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Reform priorities for prosperity of nations: The Legatum Index

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Abstract

We apply a four-stage methodology (i.e., cluster analysis, data mining, partial least square path modeling, and importance-performance analysis) to identify the critical paths to multi-dimensional prosperity of nations. Using the Legatum Prosperity Index across 142 countries as a proxy for prosperity, we find strong evidence of the positive causal mechanisms among dimensions of prosperity. This implies that individual dimensions of prosperity should not be weighted equally in designing policies that support prosperity of nations. In line with human capital theory, we find that education and the pupil to teacher ratio are the key policy drivers of prosperity enhancement.

Keywords: Prosperity; Human capital theory; Legatum Prosperity Index; Wellbeing; Education

1. Introduction

The measurement of country's prosperity has long been a controversial issue. Policymakers traditionally focus on the accumulation of material wealth and use gross domestic product (GDP) as a measure of prosperity of nations because GDP is tangible and well understood by many people. A country with higher GDP per capita is generally considered to be a better place to live in. Though the value of GDP in this context should not be underestimated, some academics cast doubt on using only GDP as a primary benchmark of prosperity of nations. One critique is

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that GDP is a narrow measure of prosperity and does not reflect the way people perceive their wellbeing and happiness (e.g., Bonaiuto et al., 2015; Fleurbaey, 2009; Stiglitz et al., 2009). Critics also argue that material prosperity distracts people from other substantial values such as altruism and justice (Diener and Diener, 1995; Droge et al., 1993). Therefore, a broader definition of country's prosperity is more than just the material wealth represented by GDP. A country that fails to meet the basic human needs and the quality of life of its citizens is difficult to achieve sustainable development goals. In this regard, there have been initiatives across the world to measure prosperity relied on levels of both income and wellbeing.

As the public has a deep desire for higher levels of income and wellbeing, so does the need to precisely assess prosperity. However, prosperity is inherently complex concept with tradeoffs among multidimensional prosperity measures (e.g., Aristei and Perugini, 2010; Cifuentes et al., 2016). To capture the complexity of prosperity, the evaluation of prosperity often requires the integration of multiple indicators into the composite index, which is a well-known tool for evaluating the country's performance on prosperity creations. Among a number of prosperity indices, the Legatum Prosperity Index provides a unique insight into both material wealth and wellbeing dimensions of prosperity. In addition to the individual sub-index scores, the Legatum Prosperity Index provides the overall score and the ranking based on the equally-weighted aggregation of the sub-index scores.

The development of the overall index tends to be the default option used to simplify multidimensional indicators, as it provides a fast technical synthesis (Wong, 2015). Due to its simplicity, the equally-weighted overall score is the most commonly used aggregation method to summarize multiple indicators in a way that facilitates assessment and comparison (e.g., Becker et al., 2017; Goyal and Rahman, 2015). However, this paper argues that the use of the overall score of the Legatum Prosperity Index as a main policy tool is controversial because the simple average overall score assumes that each sub-index has an equal importance – that the individual sub-indices have an identical contribution to prosperity. Moreover, the simple aggregate average assumes that the composite measures of prosperity are independent, without any causal interrelation among individual sub-indices. This paper therefore removes these two flawed assumptions of the Legatum Prosperity Index and addresses research questions on three main themes: How much effect does each sub-index have on prosperity? Are there causal relationships between the eight sub-indices of prosperity? How should policymakers identify the critical drivers of prosperity for policy reforms?

To tackle the above research questions, this paper applies a four-stage integrative methodology: Expectation Maximization (EM) cluster analysis, Bayesian Network classifiers with Tree Augmented NaiveBayes (BN-TAN) data mining, partial least square (PLS) path modeling and importance-performance analysis (IPA). This methodology enables policymakers to examine the direct and indirect causal interrelations between sub-indices of the Legatum Prosperity Index, estimates the relative importance of individual sub-indices and pinpoints the critical sub-indices for reform priorities. To the best of knowledge, this four-stage methodology is the first attempt to construct pathways to prosperity of nations proxied by of the Legatum Prosperity Index. This paper finds strong evidence of the direct and indirect causal interdependences and the positive synergistic effects among sub-indices of prosperity, with unequal impacts of individual sub-indices on prosperity. Of all the sub-indices of prosperity, education is the most critical driver of prosperity enhancement, followed by economy, health, governance, safety and security, entrepreneurship and opportunity, personal freedom, and social capital. In line with human capital theory, the results of this study suggest that policymakers should give the first priority to improving the pupil to teacher ratio, the most critical variable of the education sub-index. The top-down approach to prioritizing the sub-indices and variables of the Legatum Prosperity Index has important implications for policy formation and assessment.

The remainder of this paper is organized as follows. Section 2 presents theoretical framework and hypothesis development. Section 3 describes the Legatum Prosperity Index. Section 4 presents the four-stage methodology. Section 5 reports the empirical findings. Given the obtained results, policy implications are provided in Section 6. Finally, Section 7 concludes the paper.

2. Theoretical framework and hypothesis development

The first flawed assumption of the Legatum Prosperity Index is that its simple average overall score assumes each sub-index of prosperity has an equal importance. The equal weighting scheme has aroused controversies, most of which concentrate on transparency and validity of the equally-weighted indices. While equal weighting is recognized as the simplest weighting method, it can be employed only when all the indicators are considered equally important or when no statistical evidence supports other weighting schemes (OECD, 2008). The main drawback of equal weighting is that any interrelation between sub-indices may cause the double weighting of a particular sub-index (Goyal and Rahman, 2015). Moreover, assuming equal weighting system implies that improving the performance of any sub-index would equally contribute to prosperity as a whole. This assumption is rarely the case in real world applications because different countries may focus on different sub-indices. Questions may undoubtedly be asked whether it is sound to assign the same weight to all sub-indices. If policymakers would like to improve levels of wellbeing and national income, is a country's education system as important as its healthy economy? Parallel studies show that the validity of the composite index substantially depends on how multidimensional indicators are weighted (Becker et al., 2017; Budsaratragoon and Jitmaneeroj, 2020). Countries with the top-ranked overall scores of prosperity usually attract great attention and foreign direct investment from multinational companies, which in turn heightens income and wellbeing dimensions of prosperity. Besides, the overall score and ranking outcomes force governments to question their policy effectiveness (Kelley and Simmons, 2015). Therefore, it would be more reasonable if the weighting system of the Legatum Prosperity Index displayed the relative importance of sub-indices rather than giving equal weight to them. This argument leads to the following hypothesis.

H1. Individual sub-indices of the Legatum Prosperity Index have unequal effects on prosperity.

Besides the issue of equal weighting schemes, a simple average overall score of the Legatum Prosperity Index assumes that the multidimensional measures of prosperity are independent, without any interrelation among sub-indices. This assumption may be misleading if policymakers select to improve certain aspects of prosperity, but these are correlated with others that also matter for the outcomes they are trying to achieve. Numerous studies find causal connections between indicators of prosperity. As pointed out by Wong (2015), the challenge of developing the city prosperity index is more than selecting the suitable weighting scheme, but it should consider different aspects of prosperity and causal relationships between different driving forces of prosperity (i.e., productivity, quality of life, infrastructure development, equity and social inclusion, environmental sustainability). Recently, Tomich et al. (2018) find a set of 18 possible pathways to prosperity by analyzing both direct and indirect causal mechanisms between investments in agricultural research and prosperity. To provide guidance on reform priorities, policymakers may wish to know which sub-indices contribute most to prosperity and how individual sub-indices interact with one another. For example, does the improvement of safety and security of nation result in lower personal freedom? However, the Legatum Prosperity Index does not provide such causal relationships for policymakers to identify the critical policy levers that should be prioritized to enhance prosperity. With information about causal interrelations among sub-indices, policymakers could focus more accurately on the critical areas of prosperity. Thus, it would be more beneficial to construct causal relationships between individual sub-indices of the Legatum Prosperity Index. In this spirit, the following hypothesis is proposed.

H2. There exist causal relationships between individual sub-indices of the Legatum Prosperity Index.

According to human capital theory, prosperity can be enhanced by not only financial capital, labor and natural resources but also the knowledge and skill of individuals (e.g., Schultz, 1961; Becker, 1993). Considering education as an investment in human capital forms the basis for arguments that government funding on education policy should be increased. Holden and Biddle (2017) point out that human capital theory implies that effective education policy is able to advance goals – first faster economic growth, then poverty reduction – that circumstances push to the top of the US policy agenda during the period of human capital theory's initial development. In this sense, policymakers usually view education through the lens of human capital theory, in which education is a means of developing knowledge and skill and achieving prosperity (Crocker, 2007; Fitzsimons, 2017). At present, a number of survey articles on the relationship between human capital and education generally have referred to a seminal work of Mincer (1974) who proposes that earnings are the function of level of education and work experience (e.g., Heckman et al., 2013; Lemieux et al., 2009). Understanding the determinants of earnings helps policymakers develop strategies to promote prosperity. For instance, Annabi et al., 2011 find that higher education expenditure in Canada has a positive influence of human capital accumulation and leads to an increase in GDP although this relationship depends on the financing sources of education policy. Due to the important role of education in prosperity enhancement, the following hypothesis is formulated.

H3. Of all the eight sub-indices of the Legatum Prosperity Index, the education sub-index is the most critical driver of prosperity.

3. The Legatum Prosperity Index

The Legatum Institute launches the Legatum Prosperity Index from a concern that prosperity of a country is not adequately expressed by the GDP per capita. The 2015 Legatum Prosperity Index provides a unique framework to assess prosperity in terms of both income and wellbeing across 142 countries. Through a careful study of empirical research, Legatum Institute collects a total of 89 variables including both objective and subjective measures of prosperity. The objective variables are classified into three categories: survey-based variables such as how many mobile phones are in a household, statistics such as inflation rate, and expert assessments such as the World Bank's governance indicators. The subjective variables measure respondents' perceptions of their life such as health satisfaction. 89 variable scores are standardized and then aggregated into eight sub-index scores by using a weighted average. Each sub-index has both income and wellbeing indicators. The weight attributed to each variable score is determined by regression analyses. The sub-index scores provide an indication of what policy reforms a country might make to improve its prosperity in comparison with other countries. In contrast to the sub-index scores, the overall score of prosperity is computed by the equally-weighted aggregation of the eight sub-index scores. A simple average overall score suggests that Legatum Institute considers all elements of prosperity as having equal importance[1] .

4. Analytical framework

4.1. Expectation Maximization cluster analysis

The previous studies demonstrate that performing EM cluster analysis prior to data mining improves the accuracy of BN-TAN algorithm in searching for all possible causal connections between variables (Lan et al., 2013). EM clustering technique is an unsupervised cluster analysis that automatically partitions 142 countries into a set of coherent clusters based on the eight sub-index scores of the Legatum Prosperity Index. Each cluster contains relatively similar sub-index scores – at least, the similarity among countries within a cluster should be greater than the similarity among countries in different clusters. This paper uses Waikato Environment for Knowledge Analysis (WEKA) software for EM cluster analysis with a test mode of ten-fold cross validation mode (Witten et al., 2011).

4.2. Bayesian Network classifiers with Tree Augmented NaiveBayes data mining

Without data mining technique, researchers subjectively assign causal directions by using their own judgment. Contradictory theoretical perspectives may lead to contradictions in the sequences of causal directions. When there is no theoretical background on causal directions, several studies consider BN-TAN data mining as a promising tool for dealing with the uncertainty of causal models (e.g., Cerquides and De Mantaras, 2005; Lan et al., 2013). Rather than assuming subjective causal directions between sub-indices of prosperity, BN-TAN estimates all the possible causal directions given by different combinations of sub-index scores to construct a causal diagram that maximizes the likelihood function. This paper uses WEKA software for BN-TAN data mining with a test mode of ten-fold cross validation.[2] Following previous literature, causal directions constructed by BN-TAN data mining have to be reversed before estimating PLS path modeling (e.g., Lan et al., 2013). The rationale for reversing the preliminary causal directions generated by the BN-TAN is that the overall score is the target variable and the causal arrows should be pointed from sub-index scores towards the overall score.

4.3. Partial least square path modeling

PLS path modeling has gained increasing attention in many disciplines because it requires less restricted assumptions about the distribution of data and sample size (Lan et al., 2013). PLS path modeling is widely used to examine causal relationships among several variables (Jitmaneeroj, 2016). This paper uses SmartPLS software to estimate the PLS path models and test whether the hypothesized causal directions constructed by BN-TAN data mining are statistically significant. Rather than assuming equal weight for all sub-indices, PLS path modeling estimates the direct and indirect effects of individual sub-index scores on the overall score of prosperity. The direct

[1] A detailed description of sub-index scores and variable scores can be found in the methodology and technical appendix of the 2015 Legatum Prosperity Index at http://www.prosperity.com

[2] More concretely, WEKA separates the data randomly into ten folds, iteratively utilizes the cross validation method to estimate the error of BN-TAN classifier, and reports the highest accuracy results as a preliminary causal diagram.

effect is the direct causal link between the sub-index scores and the overall score. The indirect effect is the indirect causal connection from the sub-index scores to the overall score via any other sub-index score. The total effect is the combination of the direct and indirect effects.

4.4. Importance-performance analysis

Using the estimation results from PLS path modeling, IPA contrasts the importance of sub-indices (the total effect) on the x-axis and the performance of sub-indices (the average values of rescaled sub-index scores) on the y-axis. To construct IPA, the SmartPLS software rescales individual sub-index scores to obtain index values by subtracting the minimum possible value from a data point and then dividing this data point by the difference between the maximum and minimum data points.[3] Conclusions can be drawn about both the importance and performance dimensions that are particularly important for prioritizing sub-indices for policy reforms. Policymakers should focus on a sub-index with high importance but where performance is relatively low. In other words, the sub-index with the lowest performance-importance ratio deserves to be the first priority for policy reforms.

5. Empirical results

5.1. Expectation Maximization cluster analysis

EM clustering technique partitions 142 countries into seven groups relied on the eight sub-index scores of the Legatum Prosperity Index: economy (P1), entrepreneurship and opportunity (P2), governance (P3), education (P4), health (P5), safety and security (P6), personal freedom (P7) and social capital (P8). Fig. 1 shows the list of countries in each cluster: cluster 1 (20 countries), cluster 2 (11 countries), cluster 3 (24 countries), cluster 4 (20 countries), cluster 5 (22 countries), cluster 6 (32 countries) and cluster 7 (13 countries). It is noted that all countries in cluster 4 are developed countries. One would thus expect that the sub-index scores and the overall score of cluster 4 are higher than any other cluster. The number of clusters will be used as a categorical variable in the subsequent analysis of BN-TAN data mining.

5.2. Bayesian Network classifiers with Tree Augmented NaiveBayes classification analysis

BN-TAN data mining searches for all feasible causal connections and constructs a preliminary causal diagram as displayed in Fig. 2.[4] The causal diagram indicates that all sub-index scores not only have causal interrelations with the overall score but also have causal connections with one another. More specifically, there are eight causal relationships between the sub-index scores and the overall score and seven causal relationships among the sub-index scores.

[3] For instance, a sub-index score for education (P4) in the United Kingdom is 0.970, whereas the maximum and minimum P4 across all countries are 1.205 and 0.110, respectively. Hence, the rescaled sub-index score for P4 in the United Kingdom is 100*(0.970-0.110)/(1.205-0.110) = 78.539.

[4] The causal diagram is comprised of exogenous and endogenous variables. Any variable that has only single-headed arrows going out of it is an exogenous variable (i.e., those variables that explain other variables in the model: P3, P4, P5, and P7). Endogenous variables can have either single-headed arrows going both into and out of them or only going into them (i.e., those variables that are being explained in the model: P1, P2, P6, P8, and OVERALL).

Clusters	Countries
1 (20 countries)	Bangladesh, Bolivia, Botswana, Dominican Republic, El Salvador, Ghana, Guatemala, India, Lao, Morocco, Namibia, Nepal, Nicaragua, Paraguay, Peru, Philippines, Rwanda, Senegal, South Africa, Tajikistan
2 (11 countries)	Algeria, Armenia, Bosnia and Herzegovina, Egypt, Arab Rep., Honduras, Iran, Jordan, Lebanon, Moldova, Tunisia, Venezuela
3 (24 countries)	Chile, Costa Rica, Cyprus, Czech Republic, Estonia, Hong Kong, Hungary, Israel, Italy, Korea, Kuwait, Latvia, Lithuania, Malaysia, Malta, Poland, Portugal, Saudi Arabia, Slovak Republic, Slovenia, Spain, Taiwan, United Arab Emirates, Uruguay
4 (20 countries)	Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Iceland, Ireland, Japan, Luxembourg, Netherlands, New Zealand, Norway, Singapore, Sweden, Switzerland, United Kingdom, United States
5 (22 countries)	Benin, Burkina Faso, Cambodia, Cameroon, Congo, Rep., Cote d'Ivoire, Djibouti, Ethiopia, Iraq, Kenya, Malawi, Mali, Mauritania, Mozambique, Niger, Nigeria, Sierra Leone, Tanzania, Togo, Uganda, Zambia, Zimbabwe
6 (32 countries)	Albania, Argentina, Azerbaijan, Belarus, Belize, Brazil, Bulgaria, China, Colombia, Croatia, Ecuador, Georgia, Greece, Indonesia, Jamaica, Kazakhstan, Kyrgyz Republic, Macedonia, Mexico, Mongolia, Montenegro, Panama, Romania, Russian Federation, Serbia, Sri Lanka, Thailand, Trinidad and Tobago, Turkey, Ukraine, Uzbekistan, Vietnam
7 (13 countries)	Afghanistan, Angola, Burundi, Central African Republic, Chad, Congo, Dem. Rep., Guinea, Haiti, Liberia, Pakistan, Sudan, Syrian Arab Republic, Yemen

Fig. 1. The list of countries classified by the EM cluster analysis.
Notes: The EM cluster analysis partitions 142 countries into seven clusters based on the eight sub-index scores for prosperity: economy (P1), entrepreneurship and opportunity (P2), governance (P3), education (P4), health (P5), safety and security (P6), personal freedom (P7) and social capital (P8). WEKA software is used to perform the EM cluster analysis with the mode of 10-fold cross validation.

As EM clustering enables BN-TAN data mining to search for accurate causal relationships, the quality of EM clustering is, therefore, assessed by the predictive accuracy of BN-TAN algorithm relative to other data mining algorithms (e.g., Lan et al., 2013). This implies that the results of EM cluster analysis are not directly evaluated per se but are regarded as a means to improving the accuracy of BN-TAN algorithm. In this context, a number of data mining algorithms are used to evaluate the predictive accuracy of BN-TAN algorithm. The accuracy of each algorithm is listed as follows: J48 (90.12%), NaiveBayes (91.25%), RBFNetwork (92.18%), DTNB (93.23%) and BN-TAN (95.54%). It is evident that BN-TAN algorithm outperforms any other algorithm.[5] Therefore, performing EM clustering prior to BN-TAN data mining is quite satisfactory.

5.3. Partial least square path modeling

After reversing the causal diagram generated by BN-TAN data mining, we estimate the PLS path model and report the results in Table 1. Focusing on the path coefficients that directly link sub-indices to the overall score, it can be seen that individual sub-indices have unequal direct effects on prosperity. P6 has the greatest direct effect (0.154), followed by P4 (0.153), P5 (0.147), P2 (0.145), P3 (0.145), P7 (0.139), P8 (0.138) and P1 (0.114). All sub-indices significantly positively affect the overall score of prosperity at the 5% significance level. It is worth noting that all causal directions from the sub-index scores to the overall score and five out of seven (71%) causal directions among sub-index scores are statistically significant at conventional levels.

[5] The detailed results of comparisons between different data mining algorithms are available upon request.

Table 1
The results of the PLS path model at the sub-index level.

Causal relationship (1)	Direct effect (2)	t-stat (3)	Indirect effect (4)	t-stat (5)	Total effect (6)	t-stat (7)	Performance (8)	Performance Importance (9)
P1 -> OVERALL	0.114***	23.65	0.147***	10.25	0.261***	19.12	52.38	201.04
P1 -> P6	0.680***	15.35			0.680***	15.35		
P2 -> OVERALL	0.145***	41.30	0.063***	3.94	0.208***	12.55	55.20	265.79
P2 -> P8	0.454***	4.01			0.454***	4.01		
P3 -> OVERALL	0.145***	37.55	0.024	1.23	0.168***	8.64	39.91	236.99
P3 -> P8	0.170	1.23			0.170	1.23		
P4 -> OVERALL	0.153***	23.29	0.182***	11.33	0.335***	23.38	61.73	184.26
P4 -> P1	0.699***	16.61			0.699***	16.61		
P5 -> OVERALL	0.147***	30.32	0.141***	8.49	0.288***	15.31	58.31	202.61
P5 -> P2	0.677***	12.00			0.677***	12.00		
P6 -> OVERALL	0.154***	30.69	0.061***	4.69	0.216***	14.79	54.85	254.51
P6 -> P2	0.295***	4.99			0.295***	4.99		
P7 -> OVERALL	0.139***	24.34	0.024*	1.84	0.163***	11.26	52.98	325.49
P7 -> P8	0.175*	1.82			0.175*	1.82		
P8 -> OVERALL	0.138***	21.09			0.138***	21.09	48.16	348.30

Notes: This table reports the results of PLS path models including nine variables: economy (P1), entrepreneurship and opportunity (P2), governance (P3), education (P4), health (P5), safety and security (P6), personal freedom (P7), social capital (P8), and overall score (OVERALL). The bootstrapping procedure is used to test the hypothesized causal relationships in the path model. The total effect equals the sum of the direct effect (path coefficient) and the indirect effect. The path coefficients and their t-statistics are reported in columns 2 and 3. The indirect effects and their t-statistics are reported in columns 4 and 5. The total effects and their t-statistics are reported in columns 6 and 7. The performance dimension is in column 8 and the performance-importance ratio is in column 9. The SmartPLS software rescales each sub-index score to obtain index value by subtracting the minimum possible value from an estimated data point and then dividing this data point by the difference between the maximum and minimum data points. The performance dimension is calculated as the average values of rescaled sub-index scores. The total effect represents the importance dimension. ***, ** and * signify statistical significance at 1, 5 and 10% respectively.

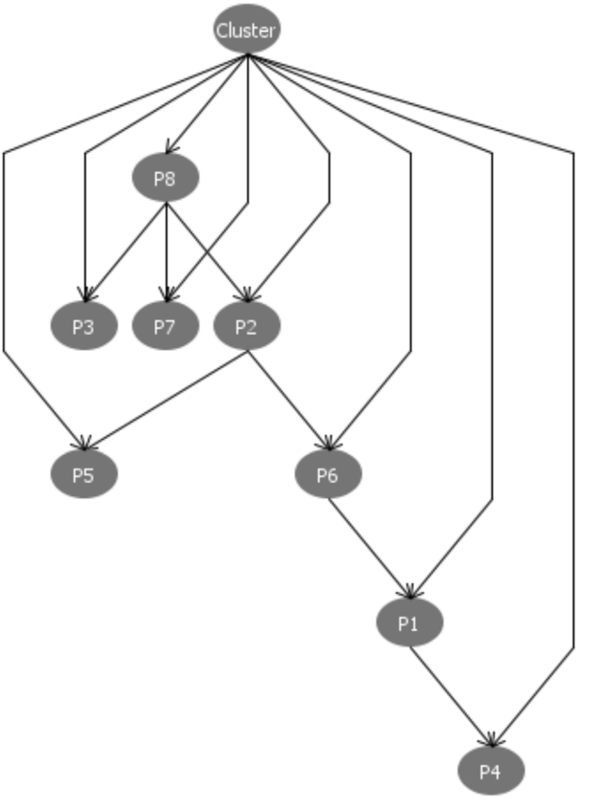

Fig. 2. The preliminary causal diagram generated by BN-TAN classifier.
Notes: This figure shows the preliminary causal diagram generated by BN-TAN classifier in WEKA software. The preliminary causal diagram consists of nine variables: economy (P1), entrepreneurship and opportunity (P2), governance (P3), education (P4), health (P5), safety and security (P6), personal freedom (P7), social capital (P8) and a categorical variable from EM cluster analysis (Cluster).

Apart from the direct effects (columns 2 and 3), Table 1 reports the indirect effects (columns 4 and 5) and the total effects (columns 6 and 7) of sub-index scores in explaining the overall score of prosperity. The relative importance of sub-indices in explaining prosperity can be investigated by the total effect which equals the combination of direct and indirect effects.[6] Of all sub-indices, P4 (0.335) has the largest total effect on prosperity, followed by P5 (0.288), P1 (0.261), P6 (0.216), P2 (0.208), P3 (0.168), P7 (0.163) and P8 (0.138). This finding supports the first hypothesis (H1) and leads to the conclusion that individual sub-indices have unequal effects on prosperity. Put differently, this paper finds evidence against the Legatum Prosperity

[6] For instance, P7 and OVERALL variables are connected by the direct effect P7→OVERALL, with the path coefficient of 0.139. Moreover, P7 has an indirect effect on OVERALL through P8 (P7→P8→OVERALL). The indirect effect can be calculated as the product of path coefficients P7→P8 (0.175) and P8→OVERALL (0.138), implying that the indirect effect equals to 0.175 x 0.138 = 0.024. As a result, the total effect is 0.163, which is computed as the sum of the direct and indirect effects (0.139 + 0.024 = 0.163).

Index's assumption that individual sub-indices have an identical contribution to prosperity. In this sense, assuming equal weight for all sub-indices provides misleading information for policy formation and assessment. In parallel studies, when policymakers are asked to allocate their resources among N options, they are more likely to put 1/N of available resources into all options. The 1/N allocation heuristic often leads to resource inefficient actions (e.g., Benartzi and Thaler, 2001; Huberman and Jiang, 2006). It is argued that the weights not only reflect the relative importance of sub-indices but also symbolize the tradeoffs among sub-indices if they are conceived as substitutable. Recently, Becker et al. (2017) explain that correlations among sub-indices tend to prevent the weights from corresponding to the sub-indices' importance. Hence, policymakers should be cautious in conducting prosperity policy because the equally-weighted aggregation of the Legatum Prosperity Index does not correspond to the relative importance of sub-indices on prosperity.

In an analysis of the causal mechanism, the primary objective is to decompose the total effect into the direct and indirect effects. The presence of positive indirect effects implies the synergistic effects among sub-indices that are not present for sub-indices in isolation. From Table 1, it can be seen that 5 out of 7 (71%) indirect effects and 13 out of 15 (87%) total effects are significantly different from zero at the 5% significance level. This implies that prosperity is not only influenced by the direct effects of sub-indices but also by the indirect effects of the interactions between sub-indices. Table 1 also shows that P4 displays the greatest indirect effect (0.182), followed by P1 (0.147), P5 (0.141), P2 (0.063), P6 (0.061), P3 (0.024) and P7 (0.024). More interestingly, the total effects of P1 and P4 are found to be predominantly due to the indirect effects. The indirect effects of P1 and P4 account for about 56% and 54% of the total effect, respectively. It may be concluded that the effects of economy (P1) and education (P4) on prosperity are primarily through other sub-indices including safety and security (P6), entrepreneurship and opportunity (P2) and social capital (P8). The existence of positive causal interactions and synergistic effects among sub-indices substantiates the second hypothesis (H2). In other words, this finding provides evidence against the Legatum Prosperity Index's assumption that there is no interrelation among individual sub-indices. The positive causal interactions between sub-indices suggest that policymakers should implement prosperity policy that incorporates all sub-indices in order to benefit from a synergistic combination of sub-indices. The positive synergistic effect among sub-indices implies that interactions between sub-indices produce a greater effect than the total of all the individual effects.

5.4. Importance-performance analysis

The presence of synergistic effects does not mean that all sub-indices should be weighted equally in policy design. IPA can be used to prioritize sub-indices and identify the critical drivers of prosperity. IPA contrasts the importance of sub-indices (the total effect) on the x-axis and the performance of sub-indices (the average values of rescaled sub-index scores) on the y-axis. Policy reforms should target at sub-indices that have relatively high importance but relatively low performance. In other words, the sub-index with the lowest performance-importance ratio deserves to be the first priority for prosperity enhancement. Table 1 reports a comparative analysis of the performance-importance ratios across all sub-indices. For instance, the performance of P3 (39.91) offers more headroom for future improvement than P4 (61.73), but the importance of P3 in affecting OVERALL (the total effect = 0.168) is rather lower than P4 (the total effect = 0.335). Hence, P3 may not justify reform priorities because the performance-importance ratio of P3 (236.99) is higher than that of P4 (184.26). After comparing the performance-importance ratios across all sub-indices, policymakers should allot their often limited resources to the highest priority sub-indices, which are ranked education (P4: 184.26), economy (P1: 201.04), health (P5: 202.61), governance (P3: 236.99), safety and security (P6: 254.51), entrepreneurship and opportunity (P2: 265.79), personal freedom (P7: 325.49) and social capital (P8: 348.30).

In line with the third hypothesis (H3), the above analysis demonstrates that education is the most critical driver for prosperity. As a powerful tool for increasing knowledge and skill, education is widely regarded as the very core of human capital theory. This finding is consistent with extant studies on economic growth that have found human capital to be a key driver for growth and non-diminishing effect of education on increasing GDP levels (e.g., Annabi, 2017; Grossmann, 2008). For example, Ludwig and Sawhill (2007) propose larger government spending in early childhood education by initiating a "Success by Ten" program to help children achieve success in school by ten years old. More recently, Heckman, Nobel laureate, and his colleagues estimate the rate of return and the benefit-cost ratio for the HighScope Perry Preschool Program, an early intervention program targeted toward disadvantages African-American youth (Heckman et al., 2013). They find that the estimated annual social rate of return typically ranges from 7 to 10 percent and the benefit-cost ratio is in the range of 7 to 12 dollars per person.

5.5. *Identifying the most critical variable of the education sub-index*

To gain a better understanding of reform priorities, the current study suggests that policymakers use the top-down approach which involves hierarchical decisions on the most critical sub-index and subsequently the most critical variable of such a sub-index. After identifying education as the most critical sub-index, policymakers may wish to know further which variable of the education sub-index is worth giving the highest priority for policy reforms. The education sub-index is composed of 9 variable scores: net primary enrolment (E1), gross secondary enrolment (E2), gross tertiary enrolment (E3), girls to boys enrolment ratio (E4), pupil to teacher ratio (E5), secondary education per worker (E6), tertiary education per worker (E7), perception that children are learning in society (E8) and satisfaction with educational quality (E9). Nonetheless, E8 and E9 are excluded from the subsequent analysis because Legatum Institute is unable to provide the data for these two variables due to restrictions on the use of the data.

To determine the most critical variable of the education sub-index, the four-stage methodology is repeated to investigate the causal relationships among seven variables of the education sub-index. In doing so, EM clustering partitions countries into similar groups based on the variable scores E1 to E7. BN-TAN data mining searches for causal relationships between variables and the education sub-index. PLS path modeling estimates the indirect and direct effects of each variable on the education sub-index. Finally, IPA identifies the most critical variable whose performance-importance ratio exhibits the lowest value.

The results of the four-stage analysis displayed in Table 2 reveal that the pupil to teacher ratio (E5) is the most critical driver of the education sub-index, with the performance-importance ratio of 129.36.[7] A plausible explanation of this finding is that while the increases in enrolment rates and years of education per worker may suggest the rise in school capacity to accommodate more students, they do not warrant the improvement in educational quality. Besides, the increases in

[7] To save space, only the results of PLS path modeling and IPA are reported. The complete results including descriptive statistics of variable scores, EM clustering and BN-TAN data mining can be requested from the authors.

Table 2
The results of the PLS path model at the variable level.

Causal relationship (1)	Direct effect (2)	t-stat (3)	Indirect effect (4)	t-stat (5)	Total effect (6)	t-stat (7)	Performance (8)	Performance Importance (9)
E1 -> P4	0.133***	15.27	0.063***	5.93	0.196***	14.26	69.87	356.70
E1 -> E2	0.005	0.06			0.005	0.06		
E2 -> P4	0.108***	3.82	−0.002	0.43	0.107***	3.78	41.91	392.34
E2 -> E3	0.188***	2.77			0.188***	2.77		
E3 -> P4	0.105***	21.34	0.047***	3.13	0.153***	9.44	51.99	340.04
E3 -> E7	0.365***	6.63			0.365***	6.63		
E4 -> P4	0.115***	9.95	0.001	0.06	0.116***	5.94	65.74	568.04
E4 -> E1	−0.0020.25-0.002	0.25			−0.002	0.25		
E5 -> P4	0.415***	9.90	−0.014	1.21	0.401***	9.08	51.84	129.36
E5 -> E1	0.112	1.24			0.112	1.24		
E6 -> P4	0.050***	2.87	0.000	0.22	0.050***	2.85	48.43	973.99
E6 -> E2	0.262***	3.20			0.262***	3.20		
E7 -> P4	0.014	0.64	0.038***	4.88	0.052***	4.82	47.55	914.42
E7 -> E5	0.539***	6.22			0.539***	6.22		

Notes: This table reports the results of PLS path models for 7 variables of the education sub-index: net primary enrolment (E1), gross secondary enrolment (E2), gross tertiary enrolment (E3), girls to boys enrolment ratio (E4), pupil to teacher ratio (E5), secondary education per worker (E6), tertiary education per worker (E7), and the education sub-index (P4). The bootstrapping procedure is used to test the hypothesized causal relationships in the path model. The total effect equals the sum of the direct effect (path coefficient) and the indirect effect. The path coefficients and their t-statistics are reported in columns 2 and 3. The indirect effects and their t-statistics are reported in columns 4 and 5. The total effects and their t-statistics are reported in columns 6 and 7. The performance dimension is in column 8 and the performance-importance ratio is in column 9. The SmartPLS software rescales each sub-index score to obtain index value by subtracting the minimum possible value from an estimated data point and then dividing this data point by the difference between the maximum and minimum data points. The performance dimension is calculated as the average values of rescaled sub-index scores. The total effect represents the importance dimension. ***, ** and * signify statistical significance at 1, 5 and 10%, respectively.

enrolment rates can lead to the poor quality of education if the number of teachers keeps constant or increases at the lower rates. With this situation, it is difficult for teachers to deal with overcrowded classrooms. As documented by UNESCO (2015), the high enrolment rate has caused the low educational efficiency in schools, which is one of the underlying reasons for the poor quality of education in developing countries. Therefore, the pupil to teacher ratio better reflects the educational quality and deserves the highest priority for a successful reform of prosperity.

6. Policy implications

The results of this paper have several important policy implications. First, despite its simplicity, the equal weighting method of the Legatum Prosperity Index seems invalid for prosperity assessment. The correlations among sub-indices can prevent the equal weights from corresponding to the sub-indices' importance (Becker et al., 2017). Policymakers therefore should be cautious in conducting prosperity policy because the equally-weighted aggregation of the Legatum Prosperity Index does not correspond to the relative importance of sub-indices. The weighting scheme of sub-indices should be revealed by their relative importance, which means that the sub-indices with greater total effects on prosperity should be assigned larger weights, and vice versa.

Second, the understanding of causal mechanism helps policymakers to make effective prosperity policy depending on causal directions and magnitudes of sub-indices. The presence of positive causal relationships between sub-indices implies that policymakers should not advance each sub-index in isolation. Prosperity policy should contain all dimensions of prosperity in order to benefit from the synergistic effects among sub-indices. Therefore, if a country aims to enhance prosperity, but its policy does not contain all dimensions of prosperity, policymakers should reconsider prosperity policy to incorporate all sub-indices of the Legatum Prosperity Index. However, this is not to say that all sub-indices should be weighted equally in policy design.

Finally, given fiscal challenges and limited resources of each country, it is crucial that well-designed public policies should be targeted to the most critical driver of prosperity. Government spending on inefficient projects or in wrongly targeted ways is not only a waste of scarce resources but also a detriment to public confidence in government efficacy. In this respect, policymakers require a combination of suitable methodologies to capture causal interdependences between sub-indices (variables) and identify the critical sub-indices (variables). To construct a pathway to prosperity, policymakers should follow the top-down approach which involves hierarchical decisions on the critical driver at the sub-index level and subsequently at the variable level. Equipped with suitable statistical techniques, like those outlined in this study, policymakers can accumulate important knowledge about causal mechanisms that enable to prescribe better prosperity policy alternatives.

7. Concluding remarks

The eight sub-indices of the Legatum Prosperity Index are powerful benchmarking indicators for evaluating prosperity policies. A problem that may be of particular importance in policy analysis is that individual sub-indices are often overshadowed by the overall score based on the equally-weighted aggregation of sub-indices. A decision-making process relying solely on the overall score is questionable because the calculation of the overall score of the Legatum Prosperity Index rests on strong assumptions that individual sub-indices contribute equally to prosperity and are mutually independent without any interrelation between them. These assumptions deserve great attention and require a combination of innovative methodologies. This paper outlines the statistical methods needed for going beyond the overall score to the estimation of causal mechanisms among sub-indices. By relaxing the two flawed assumptions of the Legatum Prosperity Index, the four-stage methodology provides a practical guide for policymakers to realize causal interrelations among sub-indices and identify the sub-indices that should be prioritized for policy reforms.

Using country-level prosperity data from the 2015 Legatum Prosperity Index across 142 countries, there is evidence of positive causal linkages and synergistic effects among sub-indices, with unequal effects of individual sub-indices on prosperity. These results imply that assuming equal weight for all sub-indices provides misleading information for policy formation and assessment. Besides, prosperity is not only positively affected by the direct effects of individual sub-indices but also by the indirect effects among sub-indices. Interestingly, a substantial portion of the total effect of economy and education sub-indices on prosperity is mainly due to the indirect effect. The presence of positive indirect effects implies the synergistic effects among sub-indices. The positive synergistic effect is the result of two or more sub-indices interacting together to produce an effect that is greater than the cumulative effect that those sub-indices produce when used individually. The concept of synergistic effects is therefore an important consideration in prosperity enhancement whenever multiple policy choices are present in decision-making process. However, the synergistic effects do not mean that all sub-indices should be weighted equally in policy design.

To construct a roadmap for reform priorities, policymakers should follow the top-down approach which involves hierarchical decisions on the critical drivers at the sub-index level and subsequently at the variable level. Importance-performance analysis suggests that policymakers should give first priority to sub-indices that have relatively high total effect but relatively low performance. The results of this study indicate that the sub-index deserving of highest reform priorities is education, followed by economy, health, governance, safety and security, entrepreneurship and opportunity, personal freedom and social capital. Taking the analysis one step further, this paper finds that the pupil to teacher ratio is the most critical driver of the education sub-index. Overall, the findings of this study provide evidence in support of human capital theory, in which education is a means of developing knowledge and skill and achieving prosperity. These results have implications for policymakers in setting targets for policy development and strategic priorities to improve prosperity. Considering education as an investment in human capital forms the basis for arguments that government funding on education policy should be increased.

While this study provides some insights into the causal relationships and the synergistic effects between sub-indices of the Legatum Prosperity Index, the current research design based on BN-TAN data mining and PLS path modeling does not allow for bidirectional causal linkages between sub-indices. One has to keep in mind that causal connections between sub-indices might also work both ways. To explore the bidirectional causal relationships, future research could use other techniques of data analysis, such as the Granger causality test on the vector autoregressive model and the error correction model (e.g., Gomez-Puig and Sosvilla-Rivero, 2015; King and Du, 2018).

References

Annabi, N. (2017). Investment in education: What are the productivity gains? *Journal of Policy Modeling*, *39*, 499–518.

Annabi, N., Harvey, S., & Lan, Y. (2011). Public expenditures on education, human capital and growth in Canada: An OLG model analysis. *Journal of Policy Modeling*, *33*, 852–865.

Aristei, D., & Perugini, C. (2010). Preference for redistribution and inequality in well-being across Europe. *Journal of Policy Modeling*, *32*, 176–195.

Becker, G. (1993). *Human Capital: A Theoretical and Empirical Analysis with Special Reference to Education*. Chicago: University of Chicago Press.

Becker, W., Saisana, M., Paruolo, P., & Vandecasteele, I. (2017). Weights and importance in composite indicators: Closing the gap. *Ecological Indicators*, *80*, 12–22.

Benartzi, S., & Thaler, R. (2001). Naïve diversification strategies in defined contribution saving plans. *American Economic Review*, *91*, 79–98.

Bonaiuto, M., Fornara, F., Ariccio, S., Cancellieri, U. G., & Rahimi, L. (2015). Perceived Residential Environment Quality Indicators (PREQIs) relevance for UN-HABITAT City Prosperity Index (CPI). *Habitat International*, *45*, 53–63.

Budsaratragoon, P., & Jitmaneeroj, J. (2020). A critique on the Corruption Perceptions Index: An interdisciplinary approach. *Socio-Economic Planning Sciences*, *70*, Article 100768

Cerquides, J., & De Mantaras, R. L. (2005). TAN classifiers based on decomposable distributions. *Machine Learning*, *59*(3), 323–354.

Cifuentes, M., Doogan, N., Fernandez, S., & Seiber, E. (2016). Factors shaping Americans' objective well-being: A system science approach with network analysis. *Journal of Policy Modeling*, *38*, 1018–1039.

Crocker, R. (2007). Human capital development and education. In G. Picot, R. Saunders, & A. Sweetman (Eds.), *Fulfilling potential, creating success: Perspectives on human capital development*. Montreal/Kingston: McGill-Queen's University Press.

Diener, E., & Diener, C. (1995). The wealth of nations revisited: Income and quality of life. *Social Indicators Research*, *36*(3), 275–286.

Droge, C., Calantone, R., Agrawal, M., & Mackoy, R. (1993). The consumption culture and its critiques: A framework for analysis. *Journal of Macromarketing*, *13*(2), 32–45.

Fitzsimons, P. (2017). Human capital theory and education. In M. A. Peter (Ed.), *Encyclopedia of Educational Philosophy and Theory*. Singapore: Springer.

Fleurbaey, M. (2009). Beyond GDP: the quest for a measure of social welfare. *Journal of Economic Literature*, *47*(4), 1029–1075.

Gomez-Puig, M., & Sosvilla-Rivero, S. (2015). The causal relationship between debt and growth in EMU countries. *Journal of Policy Modeling*, *37*, 974–989.

Goyal, P., & Rahman, Z. (2015). Identification and prioritization of corporate sustainability practices using analytical hierarchy process. *Journal of Modelling in Management*, *10*(1), 23–49.

Grossmann, V. (2008). Risky human capital investment, income distribution, and macroeconomic dynamics. *Journal of Macroeconomics*, *30*(1), 19–42.

Heckman, J., Pinto, R., & Savelyev, P. (2013). Understanding the mechanism through which an influential early childhood program boosted adult outcomes. *American Economic Review*, *103*(6), 2052–2086.

Holden, L., & Biddle, J. (2017). The introduction of human capital theory into education policy in the United States. *History of Political Economy*, *49*(4), 537–574.

Huberman, G., & Jiang, W. (2006). Offering vs. choice in 401 (k) plans: Equity exposure and number of funds. *Journal of Finance*, *61*, 763–801.

Jitmaneeroj, B. (2016). Reform priorities for corporate sustainability: Environmental, social, governance, or economic performance. *Management Decision*, *54*(6), 1497–1521.

Kelley, J., & Simmons, B. (2015). Politics by number: Indicators as social pressure in international relations. *American Journal of Political Science*, *59*(1), 55–70.

King, C., & Du, J. (2018). China's first priority in post-war state building: A wealthy state, or a strong army? *Journal of Policy Modeling*, *40*, 851–872.

Lan, L. W., Lee, Y. T., & Wu, W. W. (2013). On the decision structures and knowledge discovery for ANP modeling. *International Journal of Intelligence Science*, *3*(1A), 15–23.

Lemieux, T., Macleod, W. B., & Parent, D. (2009). Performance pay and wage inequality. *Quarterly Journal of Economics*, *124*(1), 1–49.

Ludwig, J., & Sawhill, I. (2007). *Success by ten: Intervening early, often, and effectively in the education of young children. Hamilton Project Discussion Paper 2007-02*. Brookings (February).

Mincer, J. (1974). *Schooling, experience, and earnings*. New York: Columbia University Press for the National Bureau of Economic Research.

OECD. (2008). *Handbook on Constructing Composite Indicators: Methodology and User Guide*. OECD publishing.

Schultz, T. W. (1961). Investment in human capital. *American Economic Review*, *51*(1), 1–17.

Stiglitz, J., Sen, A., & Fitoussi, J. P. (2009). *Report of the commission on the measurement of economic performance and social progress*.. Accessed 13 December 2015. http://www.stiglitz-sen-fitoussi.fr/en/index.htm

Tomich, T., Lidder, P., Coley, M., Gollin, D., Meinzen-Dick, R., Webb, P., & Carberry, P. (2018). Food and agricultural innovation pathways for prosperity. *Agricultural Systems*, https://doi.org/10.1016/j.agsy.2018.01.002

UNESCO. (2015). *Teachers and educational quality: Monitoring global needs for 2015*. UNESCO Institute for Statistics.

Witten, I., Frank, E., & Hall, M. (2011). *Data mining: Practical machine learning tools and techniques*. San Francisco: Morgan Kaufmann.

Wong, C. (2015). A framework for 'City Prosperity Index': Linking indicators, analysis and policy. *Habital International*, *45*, 3–9.