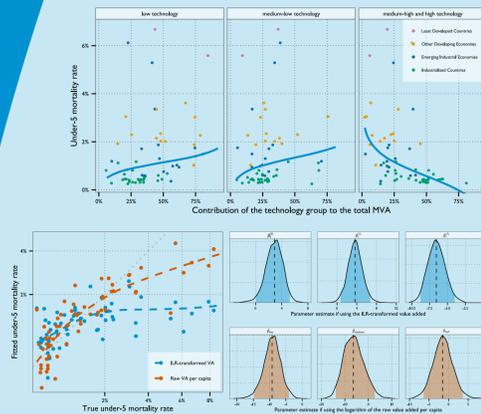
Data

was acquired from different international organizations.

- The *INDSTAT 2 2014* (ISIC revision 3, 2–digit) data set, the online database from UNIDO¹, comprises industrial statistics, including the value added (VA), for all 22 divisions of the manufacturing industry. To reduce the complexity of the analysis, a derived classification into three technology groups *low technology manufacturing*, *medium-low technology manufacturing*, and *medium-high and high technology manufacturing*, defined in UNIDO (2010, p. 244), was used. The aggregated value added for the three technology groups in 2010 was available for 66 countries.
- Achievements in the three basic dimensions of human development – a long and healthy life, access to knowledge, and a decent standard of living – are aggregated into the Human Development Index (HDI). The index was taken from the *Human Development Report* published by United Nations Development Programme² and is available for 187 countries in 2010.
- Numerous social indicators for 227 countries are available in the *World Development Indicators* database hosted by World Bank³. In this analysis we focused on indicators on poverty, health and education.

Under-5 Mortality Rate

is a key indicator for the millennium development goal of reducing child mortality and is effected by the contribution of the industrial sectors to the total MVA.



- The coefficients are for the logratio between the VA in the sector of interest and an average of the VA in the other sectors
- 4000 bootstrap samples were used to estimate the distributions of the coefficients
- Coefficients for all groups are significant
- Using the logarithm of the raw VA per capita in the groups, only the coefficient for the low-technology industry is significant, but the interpretation is misleading (Hron 2012)
- This analysis has also been done for indicators on education and it showed that the contribution of the high-technology group has a strong effect on these as well

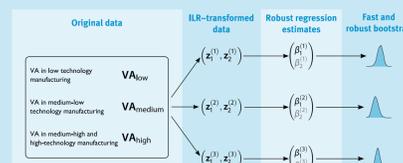
Robust Regression with Compositional Data

was chosen to be the method of analysis for the data presented here. The VA in the groups add up to the total MVA, it is thus realistic that the information is only contained in the ratios between the groups. Also, for reliable results, the regression estimates must be resistant against outliers.

Compositional data means that information is only contained in the ratios between the parts.

- Linear regression models are only reasonable if the covariates $\mathbf{x} = (x_1, \dots, x_D)'$ carry absolute information
- Ratios can not be used in regression models directly
- The data must be transformed with the *isometric logratio (ilr) transformation* which is given by the basis

$$z_i^{(l)} = \sqrt{\frac{D-i}{D-i+1}} \log \frac{x_i^{(l)}}{\sqrt{\prod_{j=i+1}^D x_j^{(l)}}}, \quad i = 1, \dots, D-1, l = 1, \dots, D$$
 where $(x_1^{(l)}, x_2^{(l)}, \dots, x_i^{(l)}, x_{i+1}^{(l)}, \dots, x_D^{(l)}) := (x_l, x_{l+1}, \dots, x_{l+i-1}, x_{l+i}, \dots, x_D)$
- All relevant information about the compositional part x_i is given by $z_i^{(l)}$
- Parameter estimates and inference statistics obtained with the model for $\mathbf{z}^{(l)}$ are only interpretable for the parameter of $z_i^{(l)}$
- To get information about all compositional parts, D models have to be fit to all three transformations



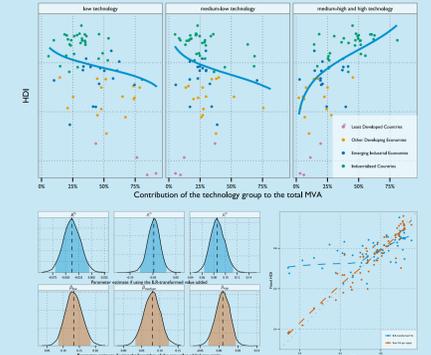
Robust regression is the means to analyze data when outlying data points are suspected. Robust MM-type estimates were used for the parameters in the three regression models of the form

$$y = \beta_0 + \beta_1^{(l)} z_1^{(l)} + \beta_2^{(l)} z_2^{(l)} + \varepsilon \quad l = 1, 2, 3$$

- where y is the value of a social indicator and the $z_i^{(l)}$ are the *ilr*-transformed ratios of the contribution to the total VA with different bases
- To get appropriate confidence intervals for the parameters $\beta_i^{(l)}$, their distributions were estimated using bootstrapping
- Fast and robust bootstrap (Salibián-Barrera 2002) was used, because standard bootstrapping approaches are not suited for robust regression estimates, as the distribution becomes numerically unstable and recalculation of the robust regression estimates is computationally expensive

Human Development

is a combination of the achievements in its three basic dimensions. As the analysis shows, all these dimensions are highly influenced by the relative sizes of the industrial sectors, thus the human development as a whole is also significantly effected. While the relative size of the low- and medium-technology sector has a significant negative effect on the HDI, **the contribution of the high-technology industry to the total MVA has the most pronounced influence on human development. The estimated coefficient is very high and significantly positive.**



Well-being of Population

is strongly influenced by the relative contribution of different industrial sectors to the total MVA. To build appropriate regression models for this thesis, it is crucial to be aware of the compositional nature of the data and for the estimates and inference to be resistant to outlying data points.

Taking into account all these properties of the data, the resulting regression models for the Human Development Index or many other social indicators and the value added in the industrial sectors, support the statement. Especially a large contribution of the high-technology manufacturing industry helps to significantly enhance human development.

References and Data Sources

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2 <https://data.unpd.org/dataset/Human-Development-Index-HDI-value/8ruz-shxu>
3 http://databank.worldbank.org/data/IASC_2014/id/e19dc18b