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Article

The principle of cascadic prosilience—Assessment of territorial recovery strategies after disrupted regional infrastructure systems in Iraq

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Abstract: This paper presents an assessment approach to fostering socioeconomic re-development and resilience in Iraqi regions emerging from the destruction and instability, in the aftermath of the war conflict in Iraq. Focusing on the intricate interplay of logistics infrastructure and economic recovery, the present study proposes a novel framework that integrates general resilience insights, data analytics, infrastructure systems, and decision support from Data Envelopment Analysis (DEA). We draw inspiration also from historical cases on "creative destruction" or "Blessing in Disguise" (BiD) phenomena, like the post-WWII reconstruction of Rotterdam, so as to develop the notion of stepwise or cascadic prosilience, analyzing how innovative logistics systems may in various stages contribute to economic rejuvenation. Our approach recognizes the multifaceted nature of regional resilience capacity, encompassing both static (conserving resources, rerouting, etc.) and dynamic (accelerating recovery through innovative strategies) dimensions. The logistics aspect spans both the supply side (new infrastructure, ICT facilities) and the demand side (changing transportation flows and product demands), culminating in an integrated perspective for sustainable growth of Iraqi regions. In our study, we explore several forward-looking strategic future options (scenarios) for recovery and reconstruction policy factors in the context of regional development in Iraq, regarding them as crucial strategic elements for effective post-conflict rebuilding and regeneration. Given that such assets and infrastructures typically extend beyond a single city or area, their geographic scope is broader, calling for a multi-region approach. By leveraging the extended DEA approach by an incorporation of a super-efficiency (SE) DEA approach so as to better discriminate among efficient Decision-Making Units (DMUs)—in this case, regions in Iraq—our research aims to present actionable and effective insights for infrastructure investment strategies at regional-governorate scale in Iraq, that optimize efficiency, sustainability and resilience. This approach may ultimately foster prosperous and stable post-conflict regional economies that display—by means of a cascadic change—a new balanced prosilient future.

Keywords: disruption; resilience; prosilience; infrastructure development; post-conflict recovery; Data Envelopment Analysis (DEA); Blessing in Disguise (BiD); Pentagon approach

1. Introduction

Spatial-economic, political and environmental systems are often faced with disturbances and shocks. In the landscape of modern regional and geopolitical research, a new focal point of intrigue emerges: the "geography of disruption" (see e.g., Yigitcanlar and Inhinen (2019)). This new conceptual realm captivates both scholars and policymakers, delving into the intricate dynamics that unfold when the

equilibrium of spatial-economic and environmental systems is abruptly shattered. The pursuit of comprehending disruptions transcends disciplinary boundaries, grappling with identifying determinants, understanding the spatial reach of impacts, navigating the multifaceted nature of shocks spanning natural, technological, geopolitical, and socioeconomic dimensions, and crafting recovery strategies that can navigate the challenging aftermath of disturbances. Rooted in catastrophe theory (Thom, 1975; Zeeman, 1977) and complexity management (Reggiani and Nijkamp, 2009), with their origins in mathematics, this scientific journey navigates diverse realms, aimed at unraveling the complex tapestry of the geography of disruption ranging from natural disasters to wars.

In this complex network of research, a considerable number of studies conducted over the past decades has focused on unraveling the negative impacts of shocks (Friesz, 2007; Tessler, 2002; Suzuki et al., 2011; Dupont and Noy, 2015; Brody et al., 2014; Fernandes, 2020; Bachman, 2020; Guan et al., 2020; Pinner et al., 2020; Sarkis et al., 2020). Urban disasters and regional or national catastrophes have garnered considerable attention, dissecting the adverse facets of disruptions such as extreme climatic events, natural disasters or sociopolitical unrest (Acemoglu et al., 2012; Barrot and Sauvagnat, 2016; Boehm et al., 2019; Cole et al., 2019; Dupor, 1999; Horvath, 2000; Knapp et al., 2010; Sieg et al., 2019; Terry, 2007). While this focus on negative consequences is valid, it often overlooks a parallel but positive narrative—a narrative where shocks have the potential to catalyze positive change. Even amidst turmoil and chaos, silver linings may emerge, driving innovation and unforeseen progress (the "Blessing in Disguise" (BiD) hypothesis; see later). This transformative aspect of disruption, which uncovers opportunities amidst adversity, has been explored in studies like Yigitcanlar and Inhinen (2019), delving into the impacts of innovation within knowledge economies, and Esposito (2021), offering a comparative analysis of innovation performance shocks across various U.S. states. These instances make it clear that disruptions are more than mere challenges; they carry within them the promise of fostering growth and renewal (see e.g., Kourtit et al. (2023)).

The effective transformation of disruptions into catalysts for positive change hinges generally on a confluence of empathetic and motivational leadership (Bergek et al., 2008; Coenen et al., 2012; Geels and Schot, 2007; Geels, 2018; Hekkert et al., 2007; Hansen and Coenen, 2015; Köhler et al., 2019; Markard et al., 2012; Smith and Raven, 2012; Van der Loos et al., 2020). The journey to convert challenges into benefits—incorporated in the BiD concept—is informed by knowledge, acumen, and a clear policy pursuit of objectives within a broader contextual framework. In this endeavor, the concepts of resilience and prosilience are intertwined-defensive measures to withstand shocks merge seamlessly with offensive strategies that harness disruptions as drivers for sustained growth (see for an exposition e.g., Aroca et al. (2021)).

As the complexities of systemic transitions and perturbations are gradually unveiled, a diverse array of statistical and modeling methodologies for studying economic shocks has emerged. Examples include operational quantitative disaster studies, as exemplified by works like Okuyama and Rose (2019) and Banica et al. (2020), which rigorously dissect the multifaceted effects of disruptions. These studies contribute to a more comprehensive understanding of the implications of disruptions

across various dimensions.

Moving beyond the realm of the regional-economic growth literature, a consensus is forming—the actionable presence of territorial capital (see Camagni (2009); Capello et al. (2011); Capello and Lenzi (2014); Nijkamp (2016); OECD (2001)) is pivotal in nurturing thriving economies. This intricate web of territorial capital encompasses infrastructure, social capital, institutional structures, environmental stewardship, and human capital (see also the Pentagon framework described in section 2). These determinants collectively form the bedrock of economic advancement, even within the dynamic and complex landscape of regions under pressure such as Iraq. The underlying premise of our research revolves around the presence and activation of these territorial determinants as drivers of economic progress. The empirical base of the present study is formed by the post-war recovery challenges of regions in Iraq.

Navigating the complex economic behavior of Iraq and its culturally diverse regions demands a dual perspective. First, the pronounced diversity of regions is underscored by socio-economic, cultural-religious, and physical-geographic variations. Second, the policy landscape is characterized by an intricate network of conflicting institutional stakeholders, each motivated by their vested interests. Within this complex web, the systematic design of development scenarios—future strategic choice options—emerges as a rational anchor, offering reference points for both national and regional-economic strategies under post-conflict conditions.

The study of deep shocks—the disruptions arising from systemic and infrastructural catastrophes like major floods or wars-challenges the very fabric of traditional static—often linear—impact models. These models, reliant on static parameters that constitute their building blocks, are shaken, as parameters undergo transformations in value, direction, or even function. Within this dynamic context, our paper seeks to unveil an innovative analytical approach that comprehends and manages transitional phenomena induced by geopolitical disruptions. This approach encompasses intervention models rooted in economic efficiency concepts, specifically leveraging the super-efficient (SE) model approach from Data Envelopment Analysis (DEA), and the strategic deployment of stimuli following systemic disruptions, particularly in the context of war and geopolitical tensions, for the regions in Iraq.

This paper seeks to frame the development options of regions in Iraq in the context of resilience and prosilience (i.e., enhanced recovery) strategies, in a multi-period perspective (hence the term cascadic prosilience). This paper is organized as follows. After a broad conceptual introduction, we use Super-Efficient Data Envelopment Analysis (SE-DEA) as an analytical methodology for strategic recovery scenarios, so as to derive policy lessons for the regions under consideration.

2. Conceptual and methodological framing

Our research endeavors to provide multi-faceted regional efficiency valuations regarding the economics of disasters and shocks. Specifically, we take a keen interest in examining the validity of the “Blessing in Disguise” (BiD) hypothesis—a captivating notion suggesting that natural disasters can potentially yield positive long-term effects on regions and cities, challenging conventional wisdom (Kourtit et al.,

2023). Additionally, we delve into the pivotal role of institutional and organizational resilience in steering the recovery process after a logistic or infrastructural disruption in a country or region. These facets are essential in understanding the intricate interplay between upheaval and recovery of Iraqi regions.

In our comprehensive study of disaster impacts across different regions in Iraq, we employ the BiD hypothesis in conjunction with the so-called Pentagon model (see for more details Kourtit et al. (2023)). This model maps out five prominent and critical factors that are essential for the development of an area. This fusion provides us with a comprehensive analysis framework to dissect the critical dimensions of infrastructural and economic recovery, as depicted in **Figure 1**, the XXQ-Pentagon, where XXQ stands for the highest quality of life or socioeconomic wellbeing—or, in general, the highest performance—in a country or region (see also Nijkamp (2008)).

Figure 1. The XXQ-Pentagon for regenerative regions.

This framework encapsulates the constellation of five critical elements that drive recovery—ranging from tangible productive assets to social and environmental considerations. The Pentagon model is essentially a generalized production function that generates through productive factors a multi-dimensional output or social value (XXQ). In alignment with this framework, we will test the BiD proposition from the perspective of prosilience. To that end, we will employ an extensive database centered on Iraq, laying the foundation for a multi-regional resilience evaluation framework based on DEA. Iraq's tumultuous history, marked by a series of shocks including recessions and political turmoil, acts as a microcosm of broader challenges faced by post-conflict regions elsewhere in the world.

The Pentagon model outlined in **Figure 1** forms the backbone of our generalized neoclassical production function approach incorporated in an extended DEA approach. The crux of the challenge lies in identifying and implementing the optimal combination of the five critical production factors of territorial capital to achieve maximum welfare outcomes. However, the operational constituents of welfare are complex and multidimensional, like GDP, employment, economic growth, poverty and socioeconomic equity. Thus, our paper contributes also to the growing literature on multi-objective optimization and extends it by including a super-efficient DEA approach, recognizing the need for highlighting the inherent choice complexity in real-world development options or scenarios, that characterize basic policy uncertainty.

Despite the wealth of literature on catastrophe theory, bifurcation theory, chaos theory, and resilience theory, clear evidence-based and actionable policy

recommendations for shock-induced reconstruction activities have remained largely absent. It is important to acknowledge that, while the introduced novel BiD concept and the subsequent notion of "cascadic prosilience" hold potential, they are not automatic solutions for all post-conflict reconstruction challenges. Building on this foundation, the subsequent sections of this paper provide evidence on the BiD conceptualization and the shock-recovery resilience mechanism, particularly in the context of a post-war economy, using Iraq as a reference frame.

The general realm of disruptions extends of course beyond hostile attacks on infrastructure, cities or nations; it encompasses a spectrum of causes, including natural disasters like earthquakes, tsunamis, and volcanoes, technological disasters such as nuclear accidents, and economic shocks like banking crises. In each case, the critical production factors that drive economic performance are disrupted or destroyed, as reflected in sudden declines in socio-economic indicators. The primary challenge lies in two dimensions: transforming downturns into upturns, and choosing and implementing recovery trajectories that mitigate economic catastrophes and foster system upgrades. This is, for instance, vividly illustrated through a recent regional resilience study focusing on Turkish regions that have experienced volatile fluctuations over recent decades (see Duran et al. (2023)); this study emphasizes the capricious dynamics of these regions and their adjustment mechanisms, underscoring the region-specific resilience factors (territorial capital) that contribute to better outcomes. Timely and effective policy interventions are of course critical (see also Berman et al. (2011); Cariolet et al. (2019); Hynes et al. (2022); Mahoney et al. (2022); Smith and Raven (2012)).

Our research explores an investment efficiency analysis for logistic infrastructure, utilizing the limited empirical data available from Iraq. This exploration is made possible by employing extended DEA models, which serve as the foundation for conducting quantitative scenario—or future option—experiments. The strategic future options are based on prioritized choice possibilities and sequenced needs planning strategies over a 5-year period, subdivided into short term (year 1), medium term (years 2–5), and total (over all 5 years). This journey is facilitated by conditional DEA models, which provide the foundation for conducting quantitative future options or scenario experiments. These experiments shed light on optimal investment trajectories and utilize DEA as a vehicle for generalized multi-criteria analysis modeling.

As mentioned, the implications of our research extend beyond the specific context of Iraq. The methodologies and insights gleaned have the potential for application in other regions and countries grappling with stress or shock conditions, such as geo-political conflicts. As we delve deeper into sustained value-adding strategies within post-conflict zones, we seek to uncover a framework that systematically dissects the intricate web of interrelated factors. This roadmap serves to empower decision-makers, offering a strategic guide to navigate choices, promote sustainable development, and foster resilience (eventually leading to prosilience as an improved re-structuring of the initial situation). Thus, this paper serves as a comprehensive exploration of the potential within our integrated framework—a framework that aims to rejuvenate economies, restore social fabrics, and nurture prosperity in the aftermath of disruptions at regional scale in Iraq.

3. Tidal movements of regions: The cascadic prosilience principle

3.1. From adaptivity to agility

The complex landscape of geopolitical conflicts and their resulting disruptions has given rise to new subdisciplines, ranging from regional conflict management to peace science (Kyprianou et al., 2022; Law and Singleton, 2014; Streeck and Thelen, 2005; Turnheim and Geels, 2013; Wang and van de Lindt, 2022). Yet, the underlying quest reaches beyond academia, delving into not only understanding the origins of conflicts but also the intricate spatial consequences of violent clashes between nations, regions, or societal factions. Amid this intellectual journey, a fundamental question arises: What conditions catalyze recovery, and within what temporal boundaries does this process occur? This inquiry intersects with another facet of exploration: Does recovery simply entail a return to the initial status quo, as encapsulated within the notion of resilience, or does it herald a profound transformation into an evolved system with even greater socio-economic potential—a phenomenon we term "prosilience"?

Central to understanding the economic developments in a country or region are the abovementioned Pentagon factors. It is important to note that during situations of war and post-war, like that experienced in Iraq, where significant parts of the five critical Pentagon factors are disrupted or devastated, the growth model depicted in Figure 1 operates in the opposite (negative) direction. Through the mechanism of "cumulative causation" (see Myrdal (1968); Batabyal et al. (2021)), a negative spiral movement ensues, potentially leading to destructive and disruptive effects on the regional or national economy, aside from the human suffering. This downward trajectory may eventually reach a point of stabilization, after which—with concerted efforts—a recovery process can begin, ultimately resulting in a new equilibrium for territorial development (a resilience case).

The recovery process is often prolonged and demanding, necessitating the efficient utilization of various input factors, as illustrated in **Figure 1**. In the context of literature on shocks, disturbances, and vulnerabilities, the concept of resilience has gained prominence. A pivotal question in resilience analysis is whether the recovery trajectory leads to a return to the original equilibrium or whether it results in a more efficient or better-functioning new equilibrium through incremental adjustments. However, a more radical perspective, in line with Schumpeterian thinking, envisions the notion of "creative destruction", leading to a profound transformation of the original system. This transformative shift leading to a radically significant enhancement of performance compared to the initial base case is termed here prosilience. These diverse patterns and phase transitions can be visualized through the cascadic system shown in **Figure 2**, which demonstrates the stepwise "battle up-hill" in case of BiD recovery strategies. In recent years, the scholarly arena has witnessed an unprecedented surge in studies within the domain of disaster management, notably spotlighting the art of managing resilience (as highlighted by the works of Berman et al. (2011); Okuyama and Rose (2019) and Banica et al. (2020)). However, this surge is accompanied by an inherent challenge—navigating the intricate landscape of regional resilience policy, vividly portrayed through the lens of a step-wise "cascadic prosilience" framework as depicted in **Figure 2**.

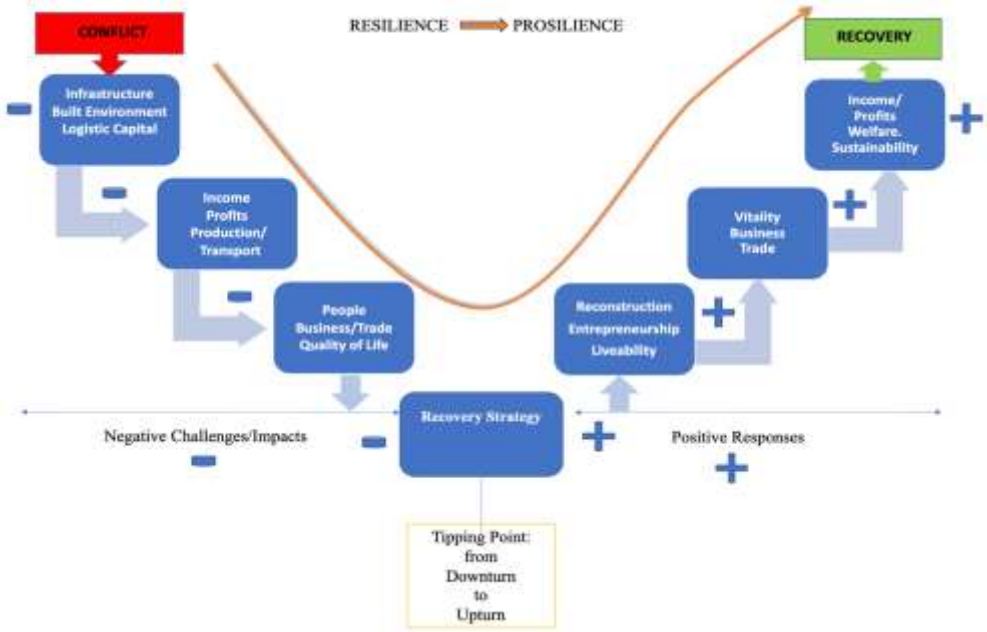

Figure 2. Regional cascadic prosilience trajectory after a geo-political conflict.

This framework goes beyond representing mere post-shock recovery; it embodies the very foundations that could potentially elevate a region's performance to unprecedented levels in the long term. It captures the nuanced rhythm of regional systems, akin to the ebb and flow of tides, oscillating within complexities much like the intricate dynamics of spatial-economic cycles or rhythms (Lefebvre, 2004). The cascadic framework will be used in our exploration on the recovery potential of regions and infrastructure. We will take Iraq as an illustrative empirical case for testing the relevance of the above sketched Pentagon framework as the basis for a prosilience approach.

The underpinnings of resilience, as a scientific analytical framework, trace their roots back over half a century. Icons such as Holling (1973) in the ecological realm and Werner and Smith (1982) within psychology have woven its narrative. However, resilience's scope extends beyond these domains, resonating across socio-economic and geographical domains, manifesting within works by Rodin (2015), Walker et al. (2004), Martin (2012), Banica et al. (2020), Pietro et al. (2004), and Batabyal and Kourtit (2020). At its core lies adaptive systems theory, where resilience's conceptualization explores into the disruptions caused within evolutionary trajectories by significant shocks that tip a system off balance. To measure adaptability, straightforward socio-economic performance metrics are often employed, including sensitivity indices that measure relative employment changes post-shock in relation to national trends (Martin, 2012). For a comprehensive overview, De Siano et al. (2020) provide an all-encompassing perspective, complemented by Banica et al.'s (2022) extensive empirical investigation.

However, the attributes of resilience in a deteriorating system are intertwined with a complex array of contextual factors, spanning socio-economic (Fingleton et al., 2012), planning (Eraydin and Tasan-Kok, 2013), ecological (De Montis et al., 2019), digital-technological (Tsuchiya, 2019), geographical (Yu and Gibbs, 2018), and organizational (Barasa et al., 2018) dimensions. Therefore, crafting a recovery strategy,

a promising post-disruption strategy requires the deft orchestration of reconstruction and support measures, meticulously timed, which might lead to prosilience. A fundamental question arises: Can a recovery trajectory post-downturn surpass a scenario untouched by shocks? Insights garnered from the aftermath of German city bombings during World War II hint at a favorable outcome (a BiD case), albeit over the long term (see Brakman et al. (2004)). The authenticity of the "cascadic prosilience" concept will be illuminated in section 4, as we delve in particular into Rotterdam's wartime devastation and subsequent revival following German bombings in May 1940.

3.2. Evolutionary recovery

The expedition into the realm of evolutionary recovery navigates a complex socio-economic and technological landscape shaped by the contours of stressor conditions in the aftermath of (post-)conflict zones. However, this endeavor is not merely a mechanical trajectory; it's a conscious cultivation of a long-range development strategy that transcends conventional views. This new perspective is intrinsically laser-focused on values that not only resonate but are deeply intertwined with societal needs, channeling the course of resurgence along paths that align with the aspirations of the people (Cuaresma et al., 2008).

As the complexities of recovery unfurl, the bedrock of institutional and social resilience emerges as the steadfast keystones upon which the edifice of resurgence is erected. These twin pillars stand as the vanguards against the tide of adversity, anchoring the trajectory of rejuvenation amidst the turbulent sea of challenges. In this narrative of recovery, an evolutionary perspective emerges as a guiding beacon. This perspective transcends the confines of linear trajectories, weaving an intricate tapestry that navigates the interplay of chaos and rejuvenation. Within this BiD paradigm, disruptions are not mere hurdles but catalysts that trigger a cascade of adaptations, innovations, and transformations (see e.g., Chang (2010)). This perspective, rooted in the realm of resilience and fortified by the spirit of prosilience, encapsulates the view that underpins the process of evolutionary recovery. Our analysis framework is thus based on a blend of critical input factors (the Pentagon model in **Figure 1**) that are cast in the context of a prosilience study on regional recovery strategies for Iraq (**Figure 2**), using a DEA as a methodological tool.

In summary, the primary concern in the present study is to peel back the layers of complexity within post-conflict regions, unraveling the intricate dynamics of recovery. This holistic mission entails probing the ramifications of shocks, harnessing the resilience of institutions and organizations, and deploying robust analytical frameworks. Through this holistic approach, we strive to chart a transformative course that ushers in a new era of progress and resilience in regions grappling with the aftermath of conflict, where Iraq will serve as an illustrative case.

4. Destruction and post-war recovery: BiD lessons for Iraq

4.1. Preface

In the tumultuous aftermath of conflicts (like in Iraq), where destruction lays bare the foundations of nations, a pioneering quest emerges within the domain of regional

science. This section delves into the case of Iraq, a nation gripped by the repercussions of war, to unveil the potential of comprehensive recovery of its regions and cities. Geopolitical conflicts and war situations like in Iraq have been extensively documented in the literature (see, for example, Barnett et al. (2005); UNHCR (2005); Massey (2007); Marr (2012); Ingram (2013); Yusoff (2013); Lederman (2014); Dixon (2016); Burch et al. (2017)). The multidisciplinary perspective of regional science serves as a guiding light, transcending conventional boundaries and embracing the holistic dynamics that dictate post-war resurgence of regions.

The landscape of Iraq, scarred by conflict-induced devastation, provides the backdrop for a study that delves not only into the intricacies of post-war recovery but also reimagines the very essence of state formation within the broader Middle-East region. Emerging from the shadows of destruction, Iraq becomes a crucible of transformation, offering insights into the intricacies of renewal amidst adversity.

Regional science, with its comprehensive approach, is uniquely poised to illuminate the intricate facets of post-war recovery at regional level. Its holistic perspective disregards artificial political borders, allowing a profound exploration of spatial dynamics, human interaction, and economic intricacies. The integrated framework of this discipline, addressing agglomerations and spillovers, stands as a potent tool in deciphering the complexities of recovery strategies in conflict-affected regions. We refer here to strategic foresight studies by Van der Heijden (1996), World Bank (2016), UNDP (2008), Peters (2021) and Maxwell et al. (2017).

4.2. Areas in ruins: Lessons for Iraq

In a war situation, cities are normally not destroyed for the sake of destruction, but they subjected to violent attacks to serve other and important strategic objectives (sometimes called “strategic bombing”), such as: to generate a fast surrender (e.g., the atom bombs on Nagasaki and Hiroshima), or to create a transit corridor (e.g., the recent destruction of Marioepol in Ukraine). A historically known example is the strategic bombing of the city of Rotterdam in the beginning of WW II in order to ensure a rapid attack for German troupes on France and Great Britain. The devastation of the city of Rotterdam meant not only a major perturbation of its internal functioning, but also a total logistic disruption of the port function of the city. Already during the war, plans were made to replace the disrupted outdated infrastructure of the city by a modern and entirely new design and lay-out of the city and to opt also for an advanced port infrastructure. As a consequence, contemporary Rotterdam has turned into a modern sky-scraper city and also into one of the biggest and advanced ports in the world. Clearly, the five Pentagon investment factors are critical here. Several studies—based on historical evidence—confirm the validity of the BID concept for the Rotterdam case, leading to a prosilient outcome. We mentioned already that similar findings on a BiD—in terms of a relatively higher economic performance—can be found in post-war German cities that were heavily bombed during the war (see Brakman et al. (2004)).

At the heart of our research lies a paramount goal: to contribute substantively to the restoration, stability, and sustainability of Iraq post-conflict. This ambition shifts the focus from arbitrary borders to a principled approach, harnessing diverse

dimensions of population well-being. While destruction may pose monumental challenges, it also presents a unique opportunity for holistic transformation—a moment to rebuild not merely what was lost but to leap forward into a more promising future.

4.3. Pathways to reconstruction

The path toward Iraq's reconstruction demands an intimate comprehension of various spheres, from reconfiguring infrastructure to fostering education and social services (Coyne and Coyne, 2019). These efforts become avenues for technological leapfrogging and comprehensive advancement. The research, inspired by Martin and Sunley (2006) and Rodríguez-Pose and Fitjar (2013), aspires to guide the formulation of strategies that mirror the demographic and economic opportunities of the region, steering away from historically expedient yet inadequate delineations.

This research extends beyond the case of Iraq. It refines existing methodologies while forging novel pathways for a more integrated assessment of regional components. Through the lens of Iraq, the research not only deepens empirical and policy analysis, but also testifies to the broad applicability of regional science methods in addressing global challenges.

Figure 3. Flow diagram of our analysis.

Figure 3 illustrates the analytical journey, encompassing multi-attribute objectives, scenario images, indicator collection, input-output data processing, DEA-analysis, scenario (strategic option) exploration, interpretation, and recommendation formulation. This rigorous process encapsulates the essence of our research, fostering a comprehensive understanding of post-conflict regional recovery. In pursuing this analysis, it is of course pertinent to pay explicit attention to policy initiatives for strengthening regional resilience based on transportation and logistics, to the balance between long-range infrastructure development and operational management, to the

multi-dimensional evaluation and implementation of land use changes, to the sustainability requirements of new development strategies and to the vulnerability aspects of new road or port construction. This will be further elaborated in subsequent sections.

5. Recovery evaluation of systemic strategies

The research leaps into the void of post-conflict transportation system restoration, introducing a holistic system-of-systems approach. By ensuring transportation logistics' resilience, viability, and sustainability, this approach becomes the backbone of broader economic growth and stability. Iraq exemplifies this model, showcasing the utility of DEA as an illuminating framework (see for more details section 6). The research framework paves the way for simulation experiments on strategic options (scenarios), offering insights into alternative transportation development programs and their emergent outcomes. This avenue not only provides novel insights but also offers guidance for future studies addressing interventions in post-conflict societies.

The intricate landscape of post-war recovery unfolds against the backdrop of infrastructure dynamics that hold the power to shape the trajectory of resurgence. In the specific context of Iraq, where the scars of conflict have left lasting impacts, a comprehensive understanding of the interplay between infrastructure, logistics, and recovery strategies becomes paramount.

The aftermath of a disaster initiates a cascade of impacts that significantly affect infrastructure and logistics systems (see **Figure 2**). These systems, often wielding physical power, bear the initial blow, setting in motion a chain reaction that reverberates through interconnected networks. The immediate impact indirectly influences nearby or related infrastructure and logistics systems, unveiling the intricate web of interdependence that characterizes recovery scenarios distributed over the short term, medium term, and total term over a five-year time period. This complex web of connections extends clearly beyond just physical infrastructure. When infrastructure and logistics systems are damaged, it has a cascading effect on related industries and communities. This cascading effect depends on how tightly connected these elements are, highlighting the complexity of the recovery process that goes beyond just physical infrastructure and considers softer, non-infrastructure factors. By assessing the extent of damages and the qualitative impacts, each sector identifies what it needs for recovery and suggests a sequence of priority actions. This encompasses the costs of rebuilding assets, providing essential services, improving specifications, and implementing measures to reduce future risks. In this complex scenario, it's crucial to strategically analyze how these impacts spread. By pinpointing critical infrastructure and logistics systems and their connections to associated industries, this may help to understand how disruptions spread through this complex network. This forward-looking analysis of recovery and reconstruction needs serves as a guide for crafting strategies that take into account the interconnectedness of these systems.

Focusing on critical infrastructure is paramount in post-war recovery efforts. Infrastructure such as buildings, road and rail facilities, electricity grids, bridges, communication networks, and oil facilities take center stage. Beyond their physical attributes, these elements serve as lifelines for societal functionality, bearing profound

implications for the success of recovery endeavors.

We also note here that sustainability in operational logistics performance is a cornerstone of effective recovery. Employing the DEA method, efficiency scores are derived to gauge how effectively operational infrastructure and logistics align with sustainability objectives. We will show that a "soft" factor like healthcare industry emerges as a linchpin, considering its crucial role in disaster recovery. Additionally, electricity and transportation infrastructure significantly impact communities and associated industries (Aljawareen, 2000).

There is no doubt that regions and urban areas introduce a layer of complexity to disaster mitigation. Larger cities, with a higher concentration of critical infrastructure and industries, magnify the interrelatedness that underpins effective management of complex disaster scenarios. A holistic recovery approach is indispensable for community resilience. Such an approach transcends physical restoration to address social, psychosocial, economic, and environmental components. This comprehensive strategy forms the basis of effective resurgence. At the analytical forefront, the application of DEA proves transformative. As a methodological state-of-the-art tool, DEA conducts multi-input and multi-output efficiency analysis, tailored to the unique challenges posed by infrastructure and logistic systems. For more details on all aspects of DEA as a strategic tool for regional performance evaluation, we refer to Suzuki and Nijkamp (2017).

In unraveling the intricate relationship between logistics capabilities and socio-economic development within each post-conflict zone, the research empowers informed decisions regarding investment in infrastructure and logistics capabilities. The research employs DEA to main outputs, encompassing total, primary, industrial, and service sector GDPs. This encompasses agriculture, agribusiness, manufacturing, energy, commerce, education, health, transportation, and more. Delving deeper, the study may also incorporate latent dimensions, such as the number of persons employed in transportation, mail, and warehousing activities, into the DEA model. This layer adds complexity and depth to the analysis, capturing the multifaceted nature of infrastructure and logistics dynamics.

In essence, these attention points collectively navigate the intricate terrain of post-conflict recovery. As Iraq seeks to rebuild and reconfigure in the aftermath of conflict, these insights become guiding beacons, informing strategic decisions, and shaping a resilient and prosperous future. Beyond physical reconstruction, our research is illuminated by the intricate interplay of interconnected systems, serving as a framework for comprehensive understanding in fostering a society of enduring strength.

6. Data and methodology

The empirical part of this study forms an illustration of post-conflict prosilience strategies in Iraq, with a specific focus on regional infrastructure. Amidst the tumultuous aftermath of war conflicts, the quest for economic viability, resilience, and sustainability takes center stage in the rehabilitation of logistics systems. Our study endeavors to unravel the intricate constellation of challenges and opportunities inherent in resurrecting logistics systems that form the backbone of post-conflict

economies. With a focused lens on the Middle East, particularly the case of Iraq, this research delves into the intricate dynamics that underscore successful recovery and development following widespread destruction.

The overarching scope of this study encompasses the creation of a formalized framework for infrastructure planning tailored explicitly to the complex needs of logistics systems operating within post-conflict zones like in Iraq. The primary stages guiding this research are the following:

- Formulate a comprehensive framework: To develop and validate a comprehensive framework of infrastructure planning, that is primed to tackle the great challenges of logistics systems supporting post-conflict economies.
- Uncover resilient pathways: To delve into the pivotal role of infrastructure reconstruction and expansion as catalysts for economic development and the creation of resilient systems capable of responding effectively to disruptions.
- Develop metrics for sustainable growth: To construct an intricate yet practical framework for seamlessly integrating structured and unstructured data, culminating in the derivation of a set of robust metrics capable of evaluating the sustainability and resilience of infrastructure systems in the aftermath of conflict.
- Harmonize economic and social goals: To analyze and ensure the seamless alignment of sustainability principles within the redevelopment of logistics systems, all while accommodating the strategic decisions of diverse actors, optimizing supply chain efficiency, and accounting for socio-economic considerations.
- Scenario (option) simulations for optimal strategies: To facilitate a relevant array of scenario simulations, critically exploring alternative investment strategies for transportation infrastructure that will underpin the resurgence of post-conflict economies.

A cornerstone of this research is the development of a decision support system, intricately weaving input- and output-based efficiency methodologies to navigate the complex landscape of post-conflict logistics systems. This framework encompasses in particular a DEA: The study harnesses the power of DEA, including a SE-oriented DEA, to assess the efficiency and effectiveness of logistics systems of Iraqi regions. This methodology provides a dynamic lens to quantify the performance of infrastructure systems and identify key areas for improvement, ultimately contributing to informed decision-making in the reconstruction process (a prosilience policy).

The above cascadic prosilience concept will be tested by employing and operationalizing a specific type of DEA. DEA finds its origin in multi-objective optimization theory and identifies the efficiency performance of actors (Decision Making Units—DMUs) by tracing the ratio of multiple outputs (multiple objectives) versus multiple inputs (e.g., the five distinct territorial capital—or Pentagon—factors), which makes DEA essentially an instrument for a productivity analysis in regional investment strategies. The actionable feature of our approach is found in a super-efficient DEA, in which pre-specified development objectives are used to judge investment productivity outcomes at regional level against the background of a broad investment portfolio supporting regional development. It goes without saying that the data base in Iraq will always be a source of concern in such post-conflict studies.

DEA is a method used to evaluate the relative efficiency of DMUs or agencies,

based on their input and output variables. In our case of Iraq, we have several regions as DMUs, and we are evaluating their efficiency in terms of input variables and output variables in various strategic options or scenarios in terms of short-, medium- and long-range planning horizons. The standard DEA model allows for the identification of efficient strategies or actions, but does not discriminate between the degree of efficiency, so that an unambiguous ranking or ordering of alternative courses of action is not possible.

Anderson and Petersen (1993) have developed the super-efficiency (SE) model based on the Charnes, Cooper, and Rhodes (1978) (CCR) model to arrive at a complete ranking of all efficient DMUs. The SE-DEA model, a prominent variant of DEA, assesses the relative efficiency of DMUs, while allowing for an extension with super-efficiency. Super-efficiency indicates that a DMU can achieve the highest unambiguous performance score as the most efficient DMU using the same amount of input, thus surpassing the efficiency score of 1 in the DEA benchmark analysis (more detail, see Suzuki and Nijkamp (2017)). In our study case, the DMUs are different regions in Iraq, while the goal is to evaluate their relative efficiency, in terms of converting inputs into outputs. In essence, the SE-DEA CCR-I model outcomes empower regions with actionable insights for better resource utilization, improved output generation, and more effective strategic and infrastructural planning. The results underscore the dynamic interplay between inputs and outputs within infrastructure, health, education and technology sectors, ultimately contributing to the overall progress and resilience of the Iraqi regions under study.

The empirical data on the Iraqi regions are systematically harnessed through a comprehensive approach that addresses various aspects of Iraq:

- Data needs and aggregation: The research meticulously defines the requisite data needs, addressing both macro and micro levels, and navigates the intricate balance between the level of detail, aggregation, and temporal aspects.
- Statistical and informal data: This study artfully integrates both statistical and informal data sources, ensuring a comprehensive understanding of the nuanced realities within post-conflict Iraqi regions.
- DEA application: DEA, a cornerstone of the present study, not only fuels the decision support framework but also injects precision into the evaluation of sustainability and resilience metrics.

In recent years, several case studies in various countries have been undertaken to investigate the recovery potential of regions and territories that have been affected by major natural disasters. The focus is then on the resilience capacity of these areas. In a very recent study, the validity of the BiD concept has been tested using a global comparative analysis of major areal devastations from natural disasters in the world, based on a multi-annual global database on disasters. On the basis of a Pentagon model experiment, the result was found that institutional inertia (ranging from lack of adjustment capacity to corruption mechanisms) was a decisive factor in explaining sub-optimal recovery trajectories in areas affected by a dramatic shock (see Banica et al. (2022); Kourtit et al. (2023)). Our research's case-study experiment will explore the conditions in Iraq, placing special emphasis on infrastructure elements such as port facilities, road networks, railways, and telecom services, as well as regional socio-economic development and comprehensive sector support to strengthen the smooth

operation of essential services.

Our Iraq database encompasses—following the DEA logic—input and output data relating to the success factors and performance outcomes of 7 provinces (referred to as "governates") within Iraq, namely Ninawa, Anbar, Salah Al-Deen, Kirkuk, Diyala, Baghdad, and Babel. The primary focus lies on the transport infrastructure and investments made in these regions. These resource variables have the potential to yield economic and social benefits, categorized into short-term (1 year), medium-term (2–5 years), and total (over 5 years) effects.

The data base available for Iraqi regions is rather extensive, but often scarred by incompleteness or unreliability. Consequently, we only retained indicators in our cross-sectional comparative analysis for which complete data were accessible for all 7 regions under examination over the period concerned. This choice appeared justified, as no significant outliers were detected among the provinces for which data were available. Consequently, we built a systematic database for the 7 regions, with distinctions between various input and output variables (see for details on the database OCHA Iraq (2015); World Development Indicators (2016); Worldbank (2018); Ministry of Planning Iraq (2018); NIC (2019); UNESCO (2019); Annual Statistical Abstract Iraq (2019); Directorate of Transport and Communications Statistics (2021)). **Figure 4** illustrates the inputs and outputs of Iraq's logistics systems and strategic public investments performance options. This figure serves as the backbone of our DEA endeavors in the context of a strategic scenario experiment for 7 regions in Iraq. The empirical follow-up will be described in section 7.

7. Scenario experiments for Iraqi regions based on DEA

Our scenario design for a prosilient future of Iraqi regions is based on the architecture mapped out in the Pentagon model in **Figure 1**, in particular regarding the combined set of input variables. This approach follows next the logic of general scenario building for a "strategic conversation" with DMUs (see Nijkamp et al. (1996); Van der Heijden (2004)). The specific constituents of the scenarios for post-war regeneration of Iraqi regions use the following building blocks included in **Figure 4**. The specific architecture of the scenarios under consideration is based on a blend of the five core elements of the Pentagon model (**Figure 1**) and the features of the cascadic prosilience model (**Figure 2**). The characteristics of the scenarios are specified in such a way that they offer contrasting perspectives on the future of Iraqi regions (including their infrastructure and logistics). Following the logic of DEA, we make here a clear distinction between input factors (I) and output factors (O), that are mutually connected through a system of intermediate factors.

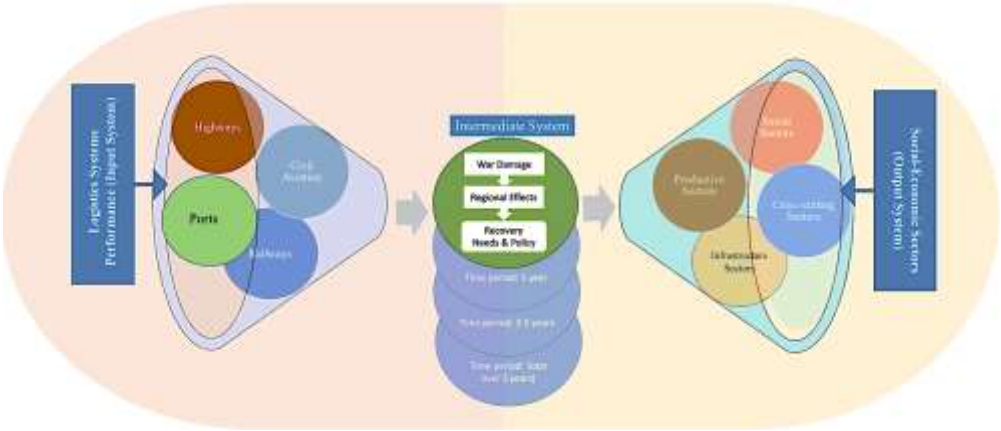

Figure 4. Iraq's logistics system performance options.

Input system (I):

- roads (km of highways, quality level road network, bridges, etc.)
- ports (capacity, storage, quality of logistic support, etc.)
- civil aviation (regional and international airports, capacity, access, etc.)
- railways (length, connectivity, capacity, etc.)

Intermediate system:

- economy of the regions (GDP, employment, export, oil & gas presence, etc.)
- war damage to the regions (destruction of dwellings, infrastructure, network damage, etc.)
- sectoral needs of the regions (industry, services, etc.)

Output system (O):

- productive sectors (manufacturing, agriculture, etc.)
- social sectors (human health, education, etc.)
- ICT developments (digital access, networks, etc.)
- cross-cutting sectors (governance, institutions, spatial organization, etc.)

Detailed data on various disaggregate indicators for the Iraqi regions can be found in a collection of background documents, in particular OCHA Iraq (2015); World Development Indicators (2016), Worldbank (2018); Government of Iraq (2018); Ministry of Planning Iraq (2018); NIC (2019); UNESCO (2019); Annual Statistical Abstract Iraq (2019); Directorate of Transport and Communications Statistics (2021). In these evidence-based information documents, a range of strategic future forecasts on regional-economic performance indicators have been made and published which form the empirical underpinning for our scenario experiments. In these documents also a systematic subdivision of future time periods for the duration of policy interventions was made, viz. a distinction into 3-time spans: (i) 1-year policy effect period; (ii) 2–5 years policy effect period; (iii) total period (1–5 years). These time spans form the structure of the time-based cascades in our prosilience approach.

It goes without saying that the design of future investment scenarios for Iraqi regions is essentially a combinatorial exercise, in which a mix of several input variables has to be combined with a mix of several prioritized intermediate variables (both regional damage effects and regional needs elicitation), while these extensive combinations can next in turn be combined with various mixes of prioritized output variables. The main challenge is now to identify a limited set of combined input—

intermediate—output variables that reflect a balanced and prosilient outcome for Iraqi regions. These specific strategic combinations will be termed regional policy scenarios.

Clearly, not all regions will be able to benefit from a win-win situation under prosilience policy strategies; spatial disparities will always be a core issue in any regional regeneration or recovery policy. From the large set of possible scenarios, we have therefore in our research distilled four investment scenarios that provide a promising outcome for the seven regions under consideration, based on the execution of an SE-DEA analysis (as described above). The four strategic investment scenarios identified in the present research are:

A. Regional sunrise scenario

This scenario is based on a traditional short-term investment expenditure strategy. It takes physical infrastructure, in particular length of roads and quality of the road network, as the pivots of a generic re-development policy. In this scenario there is not a clear orientation towards the economic, social and environmental needs of the successive 7 regions. The output of this conventional growth strategy is measured as the balance in the per capita distribution of spatial-economic growth and environmental livability. The numerical information on these development criteria and indicators is used as input data and output data in the SE-DEA experiment (see **Figure 5**).

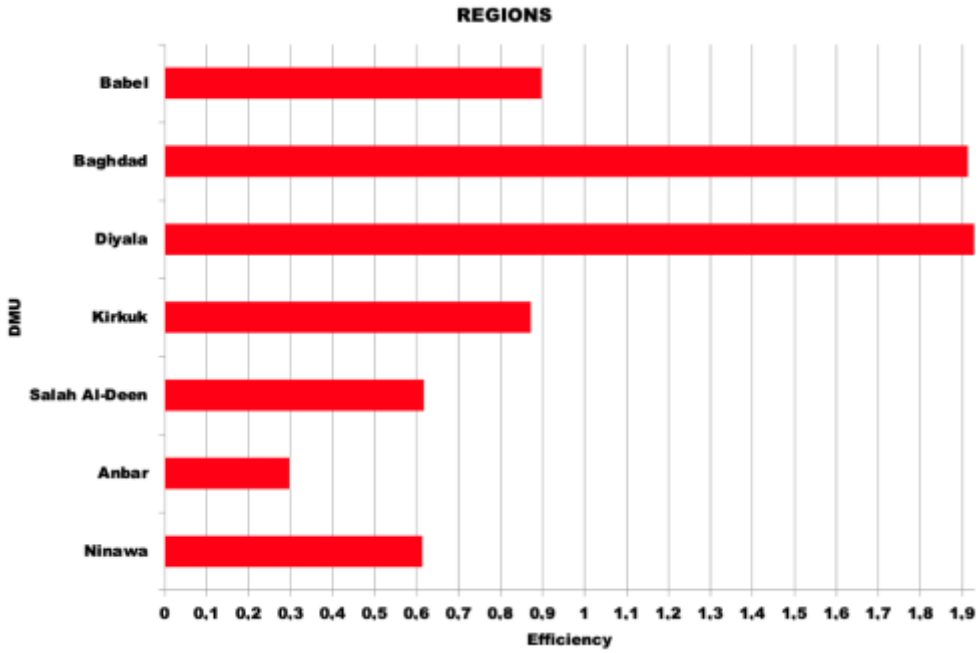

Figure 5. SE-DEA results of regional sunrise scenario.

Legend: (I) Roads (length, coverage)

(I) Quality road network (over 5 years)

(O) Per capita distribution of growth effects of investments (over 5 years)

The SE-DEA results of the regional sunrise scenario describe the strategic efficiency outcomes of the Iraqi regions under consideration from the perspective of general investments in infrastructure. The findings of this scenario are that the effects among the regions are rather skewly distributed: only 2 out of the 7 regions are generating super-efficient outcomes (i.e., exceeding the threshold value of 1).

Consequently, the long-range expectations from implementing undifferentiated infrastructure are rather mediocre, while the distributional implications are rather serious.

B. Spatial wellbeing scenario

In this scenario the focus is not on the generic supply of infrastructure as such to all regions in Iraq, but on the needs fulfilment of all infrastructure categories (the left-hand side **Figure 4**) in regard to the demands of the various socio-economic sectors in each region (the right-hand side of **Figure 4**). These needs comprise in particular of human health priorities and cultural heritage and tourism priorities. The SE-DEA results pertaining to this scenario are given in **Figure 6**.

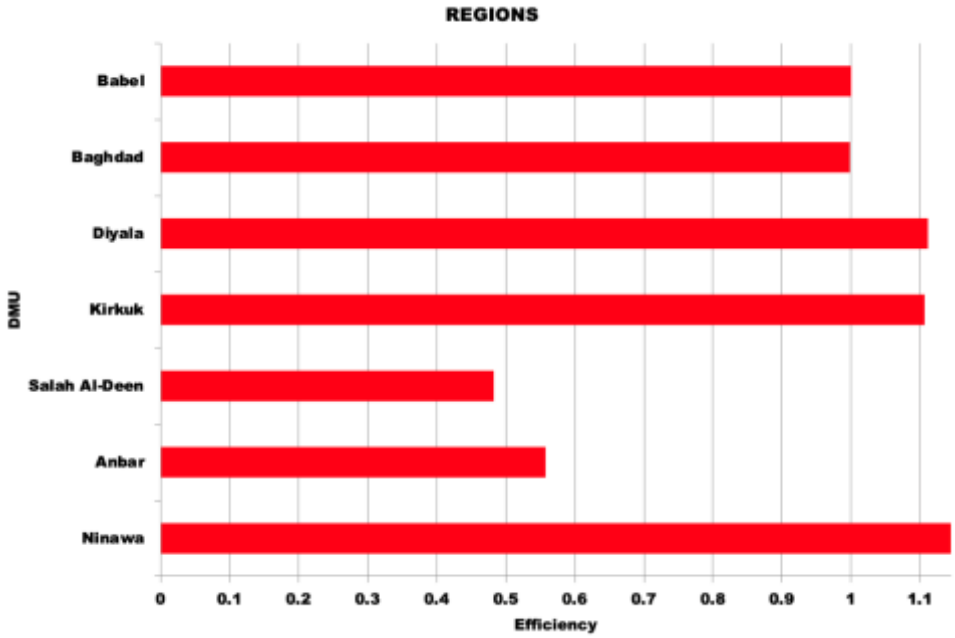

Figure 6. SE-DEA results of spatial wellbeing scenario.

Legend: (I) Infrastructure sector oriented to sectoral needs (over 5 years)
(O) Social sector health (year 1)
(O) Social sector cultural heritage and tourism (years 2–5)

The spatial wellbeing scenario leads to entirely different socio-economic consequences. The specific orientation of infrastructure expenditures towards designated regional socio-economic needs leads to a more equitable socio-economic regional map of Iraq, with at least 5 super-efficient regions. This outcome shows that socio-economic development and fair distribution among the regions can be achieved by a more tailor-made infrastructure investment policy.

C. Social prosperity scenario

The next scenario is also a demand-oriented infrastructure strategy geared towards both regional health and education needs. This selected future option is covering both short-term and long-term interests of the regions. The SE-DEA results can be found in **Figure 7**.

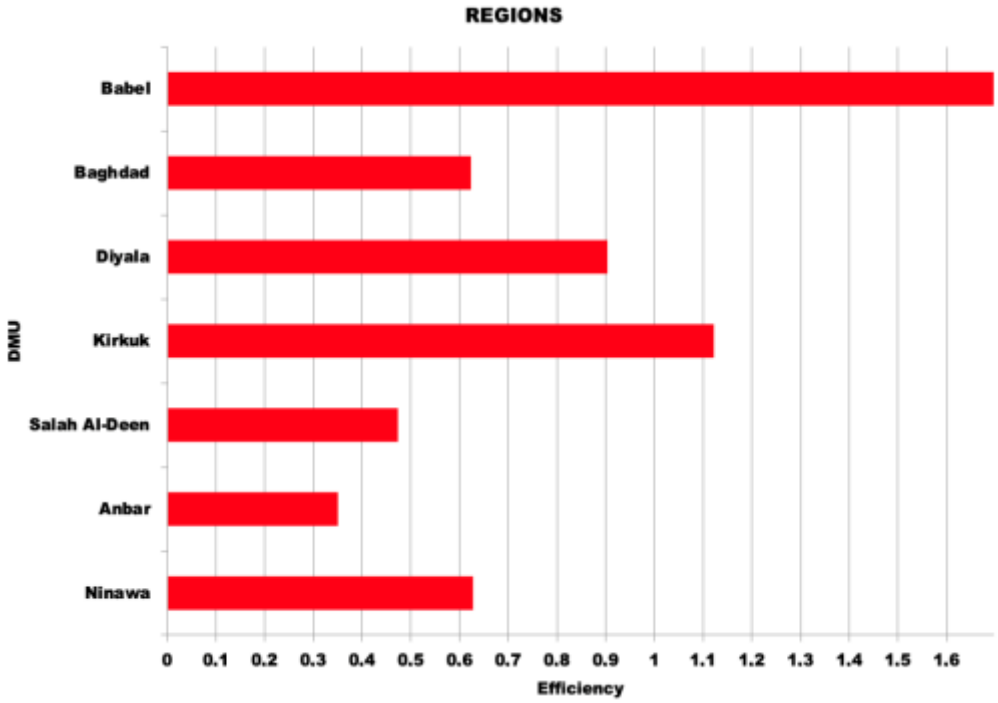

Figure 7. SE-DEA results of social prosperity scenario.

Legend: (I) Infrastructure sector oriented to sectoral needs (over 5 years)
(O) Social sector health (year 1)
(O) Social sector education (over 5 years)

The next scenario focuses on social prosperity in the Iraqi regions. It turns out that in this case the efficiency outcomes are very modest (only 2 out of the 7 regions are super-efficient), while the distribution of benefits for the regions is also rather unequal. Apparently, physical infrastructure expenditure has a far less prominent impact on social sectors like education.

D. Areal sustainability scenario

This final scenario maps out a prosilient future for the 7 regions of Iraq, characterized by a combined supply- and demand-based infrastructure expenditure strategy with human health and social security, employment and quality of life as output indicators. This long-term strategy offers a more differentiated profile of the development of Iraqi regions. The SE-DEA outcomes are given in **Figure 8**.

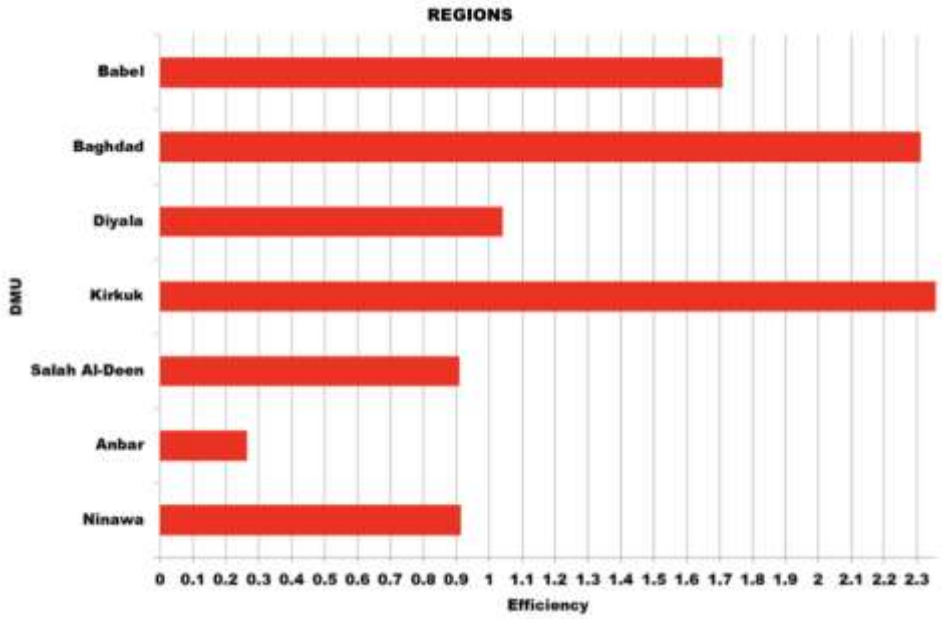

Figure 8. SE-DEA results of areal sustainability scenario.

Legend: (I) Infrastructure sector oriented to sectoral needs (over 5 years)

(I) Roads (length, coverage)

(O) Social sector health (year 1)

(O) Social sectors social protection, employment, and quality of life (including. poverty) (over 5 years)

The final scenario considered here is the areal sustainability scenario. It appears that in this case 4 out of 7 regions perform rather well in terms of efficiency of infrastructure measures undertaken. The distributional effects however, may be a source of concern in this strategic scenario.

In this section, we conducted a comprehensive analysis of various strategic development options across diverse regions in Iraq, taking into account distinct sectors and their respective requirements. The super-efficient DEA model's results offer invaluable insights that can profoundly influence policy decisions and the strategic allocation of resources to foster resilient and prosilient regional development. The optimal choice among these development alternatives hinges upon the specific objectives and priorities established by decision-makers, with each option affording distinctive advantages and addressing unique facets of regional growth. The results of the four scenarios selected in our policy strategy experiment can be summarized as follows:

- Scenario regional sunrise emerges as a compelling choice for those seeking to prioritize road infrastructure and enhance its quality, given its emphasis on road network expansion and investment allocation.
- Scenario spatial wellbeing offers a well-rounded approach, focusing on infrastructure, health, and cultural heritage, making it an attractive option for those interested in a holistic development strategy.
- Scenario social prosperity is particularly suitable for regions with a strong emphasis on education, as they allocate substantial resources to address educational needs effectively.

- Scenario areal sustainability is relevant for regions emphasizing road infrastructure, health, and social protection, allowing for a well-rounded approach to development.

In conclusion, the results obtained through the SE-DEA model analyses shed light on the efficiency of translating infrastructure requirements into diverse outputs across regions in Iraq. These findings yield invaluable insights into resource allocation strategies, output generation, and development practices. They underscore the importance of aligning resource allocation with regional development objectives, efficient governance, economic growth, and social well-being. Super-efficient regions set examples by showcasing effective resource utilization and the potential for comprehensive growth.

Overall, the SE-DEA model's outcomes offer actionable insights capable of informing policy decisions, guiding expenditure allocation, and contributing to the resilient and prosilient development of regions. The differentiation in timing is an underpinning for the cascadic approach using the Pentagon model as a frame of reference. This research emphasizes the significance of data-driven decision-making and the versatility of the super-efficient DEA model as a pivotal tool in regional development planning and policy formulation. To ensure long-term success and proresilience in the face of evolving challenges, continuous research and monitoring of regional development progress are recommended to refine and adapt strategies over time. Clearly, our results on Iraqi regions are only illustrative empirical experiments, based on scares available data. More applied research, for instance, using computable spatial equilibrium models, would be desirable.

8. Conclusions and policy recommendations

8.1. Retrospect

In the complex landscape of post-conflict recovery, where destruction and devastation leave lasting scars on regions and nations, this study takes place within the domain of regional science and transport infrastructure research. This comprehensive study has explored the intricate paths of infrastructure planning, logistics systems, and regional revitalization, with a particular focus on Iraq. By blending historical insights, innovative methods, and comprehensive data collection, this research has provided a fresh perspective on development and advancement following periods of conflict. Right from the outset of this exploration, the notion of resilience has evolved, emphasizing not only a return to pre-disaster conditions but also the proactive pursuit of prosilience. The cascading prosilience concept captures the essence of recovery, viewing it as an opportunity not only for rebuilding but for leaping forward into a more promising future.

Our regional policy framework, driven by a super-efficient DEA model, embodies innovation, guiding informed decision-making through efficiency assessments and the optimization of resource utilization. This approach is evidence of the dynamic interplay between inputs and outputs, as observed across sectors such as health, education, industry, commerce, governance, and more. The case of Iraq, with its complex landscape scarred by conflict-induced devastation, serves as a microcosm

from which broader lessons can be drawn. The research underscores the significance of strategic governance, harmonizing diverse stakeholder interests, and aligning resource allocation with multi-dimensional development goals. By employing scenario options, policymakers can effectively manage and distribute recovery and reconstruction needs across short-term, medium-term, and long-term phases over a five-year period. This enables them to explore different investment strategies and steer the revival of post-conflict economies, fostering comprehensive progress.

8.2. Policy recommendation

The insights garnered from this comprehensive study offer valuable policy directions for post-conflict recovery and resilience enhancement:

- Holistic infrastructure planning: Policymakers should adopt a comprehensive approach to infrastructure planning that aligns with the unique needs of post-conflict zones. Such planning goes beyond conventional boundaries and integrate historical insights, innovative methodologies, and multi-dimensional data.
- Prosilience strategies: Governments and stakeholders should prioritize prosilience, recognizing the potential of logistics systems in fostering economic and societal resilience. Lessons from historical cases should inform the transformation of devastation into an opportunity for accelerated development.
- Efficiency-driven decision-making: The use of the DSS framework, driven by DEA and the super-efficient CCR-I model, should guide decision-making. Policymakers can utilize these tools to optimize resource allocation, enhance output generation, and ensure effective strategic planning.
- Balanced resource allocation: Policies should harmonize economic and social goals, accommodating the strategic decisions of diverse actors (Aljawareen 2020). Resource allocation should prioritize balanced development across sectors like health, education, industry, commerce, governance, and more.
- Scenario simulations for resurgence: Policymakers should utilize scenario options to explore optimal investment strategies for transportation infrastructure and other key sectors. These strategic options provide insights into timing, scale, and economic development, facilitating informed decision-making.
- Responsive governance: Effective governance strategies should be designed to balance the utilization of civilian and military transportation systems. Lessons from history can inform innovative frameworks that harmonize diverse stakeholder interests for efficient and balanced growth.

In conclusion, the synthesis of historical insights, cutting-edge methodologies, and holistic data collection presented in this research clarifies the path toward post-conflict recovery. A comparison between the effective recovery strategies of Rotterdam, and the hesitant recovery strategies of Iraqi regions tells us that the quality of the institutional environment and, in general, of governance is a critical success factor. By prioritizing prosilience, embracing comprehensive infrastructure planning, and optimizing resource utilization through efficiency-driven approaches, nations can transform the shadows of destruction into symbols of enduring strength, ensuring a brighter future for regions emerging from the aftermath of conflict.

8.3. Prospect and limitations

Our analysis of the relevance of BiD strategies for Iraqi regions has undoubtedly relevance for infrastructural and logistics policy in the country. Clearly, it may also have a policy significance for other planning fields, such as building and construction, re-industrialization, or urban re-habilitation. Such evidence-based approaches may also be fruitful planning tools in other countries that are subject to deep shocks, e.g., Ukraine or Gaza. In all cases, the need of a solid institutional framing of development efforts is pertinent.

We also note that our approach has various limitations. Data availability may be a serious handicap for a balanced policy strategy. In addition, conflicting interests may form a serious impediment to a comprehensive and consistent recovery implementation. Nevertheless, our experiences on Iraq have brought to light that a systematic toolbox for empirical decision support in a post-conflict area is a sine qua non for sustainable development of a country and its regions.

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