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National Performance and Global Dynamics: an Unifying Knowledge-Based Approach

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Abstract

Global dynamics is a pervasive phenomenon, influencing continuously national socio-economic systems and, in emergent cases, affecting directly even individuals. There are numerous scientific theories and frameworks, mostly identifying the unequal distribution and limited renewability of resources as the primary drivers of global dynamics. To minimize their undesirable consequences, considerable effort is spent on joint harmonization of international strategic and policies of single countries. This can hardly happen without innovative decision-support tools, breaking the originally intractable complexity into a set of well-structured, explainable, and straightforwardly applicable subproblems.

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The main goal of this research was to simplify, systemize and structure the influences of global dynamics on single countries and help them to formulate viable strategies with respect to global changes. Rather than a detailed methodology, this paper proposes and with real-world examples justifies a reusable conceptual framework, based on qualitatively represented expert knowledge, specified with quantitative outputs from data mining, applied on selected national indexes.
In the design phase, a two-stage qualitative model of global dynamics was developed, validated, and functionally demonstrated. It merges traditional knowledge-based modelling of sustainable world with data-driven identification of the national-specific development drivers, complemented with global indicators, concerning the planet and humanity. The data-related level is built from the coherently selected global indexes, processed with different machine-learning tasks. Subsequent high-level qualitative model is expressed in the form of Causal loop diagram, extending the expert and domain knowledge with significant national-specific variables and relations, found in data.
The proposed way of individualized modelling of national strategies with respect to evolving global dynamics can facilitate policy-making processes on the governmental level. Its flexible and multilevel structure allows identification of a minimal set of key parameters, guaranteeing efficient and robust planning of country future. Application possibilities of such layered framework are presented for case of Germany.

Keywords – Data mining, Global dynamics, Global indexes, Qualitative modelling

Paper type – Academic Research Paper

1 Introduction

The world economy is currently undergoing significant changes. It is influenced by new phenomena that complement and condition each other, but also have contradictory manifestations. Globalization is one of the most debated terms of today. The term is very contradictory and there is no consensus among economists about its meaning - opinions differ fundamentally (Kivilcim, 2008). Globalization is perceived as a long-term process by the authors of the International Encyclopaedia of Business and Management (Warner and Kotter, 2002). The authors directly state that globalization is a process of growing integration of world civilization. This process is understood to be long-lasting and lasting practically since prehistoric times. For example, the authors state that the expansion of the first people into new territories through massive migration is a symbolic example of globalization. Siebert (2000) states that globalization means reducing market segmentation and increasing the interdependence of national markets.

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According to Hamilton and Webster (2009) globalization refers to the social, economic, political, and technological links in different countries. Globalization is a contested concept that refers to shrinkage of time and space (Steger, 2009). According to another definition globalization is the elimination or diminution of state-enforced restrictions on exchanges across borders and the increasingly integrated and complex global system of production and exchange that has emerged as a result (Palmer, 2002).

By globalization in current economic and other theories we mean a complex transformation of market relations (but also other social ones events) on a global scale, which materializes in a number of changes in the economic and non-economic spheres (Duarte et al., 2021; .Manoharan, 2021) This transformation, for many reasons, is changing the world economy and the social establishment of the world towards greater coherence and dependence of individual economic subjects, not only adds links between individual elements, but also quality changes completely and completely structurally, or creates completely new typologically (Wu and Lee, 2021).

According to World Trade Organization (Azwar and Leviza, 2020) globalization is the substantive process of economic and technological expansion looking towards the opening-up and integration of the entire world into and under one economic system. At the OECD (Padhan et al., 2020) interpret globalisation as a process of closer economic integration of global markets: financial, product and labour. Globalization, by the UNO, is defined as the global integration of economies and societies. Globalization, the process through which an increasingly free flow of ideas, people, goods, services, and capital leads to the integration of economies and societies, is often viewed as an irreversible force, which is being imposed upon the world by some countries and institutions such as the IMF and the World Bank (Tate, 2020). According to World Health Organization (2021), globalization can be defined as the increased interconnectedness and interdependence of peoples and countries. It is generally understood to include two inter-related elements: the opening of international borders to increasingly fast flows of goods, services, finance, people, and ideas; and the changes in institutions and policies at national and international levels that facilitate or promote such flows.

Globalization has number of aspects that have a selective effect on individual states in both positive and negative ways. The International Monetary Fund (IMF, 2021) lists four main aspects of globalization: international trade, movement of

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investments and capital, migration of persons and dissemination of knowledge. Many authors deal with these aspects and associated areas in their studies, e. g. studies about fair trade (Zhu et al., 2021), foreign trade (Hu et al., 2021), sense of migration (Bascuñan-Wiley, 2021), dissemination of CSR practices between international corporations and local companies (Kowalska, 2018; Tetrevova and Patak, 2019).

Today, we face many problems that are intricately interconnected and cannot simply be included in any traditional scientific discipline. Modelling of global dynamics is a very useful tool that can help. With models, we can make predictions (Hartzell et al., 2021), estimate the impact of various interventions in systems (Yun et al., 2020), and better plan various actions in addition to these concrete results, however, models are also very important on a mental level - just working with models significantly affects our way of thinking and looking at the world. Models force one to articulate our vague ideas clearly. They also make it possible to share ideas and pass on much-needed information between experts in different fields. Modelling of global dynamics is used by many authors in different areas, e. g. in healthcare (Zhang et al., 2020; Li and Zhao, 2021; Ma et al., 2021), in transport (Yoon, 2021; Danylkiv et al., 2020), in environment (Hartzell, 2021; Sverdrup et al., 2020) or in demography (Li and Xu, 2020).

GDP and the indicators that affect it can be considered as sources of global dynamics. The determinants of economic growth are made up of factors that are interrelated and together affect the rate of growth or decline of the economy. The Nature Conservancy (2021) deals with a group of factors affecting GDP. According to them, everything is connected to everything and the whole system of GDP creation is interconnected. The main factors mentioned include global employment and poverty, air quality and climate, the terrestrial, freshwater and maritime systems, energy resources, sanitation, human health, and the economic impact of disasters. It is therefore not only economic indicators that have the main influence on GDP generation, but also technological, social and environmental indicators. It points out, above all, the suitability of looking at systems from a holistic point of view and not focusing separately on each of the factors separately. On the contrary, Capra (2016) does not focus directly on the state and development of GDP, but on global problems that countries must face and be able to deal with as best as possible. It divides this issue into two main sections, namely population difficulties and environmental issues. Population problems include poverty, population growth, the pressure of demographic

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change and social inequality. Environmental topics include climate change, "climate" refugees, fossil fuel consumption and food security threats.

The main factors influencing GDP growth include the following indicators (Agarwal, 2020; Saini, 2021):

- Natural resources - e.g., oil, mineral deposits, but also native land and water availability,
- Physical capital and infrastructure (resp. equipment) - increase in investments in physical capital, e.g., roads, machinery, and factories, thanks to investments in physical capital there is an increase in productivity and performance,
- Population and labor force (resp. employment) - a growing population can result in higher availability of labor, but can also lead to high unemployment,
- Human capital - increasing investment in human capital in order to improve the skills of the workforce and consequently increase productivity,
- Technology - increasing investment in technology in order to increase productivity while reducing costs and increasing competitiveness,
- Laws, resp. rules and regulations - regulation of economic activity by the state or other institutions.

There are also holistic theories and frameworks, explaining the internal mechanisms of global dynamics from different viewpoints (Donges et al., 2020; Liu et al., 2007; Smil, 2021; Thurner et al., 2018). These multidimensional approaches arise from a complex internal network of feedback loops, interactions of which are affected with a wide range of time constants, varying from weeks to millennia. Such extensive dynamic structure naturally possesses an oscillatory and conditionally unstable behaviour, when in critically exhausted sectors even neglecting parametric changes can result in catastrophic reactions, like the widely cited Butterfly effect (Lorenz, 1963). Based on these theoretical foundations, quantitative models of sustainable world, created in accordance with the system dynamic framework, introduced in (Forrester, 1961) were designed and successfully applied (Capra, 2004; Forrester, 1971; Meadows, 1974; Turner, 2008). They typically combine the dynamics of food, industry, population, environment, and non-renewable resources sectors.

Considerable official effort is spent on harmonization of global dynamics effects with joint strategic development goals of single countries (EUR-Lex, 2016;

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UN, 2020). These interventions strive to control namely the publicly visible global impacts, including climate changes, lack of natural resources or economic, humanitarian, or migration crises. However, because of inherent spatio-temporal complexity and socio-economic character of global dynamics, it is hardly possible to design the realistic scenarios of its future evolvement or even to solve them and thus explicitly mitigate related risks (WEF, 2021). Despite the enormous effort and investments, it is evident that the worldwide distributed complex structural aspects and behavioural patterns of global dynamics, instantiated through nationally differentiated conditions, form the burning problem of the contemporary world.

2 Methods

This research followed the traditional iterative methodology proposed, e.g., in (Mitroff, 1978) and enhanced it for the dynamic problems (Meadows and Wright, 2015) as follows:

a) Problem definition, structuring, identification of key variables and formulation of dynamic hypotheses,
b) Knowledge elicitation (review of resources, capturing of knowledge) and specification (formalization of problem-describing structure and behavior),
c) Design of related model and its verification,
d) Qualitative, quantitative, or combined experiments, concerning mostly practical impacts of sensitivity and scenario analyses. Existence of quantitative models allows also parametric optimization of original problem.

Methodological specificity of presented platform insists in the combination of low-level quantitative and high-level qualitative analyses, as it is shown in Figure 1. In the design phase, a two-stage qualitative model of global dynamics was developed, validated, and functionally demonstrated. This model merged the traditional system dynamics knowledge-based modelling with data-driven identification of national-specific GDP drivers, complemented with determining global environmental and social indicators.

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Figure 1: Applied two-stage methodology of national performance modelling

Assumed temporal behaviour of selected variables results from their nontrivial synthesis within a complex systemic model, constructed from the collected data and knowledge artefacts. This model was represented with a set of simultaneously valid diagrams, gradually simplifying and specifying the real-world problem. Its highest level was represented with a mind map and further concertized in a form of system diagram. Related behavioural features were synthesized from joint contributions of mutually interconnected loops of related Causal loop diagram (CLD). Initial dynamic hypotheses were discussed with respect to the feasible execution of inner loops, exposed to typical configurations of external events. All these formalization techniques are tools thoroughly characterized in (Morecroft, 2015; Sterman, 2014).

The data-driven model processed national indexes concerning economy, population, and environment of the first 20 OECD countries during the period 2014-2019, ordered according to their GDP in the last year of analysed period (OECD, 2021): Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Iceland, Ireland, Italy, Luxembourg, Netherlands, New Zealand, Norway, Sweden, Switzerland, United Kingdom and United States. The reason for somewhat obsolete selection was that although it includes the impacts of relatively persistent global changes like terrorism, migration or environmental hazards, it was not yet affected with the current pandemics. Raw source data were cleaned, normalized and transformed into two specific sets, convenient for further

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processing by different algorithms of supervised and unsupervised machine learning. Supervised tasks considered equally discretized values of GDP per capita (GDP) as the target variable and single records were processed anonymously, i.e., without relation to the country. Instead of more typical classification or regression, the main goal of supervised analyses was dimensionality reduction, searching for a relevant subset of the most powerful GDO predictors. National-specific features were searched personally in outputs of different types of unsupervised learning procedures.

Two types of data sets for generally oriented static and nationally oriented dynamic analyses were prepared. While static data contained values of regular variables of complete indexes, dynamic, country-specific data consisted of total differences and slopes of linear approximations of every variable for the whole investigated period.

Different modules of the SAS Enterprise miner were used for machine learning tasks. StatExplore with Gini tree-based selection criterion implemented the dimensionality reduction procedures and Variable Clustering node with default parameters performed the unsupervised clustering procedures. Detailed information regarding particular machine learning and pattern recognition methods can be found in (Bishop, 2007; Witten *et al.*, 2016).

3 Results and discussion

3.1 Data-driven model

Source data, containing the desired knowledge artefacts characterizing global and national drivers of GDP, were derived from a broader set of recognized yearly published international indexes, recommended by domain experts. During the selection stage, candidates were evaluated with respect to their diversity (D), independence (I), transparency (T), internal structure (S), availability of methodology (M), trustworthiness of resource (R), and range of local coverage (C). These features were quantified in scale from 1 to 5 and indexes with the highest total scores were adopted. Besides the score, the final set also had to address all basic dimensions of internal sustainable development, including population, industry, and environment, as well as the primary resources of global dynamics. Results of this evaluation are summarized in Table 1, from where the first five candidates were chosen and extended with the yearly national levels of

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Unemployment rate (UNR) and GDP. From the system point of view, indexes of Competitiveness, Democracy, GDP, Human Development and Unemployment were considered as internal or national-level descriptors and represented the fundamental structural elements of subsequent CLD. Environmental performance index and Multidimensional poverty index, limited on developing countries, served as exogenous inputs of global dynamics and their role insisted especially in design of appropriate scenarios.

Table 1: Evaluated and selected global indexes, jointly constituting national GDP

Global index/Feature	**D**	**I**	**T**	**S**	**M**	**R**	**S**	**Total**
Democracy [DEM] (The Economist Intelligence Unit, 2020).	5	5	5	5	5	4	5	34
Competitiveness [CMP] (Schwab, 2019)	5	4	5	5	5	4	5	33
Environmental Performance [EPE] (Wendling et al., 2020a)	5	4	5	5	5	4	5	33
Human Development [HDE] (UNDP, 2020)	5	4	5	5	5	4	5	33
Multidimensional Poverty [MPO] (Conceição et al., 2020a)	4	4	5	5	5	4	4	31
Gender Gap (Schwab et al, 2020).	2	5	5	5	5	4	3	29
Knowledge (Ghriss et al., 2020).	4	3	5	4	4	4	5	29
Peace (IEP, 2019)	2	3	5	5	5	4	3	27
Terrorism (IEP, 2019a).	2	3	5	5	5	4	3	27
Climate Risk (Eckstein et al., 2020)	2	3	4	4	5	2	3	23
Migration (UNHCR, 2020a)	2	4	3	3	3	3	2	20
Crime and Safety (Numbeo, 2021a, Numbeo, 2021b)	2	3	2	1	2	4	2	16

Detailed structure of selected indexes is shown in Figure 2 with internal components marked as follows: solid lines: MPO Health (MPO_HEA), EPE Environmental health (EPE_HEA), dashed lines: MPO Education (MPO_EDU), EPE Ecosystem vitality (EPE_VIT), bold lines: MPO Living standards (MPO_LIV).

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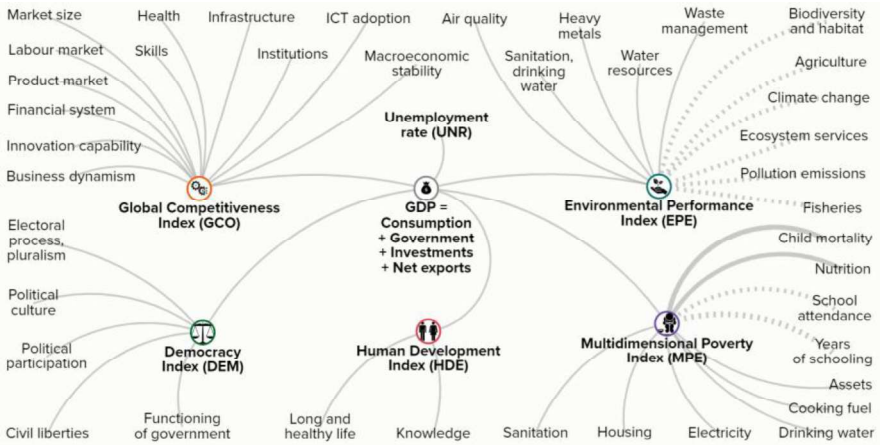

Figure 2: Internal structure od selected indexes

After this specification, complete and unreduced static set contained 120 21-dimensional records and the dynamic set had 20 28-dimensional records. Both sets were processes as follows:

- Task 1: static data processed with supervised learning, resulting to the set of general steady GDP predictors valid equally for all processed countries,
- Task 2: static data processed with unsupervised learning, resulting to the set of country-specific steady GDP predictors,
- Task 3: dynamic data processed with supervised learning, resulting to the set of general dynamic GDP predictors (data slopes) valid equally for all processed countries,
- Task 4: dynamic data processed with unsupervised learning, resulting to the set of country-specific dynamic GDP predictors (data slopes).

For better clarity, all presented graphs are relative. In absolute numbers, outputs of unsupervised tasks explain almost full variance of original data, while supervised algorithms covers only around 65% of the total variance. Moreover, the accuracy of dynamic predictions is lower because of small size of this dataset. Global indexes are not available in dynamic analyses, because their values are similar for all countries. This methodological limitation is acceptable, as in specific cases countries could promptly react on internal changes, but usually cannot simultaneously handle also considerable effects of global dynamic. Moreover, origins of these slow changes lie in the past, so the steady information could be satisfactory.

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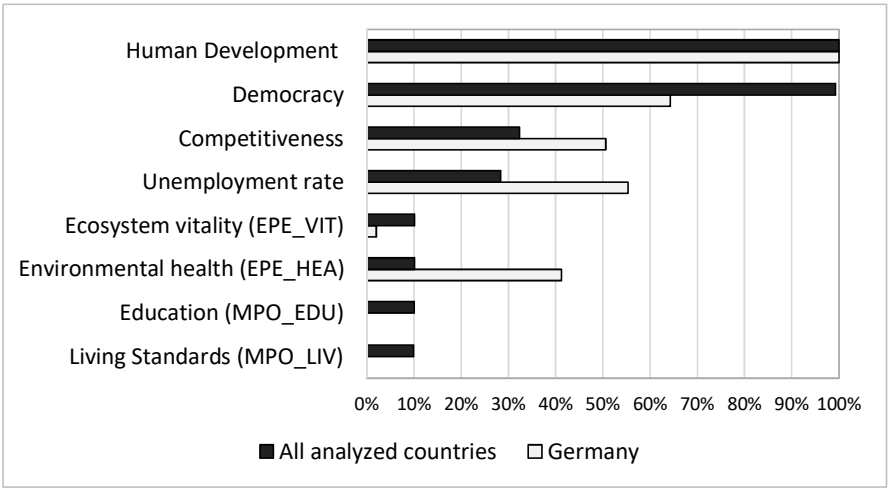

Figure 3: Comparison of regular values of the best steady GDP predictors for all analysed countries (results of Task 1) with specific findings for Germany (Task 3)

The ordered significance of general steady predictors (Task 1) in Figure 3 shows the key role of the human-related internal drivers HDE and DEM, followed by the more industrial ones, CMP and UNR. Influence of global predictors is lower and approximately equal. Situation in Germany, derived from the coordinates of the corresponding data cluster (Task 3) is slightly different (note: predictors Education and Living Standards are 0 for Germany). Although the paired dominance of HDE and DEM remained, there is a considerable mutual difference. Also, the roles of UNR and CMP increased and remarkable is also the national meaning of EPE_HEA.

These finding suggests the most powerful causal relations with respect to GDP. Because of the later applied dynamic analysis, there is no need to distinguish between the cause and effect and the only limiting factors are the durations of incorporated loops. All discovered knowledge artefacts can decrease the overall complexity of originally posted problem, contribute to specification of final qualitative model and simplify the validation of dynamic hypotheses.

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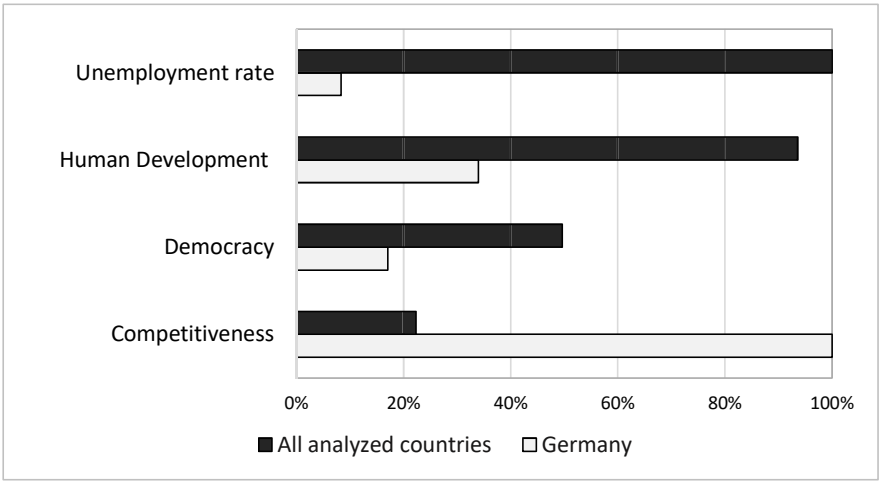

Figure 4: Comparison of slopes of the best dynamic GDP predictors for all analysed countries (Task 2) with specific findings for Germany (Task 4)

Although the dynamic analyses have rather supplementary character, in the presented case they showed the difference between the general and specific indicators. Results in Figure 4. show that in the general case UNR slope (negatively) corresponds with GDP slope, in case of Germany the significance of this indicator is minimal, and the strong role plays variable CMP. Also, the meaning of commonly influential human-related indicators HDE and DEM is suppressed in Germany.

3.2 Formulation of dynamics hypotheses

Dynamic hypotheses H1 – H5 were formulated to illustrate sample interventions between global scenarios and GDP related national-level decisions in Germany during the analysed period 2014–2019. Their starting point is represented with the annual GDP growth 3,7% in 2014. All hypotheses are indicatively quantified in Figure 5.

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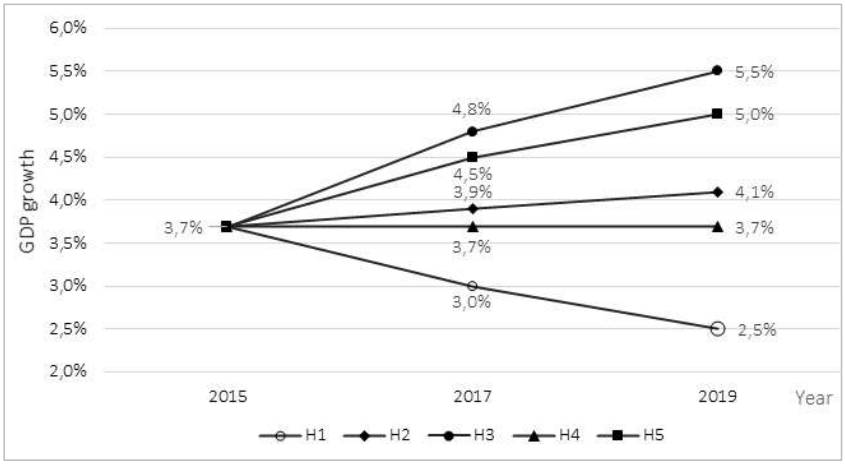

Figure 5: Dynamic hypotheses for sample scenarios

- H1, pessimistic: As a result of global changes, there is an increase in unemployment and poor availability of skilled labor. This has a negative effect on GDP growth. There are frequent gaps in the labor market, limiting the productivity of the public and private sector and reducing their competitiveness.
- H2, realistic: Global and national environmental impacts accelerate with increasing competitiveness and higher consumption. Efforts to address this situation through appropriate restrictions have a negative effect on GDP. Conversely, investment in innovation can slow down environmental change. This also has a positive effect on GDP growth.
- H3, optimistic: Life expectancy is increasing slightly, people are satisfied, and a large part of the population has an advanced level of education. The education system utilizes modern methods and technologies, the average state expenditure on education is at a higher level than the average of OECD countries. This has a positive effect on GDP growth and provides more financial opportunities to respond to negative global pressures.
- H4, conservative: Both major global factors – environmental change and global poverty – may result in population migration. At least for the time being, it has a rather negative effect on GDP growth. Efforts to directly combat these influences occur mainly through humanitarian aid and regulations.

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- H5, progressive: External influences negatively affecting GDP can be indirectly compensated, for example, by higher investment in education. These have positive effect on the level of education and knowledge of the population. Better education helps to increase human capital and the growth of a skilled workforce. As a result, unemployment falls, which will have a positive effect on GDP growth.

3.3 Knowledge-based model

The set of key variables, discovered in the data-driven stage, was used for formulation of dynamic hypotheses and their validation through the corresponding predictive qualitative model. Such model is composed from patterns of the most relevant activities and can project their joint consequences into a realistic time horizon. Established predictive support helps managers to anticipate future performance with respect to determining external scenarios and efficiently reflect their impacts. Resultant improved resilience maximizes possible benefits, minimizes losses, orchestrates internal environment and harmonizes external relations.

To obtain the desired Causal loop diagram for Germany, linear structure of mind map from Figure 2 was specified using the index-based knowledge and transformed to a cyclic, behaviour generating structure, simplified version of which is in Figure 6. Even in this reduced form for publication it contains 61 loops with length from 3 to 11 edges. Knowledge fragments discovered from indexes were utilized for modification of general high-level causal loop diagram, in which the less sensitive segments were suppressed, and the more powerful parts were analysed to introduce and justify desirable policies or strategies. These arrangements should maximize the selected target variables with the most efficient internal levers and simultaneously minimize the influence of global perturbances. Inclusion of so far unaddressed pandemic just illustrates the straightforward scalability of presented approach.

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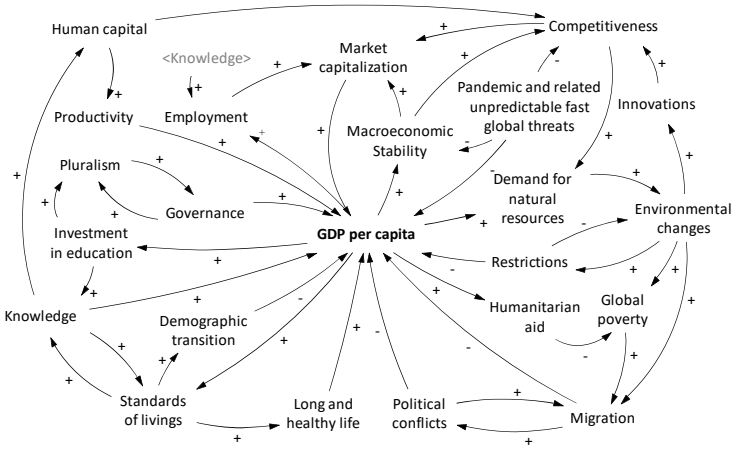

Figure 6: Causal loop diagram of presented problem, modified for German GDP

3.4 Discussion of dynamics hypotheses

- H1: There are several ways in which global factors can affect unemployment. Mostly they are linked through GDP and knowledge variables. CLD also shows the link between productivity, employment, and human capital. The raise of unemployment due to global influences has negative impact on human capital and its quality. This results in a reduction of productivity, GDP and employment. In addition, the CLD shows that employment has a direct impact on market developments, which also affect GDP.
- H2: CLD shows a link between competitiveness, natural resource consumption, environmental change, regulations, innovation, and GDP. It is also evident that higher competitiveness leads to higher consumption of natural resources, which negatively impacts the effect of environmental change. The relationship between these changes and regulations that have a negative effect on GDP is also present. Innovations arising from the need to act against environmental change lead to better competitiveness, which has a positive effect on GDP and thus offers more opportunities to combat environmental change. Although innovations resulting from environmental change do not directly lead to suppression of environmental effects, they contribute to higher GDP through the variable *Markets* and thus provide more

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funding thanks to increasing competitiveness. This dynamics can also be used to combat environmental change.

- H3: In CLD, there is a leading loop connecting living standards, long and healthy life, knowledge, and investment in education. Thus, growing GDP stimulates increase of living standards, which will have a positive effect on a long and healthy life. This raises population satisfaction and, in turns, GDP. Higher GDP enables the expansion of investment in education, which will ideally be reflected in the more widespread use of information and communication technologies in education. The growth of investment in education accompanied by higher living standards has a positive effect on the level of knowledge. It has a positive effect on employment and human capital. This together leads to higher competitiveness and, through the variable *Markets*, to higher GDP. Human capital also has a positive effect on productivity, which again has a positive effect on GDP.
- H4: CLD in Figure 6 shows the interconnection of the parameters of environmental change, global poverty, and migration. Environmental change can lead directly to migration, for example due to acute threats and natural disasters, or indirectly because of poverty, caused, e.g., by drought or lack of food. Migration currently has a rather negative effect on GDP. Its potential is not being used and migrants are not fully integrated into everyday life. This, for example, hampers the effect of possible positive demographic changes. In addition, the growth of migration can lead to the intensification of political conflicts. These have a negative impact on GDP growth. Such effects can be compensated with regulations that have a negative impact on GDP and are intended to prevent further deterioration of the environment. In addition, it is possible to use humanitarian aid, which is primarily intended to prevent local unrest and improve the living situation of the local population. The more financial resources the country has, the more support can be dedicated to humanitarian aid programs.
- H5: There are many ways to respond to external influences. According to CLD diagram, a positive effect can be observed as a result of higher investment in education. This affects not only the level of educational attainment, the knowledge of the population, human capital, and

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unemployment, but also addresses competitiveness and markets, which have a positive effect on GDP growth.

Previous discussions confirmed that all originally posted dynamic hypotheses are explainable through the presented qualitative model. It is also capable to demonstrate interactions between the German-specific and global GDP-related factors. We found that regulations, humanitarian aid or innovation serve as direct assistance in combating global negative effects and, in certain circumstances, can exacerbate environmental changes. Given the results of data mining, which showed only a minor influence of global factors on GDP growth, the positive effect of higher education or competitiveness will certainly prevail.

In the case of Germany, it is recommended to invest in education and satisfaction of the population. Investment should ideally be higher than the OECD average. The education of the population is a key indicator for the good functioning of the state and its prosperity. The quality of human capital and the level of unemployment are automatically linked to this matter. When such parameters are set correctly, competitiveness increases. The overall competitiveness of Germany can be also improved with systematic support of ICT and digital technologies, resulting into a higher productivity.

4 Conclusions

This paper analysed influence of global dynamics factors on national performance expressed in terms of GDP. To fulfil this goal, a two-stage model, combining related quantitative and qualitative aspects was proposed and discussed. The most significant decisive factors of GDP generation, composed of national and global drivers, were identified from results of different machine learning techniques, applied on selected global indexes. Based on these findings, the problem characterizing dynamic hypotheses were formulated and subsequently analysed through an accordingly designed Causal loop diagram. Applicability of resultant predictive behavioural patterns were demonstrated for case of Germany.

The authors believe that innovativeness of the suggested way of incorporation of global dynamic aspects into the national strategic decision-making processes insists in the following contributions:

- Straightforward and efficient simplification of the naturally complex problem,

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- Standardized, widely applicable and easily replicable architecture of proposed solution,
- Layered structure, composed both from the top and bottom-level knowledge artefacts,
- Understandable internal representation, supporting group decision making,
- Partial validation of model during the data processing stage,
- Straightforward computational implementation within a system dynamics framework.

Such outcomes also synthesize an applicable solution for the originally posted research problem. The proposed way of individualized modelling of strategic development with respect to typically evolving global dynamics can facilitate policy-making processes on the governmental level. Its flexible and multilevel structure allows identification of a minimal set of key parameters, guaranteeing efficient and robust planning of country future by means of well-informed, creative dialogues of involved stakeholders. On the other hand, for the national governments with yearly planning cycles, it is practically impossible to appropriately respond to the fast and rare global events, such as the COVID-19 pandemics. These out-of-system events are considered as disturbances, and their elimination depends entirely on the momentary capabilities and resources of the national planning and control system.

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