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Development process and convergence of Chinese Provinces between 1993 and 2016: A multidimensional perspective

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Abstract:

The most striking effect of the Chinese reform are probably the GDP and productivity growth rate achieved since 1978 and especially during the globalization phase after 1992 Deng Xiaoping's renowned travel to the South of the country.
Chinese provincial development is a multifaceted process based on a non-uniform transformations in the society involving culture, health, environment, and many other aspects.
In this paper we "disentangle" Chinese provinces development according to time (1993 and 2016), space and different dimension of wellbeing. Data analyzed are collected from the Chinese Statistical Yearbook and the China Compendium of Statistics 1949-2008.
The literature , so far, has mainly focused on income per capita or productivity.
This paper focuses on two aspects: the capacity of economic growth to translate into improvements in multidimensional wellbeing and the analysis of the spatial inequalities across provinces using β- and σ- convergence analysis (either absolute convergence or club convergence).
The results shed lights on whether economic growth and non-monetary wellbeing coupled at provincial level and whether they are developing toward similar or heterogeneous patterns. The understanding these multidimensional development paths, is an important step to foresee the trajectory of backward provinces and to tailor new strategies and policies.

Keywords: China; Multidimensional Development; Convergence; Provincial Development.

JEL classification: I31 O18 O53 R11

1. Introduction

Measuring multidimensional outcomes and their progress is vital for the international community (following Agenda 2030) as well as the Chinese government. In 2005 China officially adopted the goal of pursuing a "harmonious society" (HS), which become an important feature of the Chinese development strategy and drive for sustainable development (Li, Cheng, Beeton and Halog, 2016).

Since the beginning of reforms in 1978, the global economy is characterized by the emergence of China, a well-acknowledged fact in the literature[1]. The most striking effect of the Chinese reforms is undoubtedly the high GDP growth rates achieved and underlying increases in productivity (Lin, 2011). The strength of these achievements has partially obscured other outcomes, as well as differences across Chinese provinces. Chinese development to date has very much been an uneven and multifaceted phenomenon, which cannot be reduced to economic growth recorded at the national level (Saphiro, 2001; Goodman and Segal, 2002; Nolan, 2004; Shue and Wong, 2007; Lemoine, Poncet and Ünal, 2015). On the contrary, the Chinese reforms, especially after Deng Xiaoping's travel to South China in 1992, caused a deep transformation of Chinese society involving institutions, health, the natural environment, and many other aspects of progress including diverse territorial development patterns.

Most of the literature has concentrated, so far, on Chinese economic and non-economic outcomes separately. However, the separation of the 'economic' from the 'social' discourse has several shortcomings, as it often underplays the complexity of sustainable human development conceived by a multidimensional framework (Mehrotra and Delamonica, 2007; see also Ranis, Stewart and Samman, 2006; Biggeri and Mauro, 2010).

The aim of this chapter is twofold. The first aim is to provide multidimensional measurements of Chinese development trajectory achieved at provincial level from 1993 to nowadays. The Deng Xiaoping travel to South China in 1992 led to the 'definitive' transformation of the Chinese economy and society with different consequences from societal and spatial points of views, which are overlooked by traditional interest variables as income per capita. The second aim of the chapter is to include these new measures of development in the analysis of synergies among different goals, causes of development and, especially, convergence amongst provinces between 1993 and 2016.

The methodology, driven by a Sustainable Human Development framework, is based on a new method of computing multidimensional wellbeing: the Multidimensional Synthesis Indicator (MSI) introduced by Mauro, Biggeri and Maggino (2018). This methodology is adopted here for the first time at subnational level. The data, obtained from official Chinese statistics, are 34 variables measured at provincial level (all the 31 provinces are included) in the interval 1993-2016. These variables are grouped in 10 unidimensional indicators and three-levels multidimensional indexes[2]. The disaggregation at provincial level and the different dimensions of development allow to examine the effects of the adoption of the "harmonious society" strategy.

The chapter is structured into seven sections, the remaining part proceeds as follows. The second section reviews the literature about the measurement of multidimensional development and the economic convergence, with a preferential selection of China-based studies. The third section introduces the separation of the 'economic' from the 'social' discourse, presenting the research questions within the conceptual framework to explore multidimensional development in China. The fourth section explains the methodology adopted; this section is divided in three subsections, devoted respectively to the building of

[1] Among the exterminate literature about Chinese economic growth and its background, we limit here to quote the books by Nolan, Arrighi (2007), Lin (2011).

[2] The first-level multidimensional indexes are those based on a relatively homogeneous set of unidimensional indicators, the second-level indicators are more comprehensive, and the third-level index includes all the available variables.

the unidimensional indicators (through normalization), the building of multidimensional indexes (through MSI aggregation), and the convergence analysis. The fifth section presents the data. The sixth section describes and discusses separately the results on the measurement of multidimensional wellbeing, on the relation between different types of development, and on the convergence. The last section concludes the chapter and provides policy implications.

2. Literature Review: multidimensional wellbeing and convergence in China

This section involves and combines elements typical of two streams of literature: indices of multidimensional wellbeing and convergence analysis. Since the contamination between these fields has been narrow so far, we review the literature about these two topics separately, respectively in section 2.1 and 2.2. Before entering in the details of these two topics, we want to briefly introduce two broader areas of investigations that encompass the cases of multidimensional wellbeing and convergence analysis: inadequacy of economic variables to describe Chinese wellbeing and inequality between Chinese provinces.

The awareness about the shortcomings of the Chinese development model, usually focused on the singling out of weak points related to sustainable economic development, particularly in fields as environmental protection and labour conditions[3]. Beside these "unidimensional critiques", we want to mention the discourse about happiness, that has inevitably led to a radical critique to income as unique interest variable. The book *Happiness and economic growth*, curated by Clark and Senik (2014), collects three investigations based in China, underlying the weakness in the level of subjective wellbeing in contrast to the fast economic growth triggered by reforms. This result is explained by several factors, not last the worsening of employment and social safety conditions[4].

The difference in trajectories of coastal and inner areas is a major problem of Chinese development since the opening-up of the country to trade and investments with neighboring countries (Shue and Wong, 2007, Lemoine, Poncet and Ünal, 2015). The book *China Deconstructs*, by Goodman and Segal (2002) describes the peak of this this issue with its economic and political consequences. At the end of the Nineties, the Chinese central government launched a "Go-West strategy" (西部大开发) campaign to reverse this divergence across China. Fang, Dewen and Yue (2009) suggest that, beside the policy measures, also a "flying gees" process is now opposing to the provincial divide. Indeed, backward regions can benefit from transfers of capitals and technologies from the advanced ones, becoming particularly competitive in the labour-intensive industry, while the advanced regions specialize in R&D industry and in services. This phenomenon allows inner provinces to "exploit the backwardness advantages".

2.1 Multidimensional Wellbeing

Considering simultaneously the trend of different measures of wellbeing is a way of extending the economic analysis beyond its traditional boundaries (Noll, 2004). Important contributions in this direction came thanks to the Basic Need approach (Hicks and Streeten, 1979) and the Capability Approach (Sen, 2001; Nussbaum, 2011) that have been channeled in the Sustainable Human Development paradigm (UNDP, 1990; Ul-Haq

[3] The literature about Environment, Labour Conditions and Security is very broad, and a literature review about these topics is not in the purpose of this study. We want to quote however the works by Saphiro (2001) and Ngai (2005).

[4] Easterlin (2014), writes: "*The fact that life satisfaction in China failed to increase noticeably along with income and output and has a U-shape similar to that found in the European transition countries is indicative of the fundamental importance of employment and the social safety net in determining the course of life satisfaction*".

1995; Ranis, Stewart and Samman, 2006). Another relevant stream of literature about a broader conception of development was launched by the Brundthland Report *Our Common Future* accounting for environmental/ecological sustainability dimensions (1987).

Based on these considerations, various practical perspectives were carried out internationally as the Agenda 2030 and several multidimensional indices were built to measure multidimensional development. This debate was enriched by the global initiatives carried on by the OECD and by the International Panel on Social Progress (IPSP)[5]. Some individual countries took remarkable steps forward too[6], including China that in 2005 challenged the traditional perspective of the policy makers and the monolithic vision of development thanks to Hu Jintao's project of building a "harmonious society" (Joshi, 2012; Li, Cheng, Beeton and Halog, 2016).

Thereafter, we review some of the most important indexes built to measure multidimensional wellbeing and other original contribution relevant in the analysis of multidimensional development worldwide and in China.

The Human Development Index (HDI) is a remarkable example of multidimensional index, promoted by the United Nations Development Programme. This index is founded on three dimensions: Health, Education and Living Standard. The Human Development Report 2016, by adopting the HDI, testifies the development of China in all the three dimensions considered, which allowed this country to reach the average level of human development recorded in the East Asia and Pacific area[7]. Ranis, Stewart and Samman (2006) criticizes the narrow scope of the HDI, suggesting that other variables should be added to the HDI pillars[8] to obtain a more complete measurement of human development.

The 2030 Agenda set by the United Nations, identify the priorities of world development in 17 targets, named Sustainable Development Goals (SDGs). Each of these targets is related to a single dimension: Poverty; Hunger; Health; Education; Gender Equality; Water and Sanitation; Energy; Work and Economy; Infrastructure; Inequality; Sustainable Cities; Sustainable consumption; Climate Change; Water Environment; Earth Environment; Peace and Justice; International Partnership. Except for the last two goals (related respectively to policies implemented by the central governments and to a technical issue), all the other goals were considered in our definition of the measurement of multidimensional wellbeing in Chinese provinces.

The Multidimensional Poverty Index (MPI) proposed by Alkire and Foster (2011) is probably the multidimensional index more frequently applied to the Chinese context. The MPI detaches from the HDI and similar indexes (and from the purpose of this study too) because it is focused on poverty and its thresholds (the so-called "Strong-Focus" property, pointed out also in Bourguignon and Chakravarty, 2003). The MPI considers ten indicators in turn grouped into three dimensions that recall the HDI: Living Standards, Health

[5] The OECD promoted the Better Life Index, including eleven dimension (Housing; Income; Jobs; Community; Education; Environment; Civic Engagement; Health; Life Satisfaction; Safety; Work-Life Balance), available online at: http://www.oecdbetterlifeindex.org/
The IPSP put together the efforts of scholars from different social sciences with the aim of tackling the "most pressing challenges of our time" in a multi-disciplinary perspective. More information on this project and its reports are available online at: https://www.ipsp.org/.

[6] In 2008, the French government commissioned an investigation about economy and the society, which resulted in a report (Stiglitz, Sen, Fitoussi, 2009) that methodologically investigated separately the classical GDP issues, the quality of life and the sustainability. The Italian project about "Equitable and sustainable well-being" (Benessere Equo e Sostenibile - BES) includes 12 dimensions: Health; Education and training; Work and life balance; Economic well-being; Social relationships; Politics and Institutions; Security; Subjective well-being; Landscape and cultural heritage; Environment; Research and innovation; Quality of services. The 2017 BES report is available online at:
https://www.istat.it/it/files//2017/12/Bes_2017.pdf

[7] See the Human Development Report 2016, Human Development for Everyone - Briefing note for countries on the 2016 Human Development Report: China, available online at:
http://hdr.undp.org/sites/all/themes/hdr_theme/country-notes/CHN.pdf

[8] The dimensions added are: mental well-being; empowerment; political freedom; social relations; community well-being; Inequalities; work conditions; leisure conditions; political security; economic security; environmental conditions.

and Education. Alkire and Shen (2015) measure the incidence of poverty in China in 2010 and in 1014 through the MPI. Other scholars calculate indices of multidimensional poverty in China similar, but not identical, to the MPI[9]. These studies, beside the 3 pillars of the MPI, broad their set of variables, including dimensions as Nutrition, Social Security, Information, Housing etc.

The indexes analyzed above, group all the dimensions considered in a single index. This way of proceeding does not allow to distinguish dimensions which are closely related to each other from dimensions which are different (or almost antithetical). This limit is tackled by Biggeri and Mauro (2010), that investigate the 'synergies' within sustainable human development looking at the relation between social and economic outcomes in 50 countries. To do this, they build two separate multidimensional indices, one for the Social Dimensions (SD) and another for the Economic Dimensions (ED). The SD includes social, political and civil outcomes, namely: Education, Life Expectancy and Freedom Index. The ED includes economic, inequality and environmental outcomes, namely: GDP, Employment and CO_2 Emissions. The main contribution of Biggeri and Mauro (2010) is the theoretical and applied investigation of the different combinations of economic and social development. These combinations determine a variety of 'patterns of HD progress'[10]. China for example results to be characterized by a strong ED (hampered by the environmental degradation), and a weaker SD.

Despite the growing worldwide interest about multidimensional measures, in the Chinese context the literature about multidimensional wellbeing is quite narrow. With few exceptions[11], this literature either focuses on the poverty issue (Yu, 2013; Alkire and Shen, 2015; Qi and Wu, 2015; Wang and Wang, 2016; Yang and Mukhopadhaya, 2017; Nicholas, Ray and Sinha, 2017), or involve China only in an international comparison (Biggeri and Mauro, 2010), without focusing on a subnational level, or involve only a limited number of dimensions (as in the *China National Human Development Reports* published by UNDP China and Development Research Center of the State Council of China). Therefore, the issue of measuring the effect of Chinese reforms in a multidimensional framework is largely unexplored.

2.2 Convergence analysis between Chinese provinces

Convergence studies developed thanks to the precious contributions of Barro and Sala-i-Martin (1992) and Quah (1993). Section 4.3 of this chapter will be devoted to the main concepts introduced by these authors: β- and σ-convergence. In the literature, convergence analysis is mainly focused on variables as per capita GDP, factors productivity or Consumer Price Index. China is no exception, and since the Nineties the trajectory of Chinese provinces has been analyses with the lens of convergence analysis.

Chen and Fleisher (1996) are among the firsts to study convergence in the aftermath of the reforms launched in 1978[12]. They observe that convergence in per capita production during 1978-1993 is conditional on investment, human capital and proximity to the coastline. However, the inner-coastal gap did increase slightly, causing a major divide across China. Similarly, Young (2000) concludes that the reforms adopted between 1978 and 1997 caused fragmentation and divergence in prices.

[9] See, among the others Yu, 2013; Qi and Wu, 2015; Wang and Wang, 2016; Yang and Mukhopadhaya, 2017; Nicholas, Ray and Sinha, 2017. Another investigation on multidimensional poverty in China, Labar and Bresson (2011), adopts the concept of stochastic dominance, opposed to the MPI,

[10] The most striking cases, reported by the authors, are: jobless growth; ruthless growth; futureless growth; peace-less growth. Such types of growth hamper respectively employment, equity, sustainability, safety.

[11] See Bin (2016), who adopts a multidimensional index based on the Principal Component Analysis (discussed later), and Bortolotti (2018), who adopts a version of the MSI based at micro-level.

[12] Previous studies have focused on long-run inequality among Chinese regions and include the Maoist period.

Several economists have then updated the research about inequality trend within Chinese provinces, getting to different results according to the period and methodology adopted[13]. Tian, Zhang, Zhou and Yu (2016) provides a comprehensive literature review covering these investigations and their results. Moreover, their work finds the existence of two diverging clubs between 1978 and 2013, one with high-income and another with low-income, which are internally converging. This conclusion seems to confirm and extend Chen and Fleisher (1996) findings.

Lemoine, Poncet and Ünal (2015) focus the convergence of labor productivity on the manufacturing sector, considering also the spatial distribution of production at sectoral level. Their findings confirm a converging trend in the period 1999-2009. Indeed, in the new millennium (and particularly since mid-2000s) backward provinces located in inner China, were able to turn their weaknesses into strengths, triggering a "flying gees" process and eventually reducing the gap with the coastal provinces.

In addition to income-centered convergence studies of China, scholars have recently focused on the energetic and environmental issues. Several works have investigated the issue of carbon emission, generally finding a converging trend of Chinese provinces. A detailed literature review about such studies is provided by Wu, Wu, Guo and Cheong (2016), along with their own investigation, based on a continuous dynamic distribution approach, which also find convergence of carbon emissions among 286 Chinese cities in the period 2002-2011. Boussemart, Leleu and Shen (2015) incorporates CO_2 in the computation of Chinese growth, obtaining the "environmental growth", between 1997 and 2010; their results shows a convergence in carbon shadow prices among 30 Chinese provinces. Cheong, Li and Shi (2018) analyzes the electricity consumption between 2000 and 2015, highlighting a divergence trend across provinces. Démurger (2001) emphasizes the role of infrastructure (both transportation facilities and telecommunications) in driving the differences across provinces during the period 1985-1998.

To the best of our knowledge, Bin (2016) is the only study that tests convergence among Chinese provinces with reference to an index of multidimensional wellbeing. Bin constructs a multidimensional index (named "Composite Index of Regional Development") aggregating through principal component analysis five dimensions (macroeconomic; science and innovation; environmental sustainability; human capital Index; public facility) and observes its distribution density function among 30 provinces in six years (between 1998 and 2010) through a kernel method. The results points to the existence of three provincial groups, underlying the difficulty of provinces from weaker groups to join the more advanced ones in subsequent years.

Considering the blooming of interest around multidimensional poverty and spatial inequality, the narrowness of literature regarding multidimensional wellbeing convergence is quite striking, especially in a country, China, where the balancing and inclusiveness of the development strategy is a particularly sensitive topic. Our analysis tries to fill this gap, adopting an innovative method to synthetize different dimensions of wellbeing: the MSI. This technique, alternative to the traditional approaches based on the principal component analysis or the simple mean, is consistent with the hypothesis of convex preferences among dimensions, aggregated through a flexible function (see the methodology section 4.2).

3. Multidimensional analysis and Chinese development

When the Chinese Communist Party launched the reforms, its aim was to build a "Xiaokang" (小康) society, i.e. a "moderately-prosperous" society that is not exclusively concerned with economic well-being. However,

[13] Lemoine, Poncet and Ünal (2015) underline that an important difference in the methodologies is whether provinces are considered separately or grouped in three (East, Center and West) or in two (inner and coastal) categories.

during the first stages of the reforms, monetary achievements – particularly along coastal, richer, provinces – have been the main target of policymakers (Shue and Wong, 2007). At the end of the 1990s, the Chinese Central Government launched a "Go-West strategy" campaign to reverse the expanding divergence in progress across China. Fang, Dewen and Yue (2009) suggest that beside policy measures, a "flying gees" process of industrial development may aggravate the provincial divide. Indeed, backward provinces can benefit from transfers of capitals and technology from more advanced ones, thus becoming more competitive in labour-intensive industries in order to "exploit the backwardness advantages". More recently, under the leadership of Hu Jintao (2004-2012), the concern about non-monetary aspects of wellbeing resurged, with the rhetoric about an "harmonious" (和谐) growth. The leadership of Xi Jinping keep embracing an inclusive and widespread concept of development, which is part of Xi's project, named "Chinese Dream" (中国梦), or "Great Rejuvenation of the Chinese Nation". The latest targets of the reforms, announced in the 13th Five-Years Plan (valid for the 2016-2020 period), officially refer to "Xiaokang" and "harmonious" society (Joshua, 2017). Along with the concern about the sustainability of Chinese development model, Chinese leadership attempted to include a broader set of targets. In terms of policy, the period of the harmonious society has been characterised by important reforms in the environmental and social fields, as the targets of universal health coverage and green economic growth[14].

The critical monitoring of the macroeconomic achievements across Chinese territory has therefore become essential in the perspective of harmonious society (Joshi, 2012; Li, Cheng, Beeton and Halog, 2016; Xue, Weng, Yu, 2018), despite the narrowness of the existing literature[15]. Two aspects deserve attention: the inclusion in the development process of the actors who did not "get rich first" (i.e. the provinces located in the inner China) and the capacity of economic growth to trigger improvements in multidimensional wellbeing. This chapter shed lights on these topics by analysing whether economic growth and non-monetary wellbeing are coupling at provincial level. In doing this, we also want to check how different provinces achieved different outcomes, whether they are developing toward similar or heterogeneous patterns, and whether they will eventually reach a similar level of wellbeing (convergence analysis).

Dealing with the differences among provinces, traditionally scholars analyse this heterogeneity through the division between East, Centre and West China. Another way of grouping provinces widely adopted in the literature is the division between inner and coastal provinces or, respectively, "Yellow China" and "Blue China" (Lemoine, Poncet, and Ünal, 2015), with the clast economically advantaged over the second. These are not the only division possible, especially to explain differences in development broader than simple GDP growth. The convergence analysis wants to investigate if all the provinces will eventually reach a similar level of development (absolute convergence). The case of club convergence applies the concept of convergence to smaller groups sharing similar characteristics. Indeed, in a multidimensional perspective the issue of convergence is more complex, implying different criteria to observe convergence, which could lead to the coexistence of different clubs.

Dealing with the relation between different aspects of wellbeing, we propose a conceptual frame to examine Chinese provincial multidimensional progress, referring to the paradigms of Sustainable Human Development (SHD), Sustainable Development Goals (SDGs) and Harmonious Society (HS). These paradigms not only provide insights about how to select dimensions and variables but can also suggest how these dimensions dialogue with each other. The next subsection describes more in detail our approach toward multidimensional development, providing the framework of our measurement.

[14] For more insights on these green environmental development and health reforms, see respectively Su, Heshmati, Geng, and Yu (2013) and Yip and Hsiao (2009).
[15] See above, section 2.1.

3.1 Conceptual frame for exploring multidimensional patterns in China

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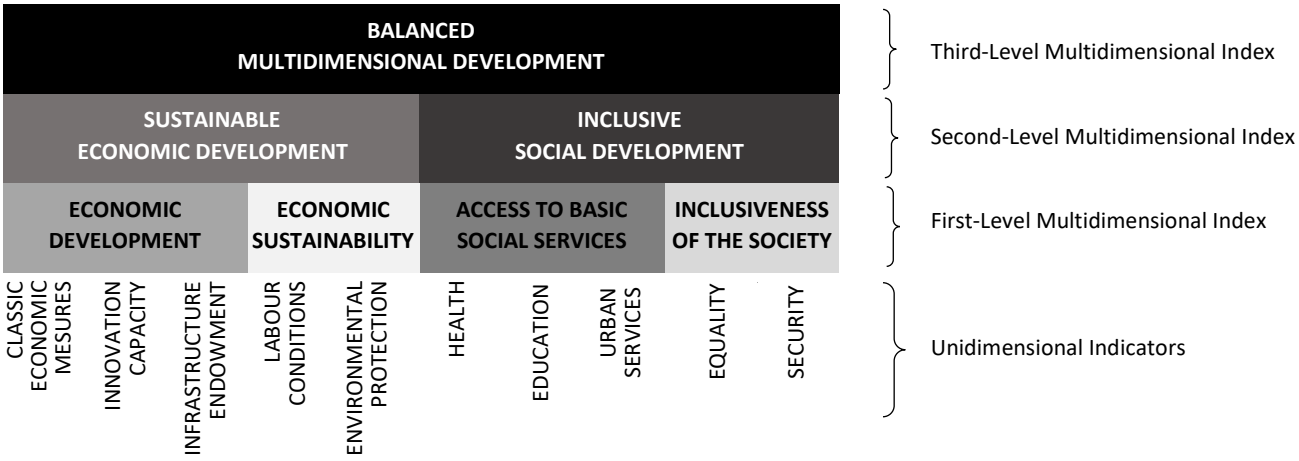
These considerations have motivated our choice of ten unidimensional indices: Classic Economic Measures, Innovation, Infrastructure Endowment, Labour Conditions, Environment Protection, Health, Education, Urban Services, Equality, Security. This list does not include other fundamental aspects often considered in the literature, as peace, justice, and corruption[16].

The first three dimensions are the pillars of Economic Development in a broad conception (the first-level multidimensional index), while labour conditions and environmental protection are two other fundamental points to preserve the harmony and the sustainability of such development (the second-level multidimensional index). Health, Education and Urban Services are the pillars of the basic social services, while equality and security are added to check the harmony and inclusiveness of social development. Considering all the ten dimensions jointly allow us to compute a third-level multidimensional index, the Balanced Multidimensional Development. Figure 1 describes all these variables in a scheme.

Figure 1: Unidimensional and Multidimensional Indicators



Source: Author's elaboration.

Following Biggeri and Mauro (2010), the synergic relation is not viewed as a trivial feature of development. We therefore investigate the relation between different multidimensional indicators, trying to distinguish the conditions under which they expand jointly (synergic patterns) or where some indicators expand at the expense of others (trade-offs). We are particularly interested in analysing three types of relations: Economic Development and Sustainable Development; Access to Basic Social Services and Inclusiveness of the Society; Sustainable Economic Development and Inclusive Social Development. The first two cases involve first-level multidimensional indices, and measures respectively if (when and where) the economic and the social development were harmonious. The last case involves the relation between the two second-level multidimensional indices and aims to shed light on the overall development of each province.

The approach and graphical representation by Biggeri and Mauro (2010) is an intuitive strategy to investigate synergies. Given two different (multidimensional) indexes, I_A and I_B, that characterize a province, we

[16] These dimensions were excluded for the specific nature of our research, which is based on official data collected at provincial level. Indeed, most of the variation in peace and justice only emerges at national level, because of the highly centralized system Chinese political system. Dealing with corruption, its nature is intrinsically difficult to be caught, and empirical analysis can offer highly contradictory data according to the angle adopted to observe this phenomenon (Li, 2016).

measure them in two orthogonal axes; then we track the development pattern for all years, and consider whether its movement conforms with one of the following patterns:

- A "Synergic" or "Balanced" pattern: the values of I_A or I_B and their growth rates are similar, moving closely to the 45-degree bisector;
- An "Unbalanced" pattern: the increase in I_A is higher or lower than the increase in I_B, and either corresponds to an I_A-oriented pattern and to an I_B-oriented pattern;
- A "Trade-off" pattern where the values of I_A increase over time while those of I_B decrease (or vice versa).

4. Methodology

To identify the relations between the social development and the economic development of Chinese provinces, we need to resume the available information form specific social and economic outcomes in a comprehensive measure of Sustainable Economic Development and of Inclusive Social Development. Analogously, the measurement of the Balanced Multidimensional Development (hereafter, BMD) requires a technique able to synthetize different information, representative of different spheres of wellbeing - comprising both monetary and non-monetary aspects- into a single value.

The most intuitive way of aggregating different dimensions of development is through the computation of their arithmetic mean. However, this methodology implicitly assumes that the dimensions in question are perfect substitutes, i.e. success in a single dimension can compensate for failure in another. This assumption seems quite fetched, especially in cases of overt poverty, where the success in a single outcome cannot compensate the bad results achieved elsewhere.

Investigations on multidimensional poverty, deepened the topic of how to aggregate poverty from different dimensions (see Bourguignon and Chakravarty, 2003; Alkire and Foster, 2011), but have always maintained a focus over a specific level of wellbeing, the poverty cut-off, overlooking the aggregation of different dimensions across all their distribution of wellbeing. This topic is instead at the core of the HDI, which abandoned the assumption of perfect substitution, rejecting the arithmetic mean in favour of the geometric mean (Klugman et al., 2011). The MSI adopt a similar, but more elaborated perspective, allowing to deal with many indicators without incurring in the problems of collapsing to zero and allowing for a flexible aggregation function (differently from the HDI).

The imperfect substitutability of one element with another is particularly important when we deal with what Maggino (2017) called a formative synthesis. In a formative synthesis, the aggregate indicator is constructed over several variables relative to different domains that are not necessarily correlated with each other. At the opposite extreme, in a reflective synthesis, the aggregate indicator is built over several variables relative to the same phenomenon that are strongly correlated with each other and are therefore interchangeable.

Our multidimensional indicators are built over 10 unidimensional indicators, in turn build over 34 variables. We will call these last "Building Blocks". The construction of the unidimensional indicators implies reflective relations[17], therefore a simple mean is sufficient to synthetize their values. The construction of the

[17] Through a correlation matrix – not reported here for space constraints- we observed the correlation among pooled variables included in each unidimensional indicator. All the variables in the Strictly Economic, Innovation, Infrastructure, Environmental, Health, Education and Services indicators are significantly (5% level) correlated to each other. In the Labor, Equality and Security indicator, all the variables are significantly correlated but to each other with one exception

multidimensional indicators implies formative relations, therefore the MSI is the methodology we preferred to synthetize their values.

4.1 Measuring multidimensional Wellbeing through MSI analysis

The MSI formula is as follows:

$$I_{it} = 1 - \left[\frac{1}{K}\sum_{k=1}^{K}(1 - w_{itk})^{g(w_{it})}\right]^{\frac{1}{g(w_{it})}} \quad (4)$$

Where w_{itk} is defined as above. K is the number of dimensions included ($k = 1 \dots K$); note that depending on how many and which dimensions k we include in the multidimensional index I_{it}, we can obtain different levels of multidimensional indexes[18]. The formula $g(w_{it})$ represents a parameter that determines how far heterogeneity is penalized (i.e. to what extent a scarce dimension of well-being can be substituted for an abundant dimension of well-being). This formula plays a crucial role, related to the properties of the MSI.

The MPI satisfies three important properties, as described in Mauro, Biggeri and Maggino (2018): Strict Monotonicity; Continuity; Heterogeneity Penalization. Strict Monotonicity guarantees that any increase in the value of any dimension considered led to an increase of the MSI index. Continuity guarantees that an infinitesimal increase in any index results in an infinitesimal increase in the MSI. Heterogeneity Penalization guarantees that if the same amount of wellbeing is added to a relatively abundant dimension of wellbeing and subtracted to a relatively scarce dimension of wellbeing, the net effect on the MSI is a reduction of wellbeing. Moreover, we do not impose this penalization to be equal for all the provinces of our sample, but we calibrate it based on their characteristics, according to the function $g(w_{it})$.

4.2 Convergence

Analysing convergence for multidimensional development entails investigating whether different provinces have become more – or less - equal between 1993 and 2016, and whether or not they will eventually reach the same levels of well-being. The lack of convergence would instead imply that the unbalances recorded at the beginning of the investigation have maintained, or have even improved (the case of divergence).

Borrowing from convergence analysis concepts as β-convergence and σ-convergence, we want to check if the efforts of Chinese government to tackle the growing inequality within provinces had notable results in the 24 years analysed.

The hypothesis of β-convergence identifies convergence with a negative relation between the initial level of the variable in question (usually the log of income per capita) and its growth rate[19]. In formula:

(these are respectively: unemployment, non-significant; gender bias in education, negatively correlated; deaths in traffic accidents, negatively correlated).

[18] We recall that our analysis adopts different multidimensional indices, as shown in Figure 1. Indeed, there are four first-level multidimensional indexes, synthetizing only 2 o 3 dimensions; there are two second-level multidimensional indexes, with $K = 5$; there is one third-level multidimensional indices, the BMD, with $K = 10$.

[19] See, among the others, Barro and Sala-i-Martin (1992)

$$\frac{1}{T} g_i = \alpha + \beta I_{i0} + u_i \quad (6)$$

Where I_{i0} is the relevant variable recorded by individual i in the first year observed, $t = 0$; T measures the length of the time passed between the first and the last year observed; g_i is a measure of the growth of I_i between the first and the last year observed; and u_i has a mean equal to zero and a finite variance. The negative relation typical of convergence is therefore $\beta < 0$, and can be estimated through a cross-section regression.

Quah's (1993) arguments (based on Galton's fallacy) contributes to the emergence of σ- convergence as another way of identifying convergence. This case of convergence is described as the case in which "*Each country eventually becomes as rich as all the others - the cross-section dispersion diminishes over time*" (Quah, 1993, p.428). Further models were elaborated to encompass issues as spatial autocorrelation and non-stationarity (Tian et al., 2016). Using this method, we observe the dispersion over the years and see if there is a constant decrease of it. The measures of dispersion traditionally adopted by the convergence analysis are the standard deviation (σ_t) and the coefficient of variation (σ_t/μ_t where μ_t is the average value of our interest variable in the year t).

Our interest variable is bounded in the interval [0;1] recalling the beta distribution. For this reason, σ_t is not likely to increase linearly with the μ_t (therefore the coefficient of variation would be misleading). However, σ_t is likely to increase when $\mu \cong 0.5$, while it must be $\sigma_t = 0$ when $\mu = 0$ or when $\mu = 1$. Considering the distortive effect of the average, the variable σ_t is also discarded, to avoid that our measure of dispersion being rather a measure of μ_t. A more proper measure of the dispersion among the provinces is then the variance (i.e. standard deviation squared) corrected for the product of the average, ranging in [0;1], and its complementary number for 1, also ranging in [0;1]. In formula: $\frac{{\sigma_t}^2}{\mu_t \times (1-\mu_t)}$.

We remind that our BMD index is bounded in the interval [0;1], even if by construction these limits are never binding for the "comparable" 26 provinces obtained excluding Beijing, Tianjin, Shanghai, Chongqing, Tibet[20]. For this reason, the convergence analysis we operate can only refer to the period 1993-2016, while extensions to a longer time-span could require an updating of the model parameters described in section 4.1. Convergence within province will be tested on the sample of 26 "comparable" provinces, while the computations with the entire sample of 31 provinces were added as a robustness check.

5. Data

This investigation is based on 34 variables, collected at provincial level in each year of the 1993-2016 period. These variables are standardized and aggregated in 10 unidimensional indicators (with the methodology

[20] These five provinces include the four direct-controlled municipalities plus Tibet, which reports relatively highly volatile data. We excluded these provinces in the calculation of the parameters necessary to compute the MSI, and their values are therefore more likely to concentrate at the extreme tails. In addition to the methodological issue, these provinces have peculiar characteristics that make it difficult to imagine a convergence toward the same steady state for them and the other "regular" 26 provinces. Dealing with the convergence analysis, it is important to underline that, the [0;1] bound is particularly binding at the level of 34 variables, while it is less binding in the case of unidimensional indicators (the only case of unidimensional indicators equal to 1 is Environment Protection in Tibet, and the only case of unidimensional indicators equal to 0 is Innovation Capacity, again in Tibet).

discussed in chapter 4.1). These are the only variables upon which we evaluate the multidimensional wellbeing. This selection includes available information in almost all most relevant spheres of wellbeing according to the literature about SDGs, Human Development and Harmonious Society. Some exceptions, anticipated in section 3, involve those important dimensions what are not catch by any available provincial-level data, while others are founded only on an incomplete set of variables for the same reason[21].

A list of the 10 unidimensional indicators follows, each of them contains in parenthesis its underlying variables (34 in total).

- Classic Economic Measures (income per capita; household consumption in PPP; investments per capita);
- Innovation Capacity (patents accepted per capita; R&D Expenditure per capita; technical market/GDP);
- Infrastructure Endowment (highways/km^2; paved roads per capita; power generation per capita; popularization rate of telephone);
- Labour Conditions (unemployment rate; labour share of GDP; labour disputes per capita);
- Environment Protection (tons of sulphur emission per capita; tons of solid waste per capita; tons of waste water per capita);
- Health (hospital beds per capita; medical personnel per capita; budget expenditure in health per capita);
- Education (share of people with primary education; share of people with college or higher education; students/teacher ratio in primary schools; budget expenditure in education per capita);
- Urban Services (floor space; access to water; access to gas; public buses per capita; green areas per capita);
- Equality (urban household consumption over rural household consumption; rate of male population with college or higher education over rate of female population with college or higher education; average wage of workers in banking and insurance sector over average wage);
- Security; (environmental emergencies per capita; inflation of food prices above the CPI; deaths in traffic accidents per capita).

These ten unidimensional indicators are calculated as simple mean of their underlying variables, which in turn are normalized according to the procedure mentioned above. The multidimensional indicators synthesize in a single value (a selection of) the 10 unidimensional indicators. According to the how many and which indicators we included, there are several possible multidimensional indices, organized in three levels. The third-level multidimensional index, the “Balanced Multidimensional Development”, includes all the ten indicators. The “Sustainable Economic Development” and the “Inclusive Social Development” are second-level multidimensional indexes and contain respectively the first five (related to the economic sphere) and the last five (related to the social sphere) indicators listed. We can further decompose the economic index in “Economic Development” (considering the pillars of economic activities: Classic Economic Measures, Innovation and Infrastructure Endowments) and “Economic Sustainability” (considering Labour Conditions and Environmental Protection). Note that the two pillars of Economic Sustainability are two aspects traditionally neglected by the Chinese economic model, but which became relevant in the discourse around the harmonious society. We also decompose the social index in “Access to Basic Social Services” (considering:

[21] Political freedom and human rights constitute the most notable missing aspect in our analysis. However, such data are mostly related with policies implemented by the central government (especially in the Chinese context), since any political discrimination applies between different provinces. A different type of omission involves those variables that were not available (or were highly incomplete across time and space of our analysis), but that we would have wanted to add in the formation of the ten unidimensional indicators. These variables are: free time and work satisfaction (Labour Conditions); homicide rate (Security).

Health, Education and Urban Services) and "Inclusiveness of the Society" (considering: Equality and Security). Again, the inclusion of the second index, "Inclusiveness of the Society", corrects a narrow concept of development thanks to the greater comprehensiveness suggested by the harmonious society. The relation between the unidimensional indicators and the multidimensional indexes follows the description provided in the second section (Figure 1).

6. Results and Discussion

To be Finalized

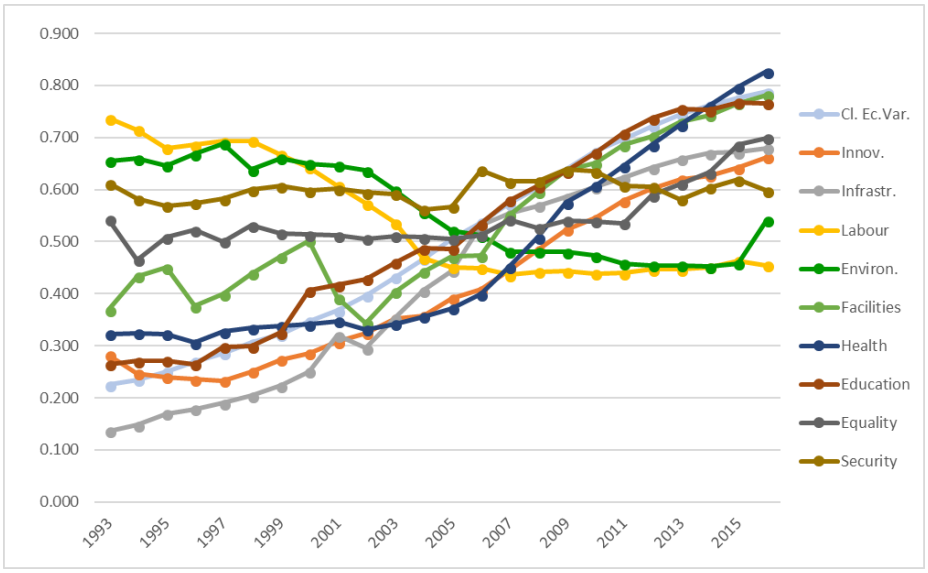
Consistently with our research questions, we divided our results in three subsections. The first analyses development over time and across provinces, adopting both unidimensional and multidimensional indexes. The second part looks at the relation between different types of development; the relation analysed are: economic development/economic sustainability; provision of social services/social inclusiveness; sustainable economic development/inclusive social development.

6.1 Chinese multidimensional development

Dealing with the 10 unidimensional variables, generally a positive trend appears considering overall China. In the 1993-2016, a remarkable growth involves particularly 4 variables: Classic Economic Measures, Innovation Capacity, Infrastructure Endowments and Education. Other three variables, Health, Urban Facilities and Equality are instead stable (or show a contrasted trend) in the first decade surveyed, while effective improvements are evident in the second period. Finally, three variables, Labour Conditions, Environment Protection and Security deteriorate over time. Figure 4 compares the trend over time of the 10 unidimensional indicators in overall China.

It is important to underline that among the three decreasing variables, no one records a considerable drop in the last years. However, such variables indicate the major weaknesses pointed out by the literature about Chinese development strategy (Saphiro, 2001; Ngai, 2005).

Figure 4: Wellbeing trend in 10 Dimensions, China, 1993-2016



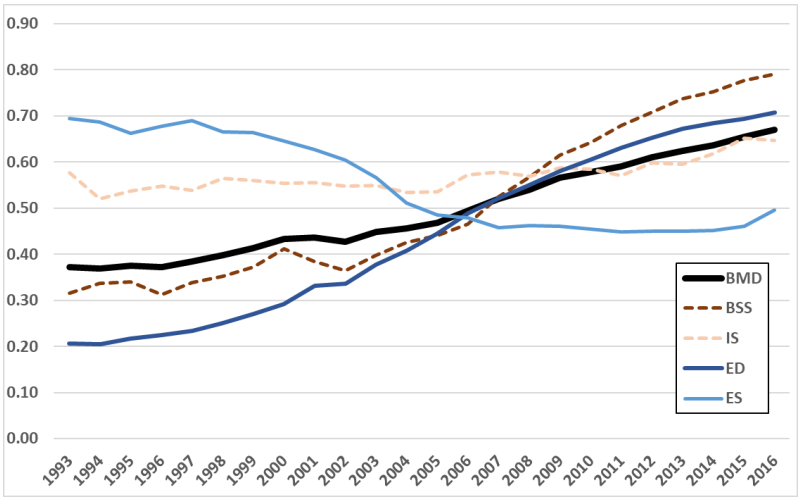
Source: Author's calculation.

As we described earlier, these unidimensional indicators can be grouped in 4 different indicators according to the type of variables included (Economic Development, Economic Sustainability, Access to Basic Social

Services, Inclusiveness of the Society), or in a single multidimensional indicator containing all of them (Balanced Multidimensional Development).

The Economic Development has constantly increased, even if with a slightly decreasing pace. Economic Sustainability has decreased in the first half of the period observed (approximately until 2005), to remain stable thereafter. The Access to Basic Social Services has improved, showing a mild increase in the Nineties characterised by booms and busts, followed by a steadier growth in the new millennium. The Inclusiveness of the Society has instead remained quite stable for most of the years considered. Figure 5 compares the trend over time of these 5 multidimensional indicators in overall China.

Figure 5: Wellbeing trend according to Multidimensional Indicators, China, 1993-2016



Source: Author's calculation. BMD=Balanced Multidimensional Development; BSS=Access to Basic Social Services; IS=Inclusiveness of the Society; ED=Economic Development; ES=Economic Sustainability.

The improvements in the multidimensional development in China has thus improved over time, sustained both by economic development and consequent better provision of social services. However, the critical points remain, as the environmental degradation, far from being recovered yet, and the scarce attention to the inclusiveness. The net evaluation of Chinese development in these 24 years is therefore dependent on the weights assigned to the different aspects of wellbeing[22], and exclusively focusing on the monetary aspects (or on the provision of services based on such economic development) is likely to overestimate Chinese achievements.

The indicators just analysed deal with development in China as a whole, but these aggregate achievements have been unequally distributed among provinces. Adopting the traditional division of Chinese provinces in the East, Centre and West regions, we observe that the eastern provinces are, on average[23], the strongest performers in terms of Balanced Multidimensional Development (and in Economic Development too). Central and Western provinces on the other hand lag behind the national average, with the western provinces always ranking in the lowest positions. The inner-coastal gap remains and is far from being closed, particularly in the sphere of "Economic Development".

[22] We recall that our measure equally weights the 10 unidimensional indicators. By weighting more the three dimensions which reports a decreases over time (Labour Conditions, Environmental Protection, Security), the net development can change become negative.

[23] The average of East, Center and West China, as well as the National average, is weighted according to the resident population.

6.2 The balancing of different types of development

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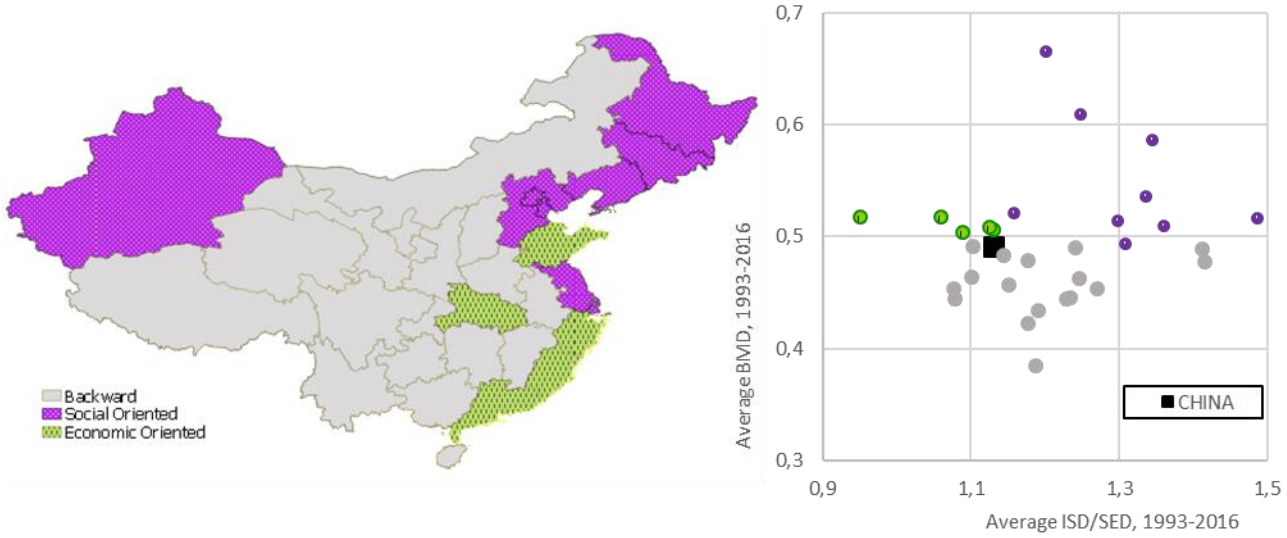
Figure 9 describes the three groups resulting from the comparison between overall China and individual provinces in terms of average multidimensional performance and average ratio between social and economic outcomes. Chinese provinces are thus divided in three groups: multidimensionally backward provinces; provinces with mainly-social development; provinces with a mainly-economic development. The map on the left Figure 9 implies a clear division between these three groups, even if some provinces are closer to intermediate situations, as we can observe from the graph on the right of Figure 9[24]. In the annex a more detailed picture represent the expansion over time of economic and social components separately.

Figure 9: Average Achievements of Chinese Provinces over Time, 1993-2016



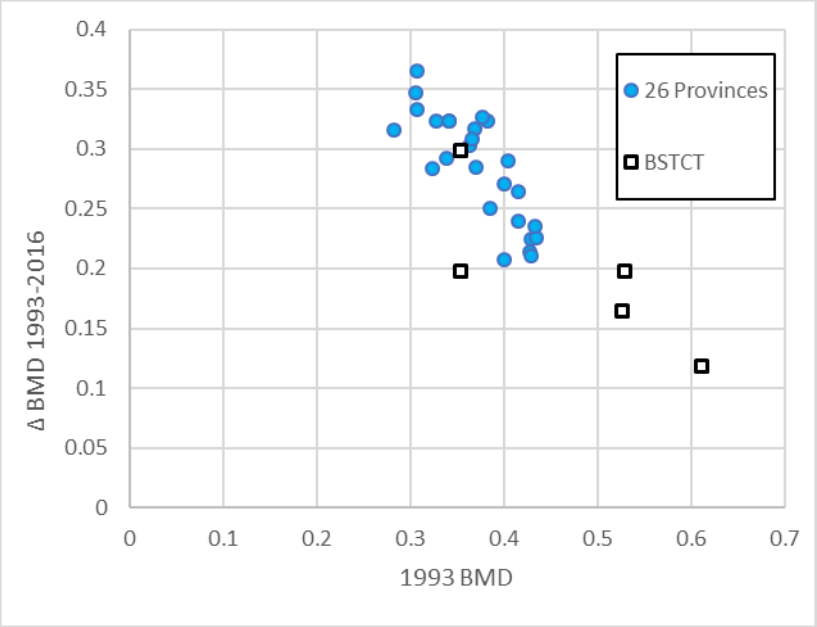
Source: Author's calculation. BMD=Balanced Multidimensional Development; ISD=Inclusive Social Development; SED=Sustainable Economic Development

6.3 Convergence

A first step in the analysis of convergence is based on the hypothesis of β-convergence. Graphically, Figure 10 shows that poorer provinces (in terms of multidimensional development recorded in 1993) are also those with the higher multidimensional growth. This statement holds both for the "normal" 26 provinces analyzed as well as for Tibet and the remaining four direct-controlled municipalities.

[24] Hainan (south-east China) has an average BMD score just below that of overall China: it is not far away from the group of Economic Oriented provinces. Qinghai and Shanxi (central China) also have an average BMD score slightly below the overall average and are not far away from the Social Oriented provinces. Hebei (central China) has a BMD score just above the overall average and is not far away from the Backward group. Hubei (central-east China) and Shandong (central China) have an average ratio between social and economic outcomes close to the overall average, and are not far away from the Social Oriented provinces.

Figure 10: relation between BMD in 1993 and the growth of BMD 1993-2016



Source: Author's calculation. BSTCT are the following five "anomalous" provinces: Beijing, Shanghai, Tianjin, Chongqing, Tibet.

We proceed to an econometric approach to test the significance of this convergence. Selecting the MSI observed in 26 provinces in 1993 and in 2016, we estimate the coefficient γ in the formula (8): if it is significantly lower than 1, we can reject the null hypothesis (the growth of the provincial MSI is unrelated to their initial multidimensional development) and confirm a converging trend.

The convergence among 26 provinces is significant. The coefficient γ is 0.17, significantly below 1[25]. This means that given two provinces, if one of them had a BMD higher of 0.01 in 1993, on average, its advantage will be only 0.0017 in 2016.

[25] The 95% Confidence interval ranges between -0.0763488 and 0.4089421.

7. Conclusions

To be Finalized

This study has tracked the evolution of China in terms of multidimensional development over the period 1993-2016. Our framework is based on the SHD, SDGs and HS. We have constructed an index of multidimensional development, the HMI, by adjusting measures of economic and social development featured in HS. Our index adopts the MSI-methodology to aggregate ten unidimensional indicators under the implicit hypothesis of convex preferences, which is consistent with the HS idea that "averages are better than the extremes", especially in the poorer contexts.

References