

CHAPTER «ECONOMIC SCIENCES»

MECHANISMS FOR SHAPING THE STRUCTURAL PILLARS OF UKRAINE'S ECONOMY: THE ROLE OF HUMAN CAPITAL IN WARTIME AND POSTWAR DEVELOPMENT

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Abstract. This article examines human capital and economic efficiency (total factor productivity) as key drivers of Ukraine's structural economic reconfiguration amid wartime and postwar transformation. The study focuses on the functional role of human capital in ensuring economic efficiency, institutional resilience, and social cohesion. The authors argue that under conditions of high turbulence, human capital should be viewed not as a passive object of policy, but as a strategic agent capable of shaping an efficient economic architecture oriented toward sustainable growth. *The purpose* of the study is to scientifically substantiate human capital and economic efficiency (total factor productivity) as structural pillars of the Ukrainian economy, and to develop an analytical framework and strategic policy directions that enable a shift from compensatory to transformational development mechanisms. To achieve this, the authors apply an interdisciplinary *methodology* combining institutional analysis, comparative statistics, regression modeling, policy document analysis, and synthesis of international experience. A four-tier analytical framework is proposed, representing the key structural dimensions of human capital: individual, institutional, social, and territorial. *Results.* The study demonstrates a

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statistically significant positive impact of total factor productivity (TFP) on Ukraine's GDP dynamics between 1994 and 2019, empirically confirming the role of human capital as a determinant of economic performance. Based on data from the Penn World Table, the State Statistics Service of Ukraine, OECD, and other sources, a comparative analysis of labor productivity and TFP reveals a substantial lag behind European countries. The authors attribute this trend to institutional fragmentation, educational disintegration, and demographic decline. *Practical implications.* The findings suggest that unlocking the potential of human capital requires a transition to transformational policy that integrates institutional coherence, inclusivity, innovation, and regional differentiation. Strategic directions proposed include the development of adaptive educational ecosystems, institutional support for mobility and reskilling, integration of the social economy, gender- and age-responsive budgeting, and cross-sectoral coordination. *Value/originality.* These elements form a comprehensive human capital policy model capable of enhancing productivity, cohesion, adaptability, and institutional resilience. Future research prospects include the development of a multifactor model for assessing human capital, analysis of regional disparities in access to educational resources, and evaluation of institutional interventions in reskilling, inclusion, and social integration.

1. Introduction

The military aggression of the Russian Federation against Ukraine has caused systemic destruction of the national economy. This manifests not only in the loss of production capacities, disruption of logistical chains, and degradation of infrastructure, but also in profound transformations of the labor market, demographic decline, mass migration, and fragmentation of the social space. Under such conditions, there arises an urgent need to reconsider the foundations of economic development – through the formation of new structural pillars capable of ensuring sustainable recovery, self-reproduction, and adaptation of the economy to conditions of uncertainty.

In contemporary economic theory, the concept of a “pillar” is increasingly interpreted not as a static sector or resource, but as a dynamic mechanism that ensures the functional integrity and self-development capacity of the economy. This approach enables a shift from sectoral analysis to a systemic

vision of the economy as a network of interrelated pillars – material, institutional, social, and human. Within this framework, human capital acquires particular significance – not as an isolated resource, but as an integrative pillar that combines knowledge, skills, health, motivation, social ties, and institutional trust.

The relevance of the study is driven by the need to transition from an extensive model of recovery to an institutionally oriented one, in which human capital functions not merely as an object of policy but as an active agent of structural formation. As noted by Yasinska T.V. [9], human capital constitutes the foundation of long-term socio-economic prosperity, and its reproduction under crisis conditions requires a systemic policy approach. The OECD [26] emphasizes that investments in education, healthcare, and digital skills are key drivers of productivity in post-industrial economies. The World Bank [41; 17] identifies human capital losses as one of the main barriers to economic recovery.

Within the scope of this study, human capital is conceptualized as a structural pillar that performs the function of integrating material, institutional, and social components into a unified functional system. This approach enables the development of an analytical model in which human capital acts not as a passive object, but as an active mechanism of economic self-reproduction. The novelty of the study lies in the conceptualization of human capital as an integrative structural pillar capable of ensuring not only economic efficiency but also social cohesion, institutional resilience, and adaptability to wartime challenges.

The purpose of the study is to scientifically substantiate a multi-level analytical framework of human capital and economic efficiency as structural pillars of the development of the Ukrainian economy in the post-war period. Within this framework, human capital is viewed as an integrative factor that ensures adaptation, labor productivity and economic efficiency, and sustainable development through the interaction of individual, institutional, social and territorial mechanisms.

To achieve this aim, the authors rely on a logical-historical analysis of the transformation of Ukraine's economic structure, institutional theory, concepts of productivity and human development, as well as endogenous growth theory, which explains the role of internal factors in long-term development. The study includes quantitative modeling of human capital

components and their interrelations with indicators of employment, productivity, and social cohesion.

A four-level analytical framework of human capital as a structural pillar of economic reconstruction is developed, encompassing individual, institutional, social, and territorial dimensions. Each level represents functional components through which human capital influences the resilience, adaptability, and innovativeness of the socio-economic system, particularly through its impact on total factor productivity (TFP).

Methodologically, the study combines structural modeling (to construct the analytical model of human capital), comparative analysis of international and national approaches, content analysis of analytical reports by international organizations (World Bank, OECD, ILO), and a critical review of Ukrainian academic literature. The authors' calculations are based on aggregated data from the State Statistics Service of Ukraine, the World Bank, ILO, and OECD, using multifactor analysis methods. This made it possible to qualitatively assess the role of human capital, obtain empirical estimates of the impact of the TFP on the country's GDP, and identify inter-level connections and institutional dependencies relevant to the formation of post-war reconstruction policies.

The structure of the study follows a stepwise expansion of the conceptual framework: beginning with the clarification of the notion and functional nature of structural pillars; proceeding to the analysis of human capital as an integrative mechanism; followed by the development of the analytical model and typology of endogenization mechanisms; the results of an empirical assessment of the impact of the TFP on GDP dynamics are presented; and concluding with the formulation of findings and practical recommendations for further research and policy implementation.

2. Human Capital as a Structural Pillar

Theoretical Foundations of Economic Structural Formation under Conditions of Transformation. The ongoing transformation of Ukraine's economy – driven by full-scale war, demographic decline, technological restructuring, and institutional fragmentation – has intensified the need to reconsider the foundations of economic development. This process entails not merely a shift in sectoral configuration, but the formation of a new functional architecture capable of ensuring self-reproduction, resilience,

and adaptation of the economy under conditions of uncertainty. In this context, the concept of a structural pillar acquires particular significance – as a mechanism that integrates material, institutional, and human components into a unified system capable of sustaining economic viability in both crisis and post-crisis conditions.

Within the national academic discourse, structural formation is increasingly viewed not as sectoral balancing, but as a process of constructing functional pillars that ensure the integrity and adaptability of the economy. This approach enables a transition from an exogenous logic of development – focused on external interventions – to an endogenous one, grounded in the internal potential of the system. In this framework, human capital emerges not as an isolated resource, but as an integrative pillar capable of combining educational, motivational, institutional, and social components into a coherent functional structure.

Its role extends beyond productivity: human capital fosters institutional cohesion, social stability, innovative dynamics, and the capacity for strategic renewal. This perspective allows human capital to be conceptualized as an informal infrastructural framework that supports the functioning of other pillars – material, territorial, technological – while simultaneously serving as a source of their renewal and adaptation. The concept of endogenization becomes particularly relevant, referring to the formation of human capital from the internal resources of the economy, without the dominance of external interventions. Endogenization involves not only investment in education and healthcare, but also the development of local institutions, social cohesion, trust, and mechanisms of horizontal coordination.

A critical review of Ukrainian scholarship reveals a gradual rethinking of the nature of human capital – from its interpretation as a set of educational and demographic indicators to its understanding as a multidimensional, institutionally embedded system [9; 3]. In contemporary academic discourse, human capital is increasingly conceptualized not as a standalone resource, but as an integrative pillar of the economy, capable of ensuring adaptability, productivity, and sustainable development in the context of wartime and postwar transformation. Central to this rethinking is the shift from exogenous models to the concept of endogenization, whereby development is rooted in internal resources – human, social, and intellectual capital – as drivers of self-development. Within this paradigm, the labor

market ceases to function merely as a mechanism of distribution and instead becomes an institutional platform for realizing social mobility, cognitive flexibility, worker agency, and innovative activity [2].

Conceptual Foundations of Economic Socialization and the Role of Human Capital. The concept of economic socialization, developed in the works of V. Heyets, views human capital as a component of institutional architecture that integrates social norms, behavioral models, cohesion, and the capacity for collective action. Particularly relevant is the idea of social quality of life as a criterion for evaluating the effectiveness of economic policy under conditions of war and reconstruction [4].

In this context, A. Hrytsenko [6] substantiates the principle of complementarity between the state and the market as a structural pillar of postwar development. Human capital, in his framework, emerges as a carrier of action, realized through institutional support, civic participation, and freedom of choice. Endogenization of development implies the activation of internal sources – not only labor-related, but also social, cultural, and cognitive – as the foundation for reconstructive growth. The cognitive dimension of human capital – its capacity for learning, critical thinking, and innovative activity – is considered a structural component that determines its effectiveness in unstable environments [8]. This approach allows human capital to be conceptualized as a multidimensional construct that integrates educational, psychological, and economic components.

In parallel, a vision is emerging of labor mobility, employment flexibility, and digital competence as adaptation mechanisms that enable human capital to maintain its productivity under crisis conditions. These characteristics are not merely individual advantages but function as structural mechanisms of resilience within the socio-economic system [2; 3]. The regional dimension also gains importance: spatial disparities in access to education, employment, and social services are viewed as barriers to realizing human potential. Y. Zaloznova [8] argues that territorial asymmetry is a critical factor in the uneven development of human capital, especially under conditions of internal displacement and infrastructure destruction.

The realities of war, emigration, and demographic losses underscore the need to rethink state policy on employment and vocational training. Antoniuk [1] analyzes the risks of human capital depletion due to war, emphasizing the necessity of institutional support for its preservation and

recovery. In this context, Duga [5] considers education, healthcare, cultural development, and socio-psychological support as channels of institutional investment capable of ensuring the resilience of human capital amid budgetary restructuring.

Overall, contemporary Ukrainian scholarship increasingly conceptualizes human capital as a systemic, institutionally mediated capacity of the economy for adaptation, innovation, and sustainable development. This perspective opens avenues for constructing new analytical models in which human capital is not merely an object of investment, but a structural driver of economic reconstruction.

Regional Disparities, International Discourse, and the Systemic Role of Human Capital. National research has increasingly focused on regional disparities in the formation of human capital. It has been established that a region's capacity for autonomous structural growth depends not only on the volume of investment, but also on the quality of institutions, access to educational resources, social cohesion, and motivational mechanisms. This suggests that the potential for endogenizing human capital is uneven across regions, and such heterogeneity must be taken into account when designing reconstruction policies [34; 30].

International discourse reinforces the core findings of Ukrainian studies, expanding them toward systemic integration. The *Compendium of Productivity Indicators 2025* [28] demonstrates that productivity is not formed in isolation, but through the interaction of human capital, institutional efficiency, innovation capacity, and the social environment [28; 26]. The report *The Global Forum on Productivity at 10* emphasizes that productivity results from the interplay of institutions, digital infrastructure, educational systems, and social capital [29]. The strategic document *Global Long-Run Economic Scenarios* models development trajectories through 2060, showing that countries with high levels of human capital endogenization exhibit not only greater productivity but also lower sensitivity to global shocks [30]. The *Education at a Glance 2025* report confirms that the quality of educational systems directly correlates with institutional effectiveness, innovation capacity, and social cohesion [31]. In *Labels for the Social Economy*, human capital is conceptualized as a pillar that links economic activity with social responsibility, shaping a new quality of economic structure [32].

Academic publications further affirm the systemic role of human capital as a structural pillar. Grimshaw & Miozzo [14] show that the relationship between human capital and productivity is contingent – dependent on organizational forms, innovation culture, and institutional context. Arokiasamy et al. [10] demonstrate that investments in human capital have a direct impact on corporate performance and on organizations' ability to adapt during crises. Giamos & Stroehle argue that human capital is a key element of strategic management, capable of ensuring the long-term resilience of business models [13]. Within this framework, the labor market is no longer viewed merely as a distribution mechanism, but as a dynamic institutional platform that enables economic adaptation to changing conditions. Its flexibility, resource mobilization capacity, support for worker agency, and institutional inclusion are not just social guarantees – they are structural mechanisms that shape economic resilience. Employment, professional mobility, reskilling, and institutional support acquire the status of pillars that not only serve production but also enable its renewal.

In parallel, the concept of social quality – as an institutional framework encompassing inclusion, equity, and access to opportunities – allows social mechanisms to be viewed not as external to the economy, but as its internal structural elements. In today's context, where economic performance increasingly depends on trust, cohesion, and social capital, these factors determine the system's capacity for self-reproduction. They not only stabilize the economy but also create conditions for its innovative renewal [24; 25].

International experience confirms that successful economies do not follow a universal growth formula but share common features: openness to the global economy, investment in human capital, institutional modernization, and strategic policy coherence. In a range of conceptual models – including reports by UNDP, OECD, World Bank, and IMF – human capital is treated as a pillar that ensures not only productivity but also the economy's capacity for adaptation, institutional renewal, and social cohesion [28–30]. Research on the complementarity of state and market mechanisms shows that the balance between regulatory frameworks and entrepreneurial freedom shapes resilient economic systems capable of strategic maneuvering in times of crisis [21]. In O'Hara's work [23], structural formation is explained through

five pillars: institutions, productivity, environmental sustainability, social cohesion, and human capital. These pillars form an interconnected system in which human capital acts as an integrator, ensuring coherence across sectors and governance levels.

Thus, in contemporary theory, human capital emerges as a key element of the structural architecture of the economy, performing functions of integration, adaptation, institutional renewal, and social cohesion. Its effectiveness is determined not only by the volume of investment, but by the quality of the institutional environment, educational infrastructure, social economy, and the capacity for strategic coordination [31; 32; 34].

Analytical Synthesis: Human Capital as a Structural Pillar of Ukraine's Economy in the Wartime and Postwar Period. The synthesis of theoretical propositions and critical review of national and international sources enables the development of an analytical framework in which human capital is conceptualized not as an isolated factor of production, but as an integrative structural pillar that ensures the functional integrity of the economy. This approach is based on the hypothesis that, under conditions of wartime and postwar reconstruction, human capital determines the economy's capacity for self-reproduction, institutional renewal, and social stability.

Unlike classical models that primarily interpret human capital through labor productivity, contemporary discourse expands its functional nature to include cognitive potential, social cohesion, institutional trust, and the capacity for horizontal coordination [28; 37; 41]. In this context, human capital should be viewed as a pillar that performs four interrelated functions: productive, institutional, social, and adaptive.

The **productive function** is manifested in human capital's ability to generate economic value through skills, competencies, professional mobility, and innovative activity. As shown in OECD reports [27; 28; 31], countries with advanced educational infrastructure and population health consistently demonstrate higher total factor productivity (TFP). For example, in Finland, where the average duration of education exceeds 16 years, TFP per capita is 30% higher than the EU average. In Ukraine, according to World Bank (2024b), the Harmonized Test Score stands at 478 points – below the OECD average (~520) – indicating the need to update educational content as a foundation for productive potential.

The **institutional function** of human capital lies in its capacity to shape effective governance practices, educational ecosystems, local initiatives, and institutional cohesion. The World Bank Human Capital Project (2023) [41] notes that countries with decentralized vocational education systems (e.g., Germany) exhibit greater resilience to economic shocks, as local institutions adapt more rapidly to labor market demand shifts. In the Ukrainian context, this implies strengthening the role of communities in shaping educational policy, developing VET hubs, and providing institutional support for reskilling.

The **social function** encompasses human capital's ability to foster trust, cohesion, inclusion, and collective responsiveness to challenges. The OECD's *States of Fragility* report (2022) [25] introduces the concept of "human fragility" – the risk of potential loss due to weak social integration. For instance, in Lebanon after the 2019 conflict, only 12% of youth were integrated into the labor market, triggering emigration and the loss of the productive core. In Ukraine, according to KSE (2025) [20], only 16% of persons with disabilities are employed, and among veterans, just 20% secured jobs after demobilization. This reflects a deficit in inclusive infrastructure, which limits the realization of human capital's social function.

The **adaptive function** refers to human capital's ability to undergo reskilling, cross-sectoral mobility, integration of new technologies, and rapid response to structural changes. Study [17] emphasizes that countries with high levels of digital literacy – such as Estonia – demonstrate faster productivity recovery following crises. This is attributed to workers' ability to transition between sectors without productivity loss, supported by advanced digital infrastructure, flexible skills, and institutional backing. Estonia, for example, exhibits high levels of digital integration beyond the IT sector, enabling the application of digital technologies in production, governance, and public services [24].

In the Ukrainian context, according to the State Employment Service of Ukraine, over 50% of employers declare their willingness to hire individuals from vulnerable groups, including internally displaced persons (IDPs) [20,36]. However, only about 30% of IDPs have access to reskilling programs, indicating limited adaptability of the employment system and insufficient institutional support for the digital transition. This discrepancy between the declarative openness of the labor market and the actual

availability of reskilling opportunities highlights the need for a systemic renewal of employment policy – particularly through digital platforms, flexible learning formats, and cross-sectoral partnerships.

The synthesis of human capital's functional roles enables the development of an analytical framework that provides a systemic view of its impact on economic resilience during the wartime and postwar period. This framework has both conceptual and practical significance: it allows for the identification of key intervention points, the definition of performance indicators, and the formulation of policy priorities. Based on an interdisciplinary synthesis of sources [26; 28; 37; 40; 41], human capital should be analyzed across four levels: individual, institutional, social, and territorial.

At the **individual level**, human capital is defined as a combination of cognitive, motivational, and psychophysiological capacities. Its key components include skills, health status, learning ability, emotional resilience, and adaptability to changing environments. According to World Bank data [41], the expected years of schooling in Ukraine is 12.9, yet the quality of education remains below the European average. The Harmonized Test Score – 478 points – indicates the need to update educational content, particularly in STEM fields, critical thinking, and digital literacy [20; 37; 17]. Moreover, over 18% of Ukrainian youth aged 18–25 experience chronic psycho-emotional disorders, including anxiety, depression, and post-traumatic conditions [36]. This directly affects their ability to maintain stable employment, pursue professional mobility, and participate in educational programs. Addressing the psycho-emotional state of youth is critical for shaping effective human capital development policy, especially in the context of wartime and postwar reconstruction.

The **institutional level** encompasses educational and governance infrastructure, labor market efficiency, and the availability of reskilling mechanisms. Countries with well-developed lifelong learning systems demonstrate higher economic adaptability. In Ukraine, only 32% of employers in 2025 plan to hire new workers, while over 50% express readiness to employ veterans, IDPs, and persons with disabilities [36]. However, only 30% of IDPs have access to reskilling programs [20], indicating structural barriers that limit the realization of human capital's institutional function.

The **social level** relates to cohesion, trust, inclusion, and collective responsiveness to challenges. The Brookings Institution’s report *Resilience through Inclusion* (2023) [40] shows that countries with high levels of social capital recover more quickly from conflict. In Ukraine, only 16% of persons with disabilities are employed, and among veterans, just 20% secured jobs after demobilization [20]. Additionally, over 1 million children have experienced interrupted educational trajectories [39], posing a risk of losing an entire generation of productive potential.

The **territorial level** concerns the local endogenization of human capital – the capacity of regions to independently develop educational, institutional, and social mechanisms. The World Bank [37] notes that communities with high levels of educational autonomy demonstrate greater economic resilience. In Ukraine, only a small share of communities have their own human capital development programs, and access to vocational education in rural areas remains limited. This creates a risk of deepening regional disparities, where high-productivity workers concentrate in major cities while peripheral areas lose the capacity for autonomous development.

To visually summarize, the following analytical table systematizes the four levels of human capital impact, their key characteristics, and strategic intervention points:

Table 1

**Analytical Matrix of Human Capital:
Dimensions and Functional Characteristics**

Level	Key Characteristics	Strategic Intervention Points
Individual	Skills, health, motivation, cognitive capacity	STEM reform, psychosocial support, soft skills development
Institutional	Educational infrastructure, labor market, reskilling mechanisms	VET hubs, training vouchers, digital platforms
Social	Cohesion, trust, inclusion, collective adaptability	Social economy, inclusive enterprises, veteran support
Territorial	Educational autonomy, local initiatives, access to resources	Regional strategies, education councils, digital infrastructure

Source: author's development

The proposed analytical matrix serves as a tool for multi-level operationalization of human capital, enabling not only the description of

its structural components but also the identification of strategic intervention points at each level. Its novelty lies in the integration of four interrelated levels – individual, institutional, social, and territorial – into a unified framework that accounts for both vertical (from personal attributes to regional strategies) and horizontal (cross-sectoral) linkages.

The scientific foundation of the matrix is based on a synthesis of classical theories of human capital, social capital, cognitive economics, and regional development. This approach allows for the inclusion of not only economic but also social, psychological, and spatial factors that influence human capital's capacity to generate value under conditions of instability.

Each level of the matrix functions as an analytical “window” through which both available resources and barriers to their realization can be assessed. For example:

- The **individual level** focuses on cognitive capacity, motivation, and skills that form the basis of productivity.
- The **institutional level** encompasses infrastructure, reskilling mechanisms, and tools for labor market engagement.
- The **social level** includes cohesion, trust, and inclusion as prerequisites for collective adaptability.
- The **territorial level** assesses regions' capacity for autonomous development, innovation, and effective resource utilization.

The matrix can be used as a strategic planning instrument: it helps identify intervention points with potential multiplier effects – for instance, the development of digital infrastructure at the territorial level can activate institutional and social mechanisms.

Thus, the analytical matrix not only systematizes the functional levels of human capital but also serves as a diagnostic tool for identifying structural failures, asymmetries, and risks at each level. Its multi-level structure enables comprehensive analysis—from individual cognitive barriers to territorial disparities that threaten social cohesion and economic stability. In this context, it is logical to delineate systemic challenges that hinder the realization of human capital as a structural force for postwar development. These challenges are multidimensional – demographic, institutional, social, cognitive, and spatial – and are shaped by risks that obstruct the transformation of human capital into an active pillar of the economy, forming a set of barriers that require strategic intervention.

The first such challenge is **demographic deformation**, manifested in the shrinking labor potential, population aging, and mass emigration. According to the State Statistics Service of Ukraine, in 2024, individuals aged 60+ accounted for over 23% of the population, while youth under 25 represented only 6.4% of labor market participants [36]. Additionally, more than 6.9 million citizens left the country between 2022 and 2024, over 60% of whom were of working age. This poses a risk of losing the innovative core of the economy, slowing total factor productivity growth [18], and increasing pressure on social systems. Similar trends were observed in Eastern European countries – for example, in Bulgaria, where post-emigration in the 2010s led to a 1.2% annual decline in GDP growth despite stable macroeconomic indicators.

The second challenge is **institutional fragmentation**, reflected in the weak local capacity of communities to formulate and implement human capital development policies. Although decentralization has created new opportunities for regional self-governance, it has also revealed deep disparities in administrative competence. Without institutional support at the local level, skills development policies cannot be effective. A successful example of localization is Poland, where municipal education strategies reduced youth unemployment by 40% over five years.

The third challenge is **inequality of access and inclusion**, which remains limited in Ukraine, indicating a deficit of adaptive infrastructure, lack of support mechanisms, and weak institutional coordination. Countries with high levels of inclusion have 1.5% higher total factor productivity, as the integration of vulnerable groups reduces structural productivity losses [19; 42]. A notable example is Canada, where the *Targeted Employment Strategy for Persons with Disabilities* increased employment among persons with disabilities by 18%.

The fourth challenge is the **loss of educational trajectories and cognitive potential** caused by military actions, population displacement, and territorial occupation. According to UNICEF (2024) [39], over 1 million children in Ukraine have experienced interrupted education, and more than 300,000 lack access to a stable learning environment. This poses a risk of losing an entire generation of productive potential: one year of interrupted education reduces future income levels by 9–12%, while prolonged educational disintegration leads to cognitive decline, loss of motivation,

and social isolation [38]. A similar dynamic was observed in Syria, where youth literacy rates dropped by 20% following the 2011–2016 conflict, resulting in long-term GDP losses.

These challenges not only complicate the implementation of the analytical framework for human capital but also generate persistent risks that threaten long-term economic stability. These risks are cumulative in nature: they do not operate in isolation but mutually reinforce one another, creating a structural vulnerability effect. Their analysis enables a shift from problem description to the development of loss scenarios and policy priorities.

The most immediate *risk* is the decline in **total factor productivity (TFP)** – a key indicator of economic efficiency. If high-productivity workers are not integrated into the economy, or if educational losses are not compensated through reskilling, TFP tends to decline [17; 22]. In Ukraine, according to the Penn World Table, the TFP level in 2019 was only 0.44 relative to the United States [33], and it shows a downward trend, especially under conditions of demographic aging and educational disintegration.

The second strategic *risk* is the **deepening of regional disparities**. The absence of educational hubs, vocational training centers, and digital infrastructure in rural communities leads to the concentration of human capital in metropolitan areas. This creates a “peripheral depletion” effect – where regions lose the capacity for autonomous development and economic activity becomes overly centralized. Regional inequality in access to education is one of the key barriers to inclusive growth. For example, in Romania, following decentralization without institutional support, regional disparities in employment levels increased by 25% [38; 41].

The third *risk* is **innovation inertia** – the economy’s inability to adapt to technological change due to weak integration of digital skills, a low share of STEM education, and limited cross-sectoral mobility. The Brookings report *Innovation and Human Capital* [40] shows that countries with STEM graduates accounting for over 35% have 1.8% higher TFP. In Ukraine, according to the Ministry of Education and Science, the share of STEM graduates among vocational education completers in 2024 was only 18%, indicating the need to revise educational priorities – particularly in applied engineering, digital literacy, and entrepreneurship.

The fourth *risk* is **social fragmentation** – gaps in access to employment, education, and social protection that undermine trust, cohesion, and collective responsiveness. In countries with high social inequality indices, TFP growth rates are 40% lower [23; 26; 42]. In Ukraine, according to KSE [20], the social integration index in 2025 was 0.52 (on a scale of 0–1), indicating systemic vulnerability, especially among internally displaced persons, persons with disabilities, and youth with disrupted educational trajectories.

Therefore, strategic policy directions must not only compensate for losses but also create a new quality of human capital – as a pillar that ensures productivity, cohesion, adaptability, and institutional resilience. The next section presents an empirical model that quantitatively assesses the impact of TFP indicator on Ukraine's GDP dynamics.

3. Economic efficiency as a Structural Pillar

Total Factor Productivity and Determinants of Economic Efficiency.

At both global and national levels, one of the key characteristics and development factors of a country is economic productivity (efficiency), which experts most commonly assess through the indicator of **total factor productivity (TFP)**. TFP reflects the economy's ability to generate income from the resources brought into circulation – producing more with fewer inputs. If an economy increases its total output without increasing the use of production factors (such as labor and capital), or maintains its income level while using fewer resources, it is considered efficient and characterized by higher TFP [42].

In recent years, the dynamics of productivity – growth in output not directly linked to increases in labor or capital – have noticeably slowed. According to experts, this slowdown accounts for more than half of the deceleration in global economic growth. Nan Li and Dia Nureldin note that in advanced economies, annual productivity growth declined from 1.4% in 1995–2000 to just 0.4% after the pandemic. In emerging market economies, the decline was from 2.5% in 2001–2007 to 0.8% post-pandemic. The situation is even more concerning in low-income countries, where productivity growth fell sharply from 2% in 2001–2007 to nearly zero after the pandemic [21].

The downward trend in TFP since the early 2000s – measured in current prices at purchasing power parity (PPP) relative to the United States

(TFP level at current PPPs, USA=1), based on data from the Penn World Table – reflects a similar pattern in European countries with historically high TFP levels. For example, between 2002 and 2019, TFP in the Netherlands declined from 1.23 to 0.94; in France, from 1.23 to 0.91; in the United Kingdom, from 0.99 to 0.79; and in Switzerland, from 1.30 to 0.97 during the period 2013–2019 [33]. This slowdown in TFP, compounded by the 2008–2009 financial crisis and the sovereign debt crisis, has significantly impacted the economic trajectories of European nations.

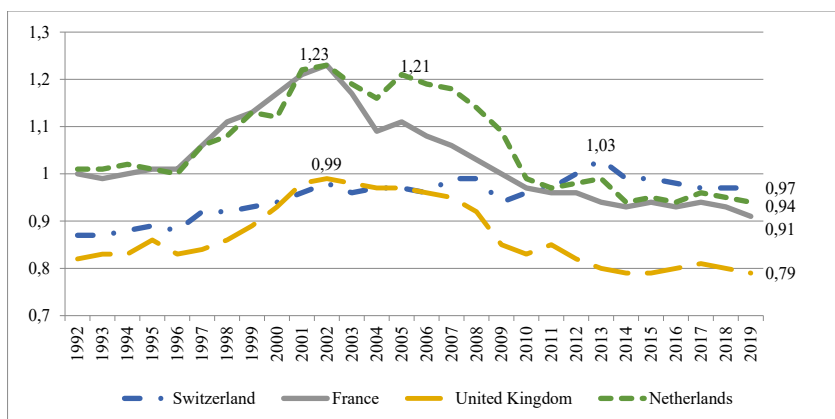


Figure 1. Dynamics of Total Factor Productivity in European Countries with the Highest TFP Levels

Source: compiled from Penn World Table data [33]

A comparative analysis of total factor productivity (TFP) dynamics based on Penn World Table data – measured relative to the United States (*TFP level at current PPPs, USA = 1*) – for selected European countries (Figure 1) and Ukraine (Figure 2) over the period 1994–2019 reveals that the productivity of Ukraine’s economy remained significantly lower than that of European countries and the United States throughout the entire long-term interval.

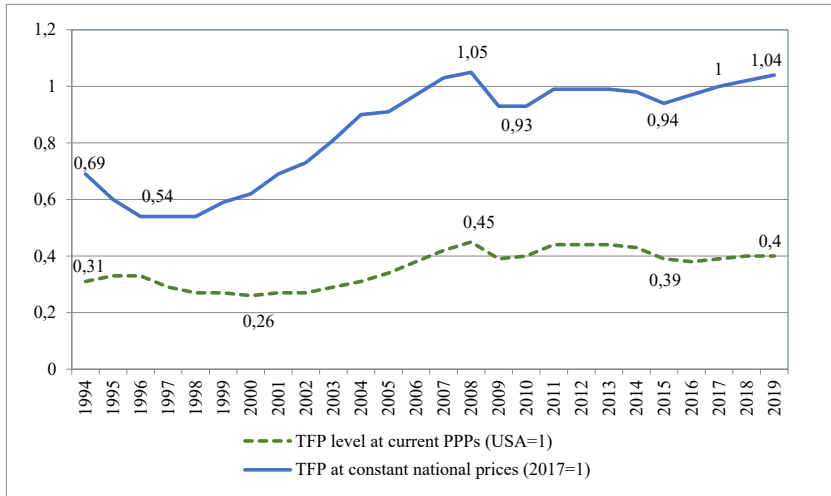


Figure 2. Dynamics of Total Factor Productivity in Ukraine, 1994–2019

Source: compiled from Penn World Table data [33]

Considering the negative impact of the 2020–2021 pandemic and the full-scale military aggression of 2022–2025 on Ukraine’s economy, it is highly likely that, in the absence of effective policy measures, the dynamics of total factor productivity (TFP) will continue to slow down by the end of the war, resulting in adverse effects stemming from declining economic efficiency.

In global practice, economic policy measures aimed at increasing productivity (efficiency) usually focus on activating factors closely related to the growth of total factor productivity (TFP). These measures operate across three main dimensions [42]:

1. Labor productivity – TFP tends to be higher in countries where workers spend more years in education, receive higher-quality training, and enjoy better health. These advantages enable the creation of greater value-added per hour worked and contribute to broader improvements in quality of life.

2. Resource allocation – For overall productivity to grow, it is crucial that the most productive firms within any given sector are able to attract

the majority of labor and capital. If this occurs, the economy is considered “efficient in resource allocation.” Conversely, if a significant share of labor and capital remains concentrated in relatively low-productivity firms, the economy is deemed “inefficient in resource allocation,” which constrains TFP growth.

3. International trade – Trade encourages countries to specialize in sectors where they hold comparative advantages, allowing for more productive use of resources. Access to global markets also enables firms to benefit from economies of scale, while international competition tends to favor high-productivity firms over less efficient ones.

Identifying the factors that contribute to TFP growth and economic efficiency requires rigorous analysis of real-world data. For this reason, experts rely on large-scale survey datasets collected across numerous countries to investigate the causes of significant productivity disparities among firms [11; 12; 16; 33; 35]. The standardized nature of these datasets provides a unique opportunity to compare average labor productivity across industries, countries, and regions, and to justify policy instruments that can enhance productivity and support growth.

A review of the literature on TFP research reveals that combining various analytical approaches has enabled experts to identify the *key determinants* of economic productivity in the modern world. These include [42]: innovation, education, market efficiency, infrastructure, and institutions. Empirical studies show that over the past decade, the most significant contributors to TFP growth variance have been market efficiency in OECD countries and education in developing economies.

For Ukraine, identifying the determinants that shape TFP dynamics and analyzing the experiences of other countries in applying economic policy tools to enhance business and national economic efficiency is of strategic importance. Productivity remains one of the structural pillars of Ukraine’s wartime and postwar development.

Empirical Assessment of the Impact of Total Factor Productivity on Ukraine’s GDP Dynamics. To empirically test the influence of economic efficiency on Ukraine’s GDP, the following hypothesis was formulated: “*Growth in total factor productivity (TFP) has a positive impact on GDP*”. Based on this, a single-factor linear regression model was constructed with the following baseline specification:

$$GDP = 582039.56 * TFP - 91873.25, \quad (1)$$

where:

GDP is the dependent proxy variable representing the dynamics of Ukraine's gross domestic product (in current prices, million UAH);

TFP is the independent variable representing the dynamics of total factor productivity in the economy.

The model includes a constant term that reflects the cumulative effect of all other factors influencing the dependent variable but not explicitly included in the model. Table 2 presents the statistical characteristics of the regression analysis for the period 1994–2019.

Table 2

Statistical Characteristics of the Regression Model Assessing the Impact of Total Factor Productivity on Ukraine's GDP

Dependent Variable: GDP				
Method: Least Squares				
Date: 02/08/25 Time: 19:37				
Sample (adjusted): 1994 2019				
Included observations: 26 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
TFP	582039.6	56971.80	10.21628	0.0000
C	-91873.25	49247.72	-1.865533	0.0744
R-squared	0.813044	Mean dependent var		400397.9
Adjusted R-squared	0.805254	S.D. dependent var		117575.4
S.E. of regression	51886.09	Akaike info criterion		24.62529
Sum squared resid	6.46E+10	Schwarz criterion		24.72207
Log likelihood	-318.1288	Hannan-Quinn criter.		24.65316
F-statistic	104.3723	Durbin-Watson stat		0.198725
Prob(F-statistic)	0.000000			

Source: Calculated using EViews 9 based on statistical data from the Penn World Table and the State Statistics Service of Ukraine.

The relatively low Durbin-Watson statistic in model (1) indicates the presence of other important factors influencing GDP dynamics that are not

included in the equation. This is logical, as the model does not account for fundamental production inputs such as capital, labor, and technological progress.

Overall, the results of the analysis confirm the validity of the proposed hypothesis: economic efficiency, as measured by total factor productivity (TFP), is statistically significant (Prob. t-Statistic at the 1% level) over the period 1994–2019. All else being equal, increases in TFP positively influenced Ukraine’s GDP dynamics.

Within the broader analysis of TFP as an indicator of human capital efficiency, it is appropriate to separately examine **labor productivity** – a metric that directly reflects the effectiveness of labor resource utilization. Labor productivity is an operational expression of the TFP at the level of enterprises, industries, and the economy as a whole. . It determines output per employed person and serves as a basis for assessing the intensity of economic growth.

In international practice, labor productivity in industry is measured as real output per worker, adjusted for purchasing power parity (PPP). This allows for meaningful comparisons between countries with different price levels and exchange rates. According to OECD (2025) [29], countries with advanced industrial bases demonstrate stable growth in this indicator, which correlates with investments in human capital, production modernization, and institutional quality (Table 3).

Table 3

Labor Productivity in Industry (2024, thousand USD, PPP)

Country	Labor Productivity	Change since 2010 (%)
Switzerland	142.3	+28.7%
Germany	128.6	+21.4%
France	119.4	+18.1%
United Kingdom	113.2	+14.6%
Poland	89.7	+39.2%
Slovakia	84.1	+36.9%
Turkey	78.4	+64.3%
Romania	76.2	+48.9%
Ukraine	42.7 *	–15.8%

Source: OECD Compendium of Productivity Indicators 2025; Ukraine data for 2018, calculated using Penn World Table (version 10.0)

As shown in the table, Ukraine demonstrates the lowest level of industrial labor productivity among the compared countries, with a negative trend relative to 2010. This reflects not only technological lag but also systemic inefficiencies in labor resource utilization. While OECD countries are increasing productivity through automation, digitalization, and skill investment, Ukraine faces industrial degradation, labor force losses, and weak institutional support for modernization.

The gap between Ukraine and Poland is particularly illustrative. Despite similar post-socialist trajectories, Poland has reached a labor productivity level of 89.7 thousand USD per worker – more than double Ukraine’s figure. This outcome stems from a consistent human capital development strategy, integration into European production chains, and active industrial investment.

Without production modernization, updated educational pathways, and institutional support for reskilling, Ukraine’s labor productivity potential will remain unrealized. Labor productivity, therefore, is not merely a technical metric – it is a socio-economic marker of efficiency, equity, and resilience. Its growth must become a priority of human capital policy – through industrial modernization, skill development, institutional support, and fair distribution of labor outcomes.

In the context of Ukraine’s wartime and postwar reconstruction, human capital must be viewed not as a passive object of policy, but as an active agent of structural reconfiguration. Its endogenization – through local education systems, institutional support, the social economy, and digital infrastructure – is a key condition for shaping a new economic architecture capable of sustainable development. At the same time, implementing the analytical framework that encompasses individual, institutional, social, and territorial levels requires a strategic rethinking of human capital policy.

Critical analysis reveals that compensatory measures – such as targeted support, short-term reskilling programs, or employment subsidies – are insufficient to ensure long-term resilience. What is needed is a transformational policy that combines institutional coherence, inclusivity, innovation, and regional differentiation. Such a policy must be grounded in the development of educational ecosystems that integrate formal, informal, and digital learning, fostering adaptability and professional mobility. Under

conditions of high turbulence, educational hubs, microlearning platforms, and modular programs become the infrastructure of resilience.

Institutional support for mobility – through vouchers, microgrants, and personalized learning trajectories – is essential for realizing the adaptive function of human capital. However, without inclusive infrastructure, these mechanisms remain inaccessible to vulnerable groups. The social economy – cooperatives, inclusive enterprises, and civic initiatives – serves not only as a compensatory mechanism but also as a source of cohesion, trust, and local development. Its integration into human capital policy enables the alignment of economic efficiency with social justice.

A condition for sustainable growth is also the fair distribution of labor outcomes. Productivity growth without corresponding increases in labor income leads to fragmentation, loss of motivation, and erosion of institutional trust. Gender- and age-responsive budgeting – as policy instruments – allow for demographic specificity, ensuring the participation of women, older adults, and other groups in recovery processes.

Finally, cross-sectoral coordination – among education, business, communities, and government – is critical to avoid fragmentation. Regional human capital councils, educational platforms, and employment centers must operate as a coherent system that ensures strategic integration. Without such coordination, even the most advanced tools remain fragmented and fail to generate systemic transformation.

In conclusion, strategic human capital policy must be proactive – not merely compensating for losses, but creating a new economic quality. Its goal is to transform human capital into a structural force that ensures productivity, cohesion, adaptability, and institutional resilience.

4. Conclusions

This study has successfully achieved its stated objective: to develop an analytical framework for human capital as a structural pillar of Ukraine's economy during the wartime and postwar period. Based on interdisciplinary analysis, four levels of human capital impact were identified – individual, institutional, social, and territorial – alongside key challenges and strategic risks that hinder its realization. Policy directions were substantiated to transform vulnerability into a resource for development.

Empirical assessments confirmed the statistically significant influence of total factor productivity (TFP) on Ukraine's GDP dynamics, as well as the growing role of labor productivity as a determinant of human capital efficiency. Institutional fragmentation, demographic deformation, educational losses, and social inequality were identified as critical points of potential loss requiring systemic response. Strategic human capital policy must be grounded in the principles of inclusivity, institutional coherence, regional autonomy, and innovative openness. Its implementation will not only compensate for losses but also create a new economic quality – adaptive, equitable, and productive.

Future research should focus on developing a multifactor model to assess the impact of human capital on economic resilience, analyzing regional disparities in access to educational resources, and evaluating the effectiveness of institutional interventions in reskilling, inclusion, and the social economy. Particular attention should be given to designing an indicator system for monitoring human capital policy implementation at the community, regional, and sectoral levels.

This article proposes a multi-level analytical framework for human capital that enables a systemic understanding of its role in wartime and postwar reconstruction processes. The integration of individual, institutional, social, and territorial dimensions into a unified matrix ensures not only conceptual coherence but also practical applicability for strategic planning.

The scientific novelty of the approach lies in the synthesis of classical human capital theories with contemporary concepts of cognitive economics, social cohesion, and regional autonomy. This allows for the consideration of the multidimensional nature of the challenges facing Ukraine in its transformation – from demographic losses to institutional fragmentation and spatial inequality.

The analytical framework functions as a diagnostic tool capable of identifying structural barriers and intervention points with high potential for multiplier effects. Its application opens opportunities for shaping adaptive, inclusive, and territorially balanced human capital development policies.

Further research should aim at empirical validation of the proposed model, development of effectiveness indicators for interventions at each level, and assessment of their impact on long-term economic stability and social cohesion.

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