A Dynamic Measure of Social Welfare in the European Sport Industry

Presenter: Pin-Hsuan Sung 宋品萱
Advisor: Prof. Dr. Chin-Yi Fang 方進義 特聘教授

May 14, 2026

Graduate Institute of Sport, Leisure, and Hospitality Management,
National Taiwan Normal University
Email: michellesung8@gmail.com

Sport Industry Beyond Economic Value

- Governments increasingly use sport as a policy instrument to improve public sport services and public health (Zhang, 2021).
- The role of sport has expanded beyond economic growth to broader social contributions, including:
  - Public health improvement (Rossi et al., 2024)
  - Sustainable public health systems (Schweizer et al., 2021)
  - Long-term sustainable development (Xu et al., 2024)
  - Physical, psychological, and social well-being (Castillo-Rodriguez et al., 2019; Zarotis & Tokarski, 2020)
  - Social connection and community cohesion (Brehm & Kurz, 1988)

→ The value of the sport industry has gradually shifted from purely **economic value** toward broader **social welfare value**.

European Welfare State & Sport Participation

- In European welfare states, a central goal is to ensure equal life opportunities and the fair distribution of public services and resources.
- Within this framework, sport policy is strongly embedded in the principle of "Sport for All", reflecting both a policy objective and a welfare-state responsibility (Heinemann, 2005).
- Across European countries, sport participation is driven by multiple motives. However, within public welfare agendas, health is the primary objective directly linked to government policy goals.
- Evidence from European citizens shows that the main motivation for sport participation is improving health and physical fitness, while performance-related motives are relatively minor (Elmose-Østerlund et al., 2020).

Relationship Between Health and Economic Outcomes (Bleakley, 2010)

- Health influences labor participation and productivity; healthier individuals tend to work more consistently and efficiently.
- Health and expenditure are linked through circular causation: higher expenditure increases health investment, while better health further enhances economic capacity.
- Poor health reduces available working time and lifetime labor participation, resulting in long-term productivity losses.
- Open trade helps countries grow by giving them access to bigger markets, reducing reliance on local resources, and allowing more workers to be absorbed into the global economy.

Research Motivation

- European countries promotes sport as a policy tool to enhance employment, social cohesion, and population well-being.
- However, the outcomes of sport-related policies vary significantly across European countries, creating challenges in both efficiency and equity of resource allocation, social welfare requires a balance of efficiency (maximizing outcomes).
- In this context, sport contributes not only to health outcomes, but also to community cohesion, employment opportunities, and social inclusion.
- Nevertheless, there is still limited empirical evidence on how effectively sport investments are transformed into measurable social welfare outcomes across countries.

Research Gap

1. Resource allocation & social welfare outcomes vary across European countries despite shared policy goals
2. Existing studies often analyze: Sport participation, Welfare outcomes, Public spending in isolation (Gao et al., 2024; Hayashi, 2017; Hsiao & Hsiao, 2015; Hu et al., 2020; Jing, 2018; Lábaj et al., 2014; Lee & Chang, 2015; Lu et al., 2022; Moraes et al., 2021; Ren & Liu, 2021; Singh, 2016; Xu et al., 2024; Ye et al., 2023)

   → Rarely integrate the sport industry into broader social welfare production
3. **Most analyses are static, ignoring:**
   - Dynamic changes over time
   - Networked structure

→ As a result, there is limited understanding of how effectively European countries transform sport-related investments into long-term social welfare outcomes.

Research Purpose

This study develops a framework linking the sport industry and social welfare to evaluate how efficiency has changed over time across 30 European countries (2015–2023).

1. **Measure cross-national efficiency differences**
2. **Analyze the internal structure of the welfare system**
   - Sport industry stage efficiency
   - Social welfare output stage efficiency
3. **Capture intertemporal dynamics (2015–2023)**

Literature Review-DEA

- Traditional Data Envelopment Analysis (DEA) models, including the CCR-DEA model (Charnes et al., 1978) and the BCC-DEA model (Banker et al., 1984), measure the relative efficiency of DMUs (e.g., countries, firms, hospitals) under multiple inputs and outputs. Efficiency scores range from 0 to 1.
- These models provide a non-parametric approach to efficiency measurement by constructing an empirical efficiency frontier and comparing each DMU's performance relative to the best-performing peers.
- To address limitations of radial measures in traditional DEA, Tone and Tsutsui (2001) proposed the Slack-Based Measure (SBM)-DEA model, which directly incorporates input excesses and output shortfalls (slacks) into the efficiency evaluation.

Literature Review- Social Welfare & Assistance

→ Employment
→ Government expenditure

Table 1. DEA Applications in Evaluating Social Welfare Issues

Study	Methodology	Research Purpose	Inputs / Intermediate	Outputs
Hsiao & Hsiao (2015)	DEA + Modified Delphi	Evaluate elderly welfare performance	Number of multifunctional centers, welfare personnel, budgets	Budget execution efficiency, welfare activity participation
Lee & Chang (2015)	DEA (CCR/BCC) + AHP	Assess welfare facility efficiency in Korea	Budgets, personnel, number of clients, facility size	Operational management, number of clients, profitability, elderly welfare outcomes
Hu et al. (2020)	DEA + SFA	Evaluate social security expenditure efficiency in 31 Chinese provinces	Per capita social security spending	Coverage of pensions and medical beds, low-income assurance coverage, employment rate, consumption level, urban–rural gap
Hayashi (2017)	Input-oriented DEA (CCR) + Two-stage regression	Assess welfare office efficiency in Japan	Number of caseworkers, administrative staff	Beneficiary cases across five welfare categories
Jing & Jing (2018)	DEA-BCC + Tobit	Evaluate performance of 27 public welfare foundations	Registered capital, full-time staff, basic conditions	Economic performance (assets, capital preservation), social welfare performance
Singh (2016)	DEA + Cross-efficiency	Evaluate performance of MGNREGA program in India	Wage expenditures, material expenditures, administrative costs	Number of households employed, workdays, women/SC/ST participation

Literature Review- Social Welfare & Assistance

→ Employment
→ Government expenditure
→ Area

Table 1. DEA Applications in Evaluating Social Welfare Issues (cont.)

Study	Methodology	Research Purpose	Inputs / Intermediate Variables	Outputs
Xu et al. (2024)	DEA-SBM (FRUE) + Meta-frontier + Malmquist + Kruskal–Wallis	Measure sports infrastructure resource efficiency and TFP	Six categories of sports investment funds	Six categories of sports facility areas
Gao et al. (2024)	Super-efficiency DEA + Malmquist + Tobit RE	Assess fiscal expenditure efficiency in national fitness services	Per capita financial expenditure, share of public fitness service expenditure within local budget	Sports venue area, number of instructors, sports organizations, activities, exercise participation rate
Ren & Liu (2021)	Three-stage DEA (BCC + SFA)	Analyze public sports service efficiency in 31 provinces	Public sports expenditure per capita, Public Sports Funds in Local Financial Expenditure	Human resources, facilities, and sports activities
Ye et al. (2023)	Output-oriented Super-SBM + DEA-Malmquist	Evaluate county-level allocation efficiency of sports resources	Sports service personnel, fiscal investment, venue area	Regular exercisers, number of sports organizations

Literature Review- Cross-Country Efficiency

→ Employment
→ Government expenditure
→ Working hours
→ Area

Table 1. DEA Applications in Evaluating Social Welfare Issues (cont.)

Study	Methodology	Research Purpose	Inputs / Intermediate Variables	Outputs
Liu et al. (2022)	Two-stage Network DEA (DDF) + Network ranking	Measure competitiveness and welfare enhancement under resource constraints across 29 countries	Stage 1: Land, capital, labor, energy; Stage 2: GDP (intermediate), government spending	Stage 1: GDP, CO_2 (undesirable); Stage 2: Employment, elderly population, education enrollment
Lábaj et al. (2014)	Extended DEA (BCC-O / VRS)	Develop economic performance measure beyond GDP	Capital, labor, GHG/CO_2	GDP, pollution (undesirable), social equality (1–Gini)
Moraes et al. (2021)	Two-stage Neural Network (GMSS-DEA / MLP / HMM)	Analyze labor efficiency and endogeneity of social variables	Stage 1: Labor, working hours, idle labor; Stage 2: Wages	Stage 1: Volume index; Stage 2: Value-added index

Literature Review

DEA

- **Single-stage DEA:** Hsiao & Hsiao (2015), Lee & Chang (2015), Hayashi (2017), Singh (2016)
- **Multi-stage / Two-stage DEA:** Hu et al. (2020), Jing & Jing (2018), Ren & Liu (2021), Moraes et al. (2021)
- **Super-SBM DEA:** Gao et al. (2024), Ye et al. (2023)

Malmquist Productivity Index

- Xu et al. (2024), Gao et al. (2024), Ye et al. (2023)
- Used to analyze changes in intertemporal efficiency. It can be decomposed into Technical Efficiency Change (TEC) and Technological Change (TC).

Dynamic DEA Model

- Existing DEA studies mainly focus on traditional models such as CCR-DEA, BCC-DEA, and SBM-DEA.
- However, these models often overlook possible intermediate stages or linking activities within the production process.
- To address this limitation, Network SBM-DEA incorporates intermediate products into the DEA framework, allowing researchers to simultaneously evaluate both the overall efficiency and stage efficiency of decision-making units (DMUs).

Dynamic DEA Model

- According to Tone and Tsutsui (2014), the Dynamic Network SBM-DEA model integrates the Dynamic SBM-DEA model with the Network SBM-DEA model, enabling the simultaneous consideration of dynamic changes across periods and internal network structures within the production process.
- The model enables a comprehensive evaluation of:

1. The overall efficiency score over the entire observation period
2. Dynamic efficiency across different time periods
3. The temporal evolution of stage-specific efficiency scores

Variables Selection

Stage 1 (Sport Industry Efficiency)
Input:
- *Sport employment* (Hsiao & Hsiao, 2015; Hayashi, 2017; Jing, 2018; Lu et al., 2022; Ye et al., 2023)
- *COFOG – Government expenditure on recreation, culture, and sports* (Gao et al., 2024; Hsiao & Hsiao, 2015; Hu et al., 2020; Jing, 2018; Lee & Chang, 2015; Ren & Liu, 2021; Singh, 2016; Xu et al., 2024; Ye et al., 2023)
- *Average weekly working hours* (Moraes et al., 2021)

Intermediate Output:
- *EU trade in sporting goods (imports)*
  EU trade in sporting goods (exports)

COFOG "Recreation, culture, and religion"
- Includes government spending on activities such as sports, arts, and cultural heritage.
- This classification is used to track government expenditure and is further broken down into specific categories like "Recreational and sporting services" (COFOG-A 081) and "Cultural services" (COFOG-A 082).
- The specific amounts vary by country, but global data shows this is a relatively small, but stable, portion of total government spending.

Variables Selection

Stage 2 (Social Welfare Efficiency)
Input:
- Intermediate output from Stage 1

Undesirable Final Output:
- *Harmonised Index of Consumer Prices (HICP)* (Hu et al., 2020; Moraes et al., 2021)

Desirable Final Output:
- *Self-perceived health*

Dynamic Carry-over:
- *Land area* (Hayashi, 2017; Lu et al., 2022)

Harmonised Index of Consumer Prices (HICP)
- A measure of inflation that allows for comparable price change data across different countries
- Primarily used within the European Union and EFTA
- Tracks the price changes of a representative basket of consumer goods and services over time using a harmonized methodology

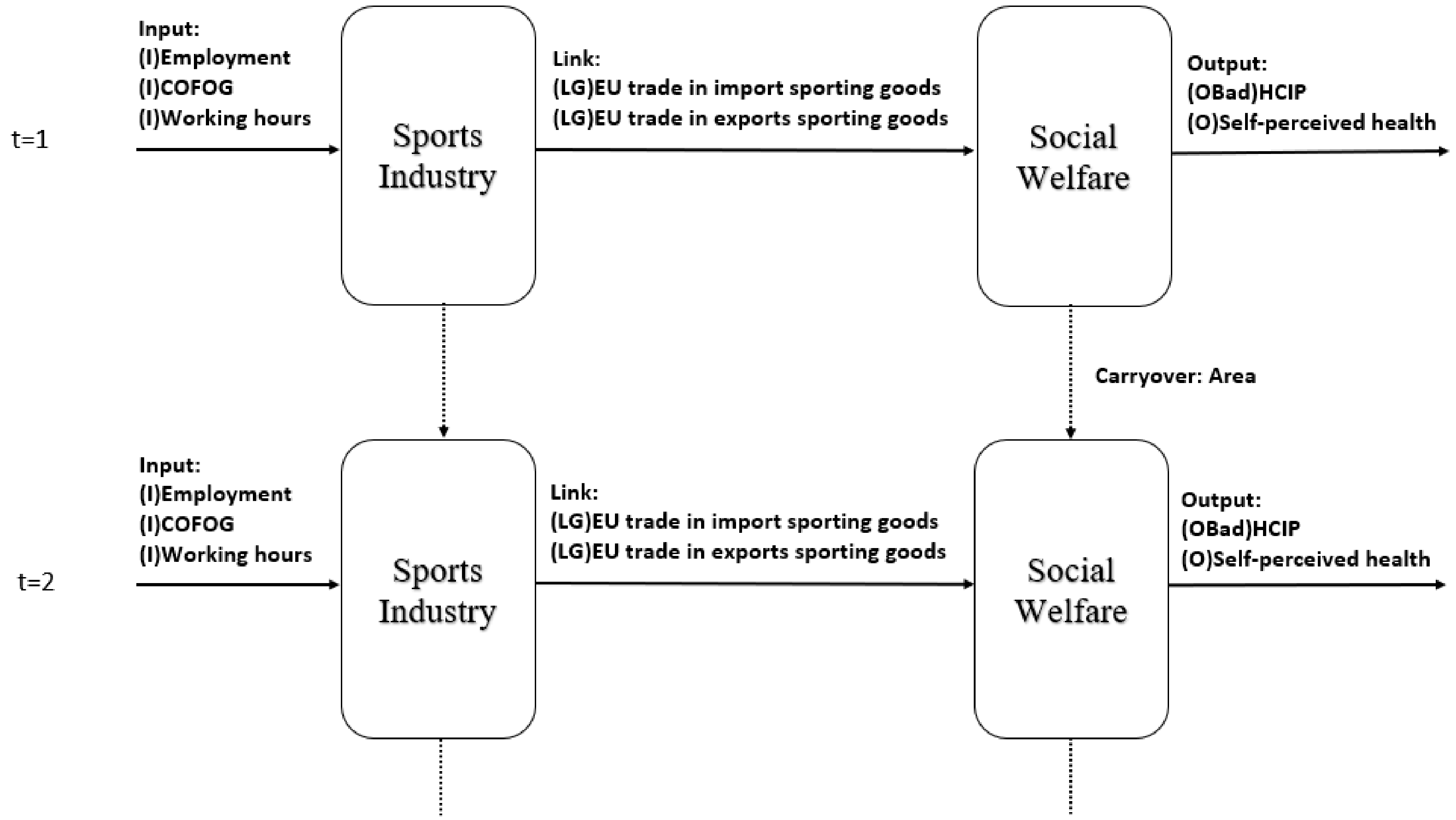
Data

Table 2. Thirty Selected European Countries

Belgium	Bulgaria	Czechia	Denmark	Germany	Estonia	Ireland	Greece	Spain	France
Croatia	Italy	Cyprus	Latvia	Lithuania	Luxembourg	Hungary	Malta	Netherlands	Austria
Poland	Portugal	Romania	Slovenia	Slovakia	Finland	Sweden	Iceland	Norway	Switzerland

- These country were selected based on the following considerations:
  - Data Availability (EuroStats Database)
  - Geographical Coverage
- 30 DMUs, 9 terms (2015–2023)

Research Design



- **Data Envelopment Analysis (DEA):** Estimate annual efficiency scores
- **Malmquist Productivity Index (MPI):** Analyze intertemporal productivity changes

Dynamic Network SBM-DEA Model

We consider n decision-making units (DMUs), representing sport-related entities ($j = 1, \ldots, n$), operating over T periods ($t = 1, \ldots, T$) and across K network stages ($k = 1, \ldots, K$). In this study, $T = 9$ years, $K = 2$ stages, and $n = 30$ countries. In the present application, ($m_1 = 3, m_2 = 2$) and ($r_1 = 2, r_2 = 2$). The link from stage k to stage h is denoted as $(k, h)_l$, where L_{kh} is the number of intermediate links between the two stages. Since the current study includes one intermediate link, we have $L_{kh} = 2$.

Variable Return to Scale (VRS)

- **Term:** $t = 1, \ldots, 9$
- **Stage:** $k = 1 (Sport Industry)$、
  $k = 2\ (Social\ Welfare)$
- **DMU**：30 European countries
- **Input:** $(m_1, m_2) = (3,2)$
- **Output:** $(r_1, r_2) = (2,2)$
- **Link:** $L_{12} = 2\ (Sport\ Industry) \rightarrow (Social\ Welfare)$
- **Carryover:** 1

Dynamic Network SBM-DEA Model

- For DMU_j, the stage-specific inputs, desirable outputs, and intermediate link variables are defined as $x^t_{ijk} \in R_+$ $(i = 1, \ldots, m_k;\ j = 1, \ldots, n;\ k = 1, \ldots, K)$; denotes input *i* of DMU_j in stage *k* during period *t*. $y^t_{rjk} \in R_+$ (r = 1,…, r_k) denotes the desirable output *r* of DMU_j in stage *k* during period *t*, $z^t_{j(kh)_l} \in R_+$ denotes the intermediate output linking stage *k* to stage *h* during period *t*.
- The model assumes Variable Returns to Scale (VRS), with the production frontier constructed through convexity constraints based on observed DMUs. The production possibility set for DMU_o $(o = 1, \ldots, n)$over period t is expressed as:
- **Production Possibility Set:** $P^t = \left\{\left(x^t_k, y^t_k, z^t_{(kh)}, z^{(t,t+1)}_{kl}\right)\right\} (t = 1, \ldots, T)$ (1)

Dynamic Network SBM-DEA Model

(1) Inputs and Outputs

- Inputs and desirable outputs at each stage satisfy:

$$x_{ok}^{t} = X_{k}^{t}\lambda_{k}^{t} + s_{ok}^{t-} \ (\forall k, \forall t)$$

$$y_{ok}^{t} = Y_{k}^{t}\lambda_{k}^{t} - s_{ok}^{t+} \ (\forall k, \forall t)$$

$$e\lambda_{k}^{t} = 1 \ (\forall k, \forall t)$$

$$\lambda_{k}^{t} \geq 0, \ s_{ok}^{t-} \geq 0, \ s_{ok}^{t+} \geq 0, (\forall k, \forall t) \qquad (2)$$

- Here, X_k^t and Y_k^t are matrices of inputs and desirable outputs, and s_{ok}^{t-}, s_{ok}^{t+} denote input and output slacks, respectively.

Dynamic Network SBM-DEA Model

- In Stage 2, the final output is undesirable. Let b_{ok}^{t} denote the undesirable output (HICP).
- The corresponding constraint becomes:

$$b_{ok}^{t} = B_{k}^{t}\lambda_{k}^{t} + s_{ok}^{t(b+)},\ s_{ok}^{t(b+)} \geq 0 \qquad (2')$$

- reflecting that larger undesirable output implies inefficiency, treated analogously to input expansion or undesirable output reduction in SBM.

Dynamic Network SBM-DEA Model

(2) Intermediate Link

- Intermediate links $z_{j(kh)_l}^{t}$ represent outputs from stage k used as inputs for stage h. Following Tone & Tsutsui (2010), four cases are possible; this study adopts the "as-output" (LG) specification, where intermediate links are treated as outputs of the previous stage, and associated slacks reflect inefficiency.

$$z_{o(kh)}^{t,out} = Z_{(kh)}^{t,out}\lambda_k^t - s_{o(kh)}^{t,out+} \ \left((kh) = 1, \ldots, link_k\right) \qquad (3)$$

$$Z_{(kh)}^{t}\lambda_h^t = Z_{(kh)}^{t}\lambda_k^t, \ (\forall(k,h), \forall t\ ) \qquad (4)$$

- ensuring continuity between stages. Slack $s_{o(kh)}^{t,out+}$ captures link slacks.

Dynamic Network SBM-DEA Model

(3) Carryover

- Carryovers $z_{jk_l}^{(t,t+1)}$ represent good (desirable) intertemporal stocks transferred from period t to $t+1$. Good carryovers are treated as outputs ("as outputs"), and their observed values form lower bounds to which slacks are attached:

$$\sum_{j=1}^{n} z_{jk_l}^{(t,t+1)} \lambda_{jk}^{t} = \sum_{j=1}^{n} z_{jk_l}^{(t,t+1)} \lambda_{jk}^{t+1} \ (\forall k; \forall k_l; t = 1, \ldots, T-1) \qquad (5)$$

$$z_{ok_l}^{(t,t+1)} = \sum_{j=1}^{n} z_{jk_l}^{(t,t+1)} \lambda_{jk}^{t} - s_{ok_l}^{(t,t+1)} \ (k_l = 1, \ldots, good_k; \forall k; \forall t) \qquad (6)$$

$$s_{ok_l}^{(t,t+1)} \geq 0 \qquad (7)$$

- where $s_{ok_l}^{(t,t+1)}$ measures insufficiency of carryovers.

Objective Function- Overall Efficiency (non-oriented VRS)

- For the non-oriented dynamic network SBM, overall efficiency is defined as:

$$\theta_o^* = \min_{\lambda_k^t, s_{iok}^{t-}, s_{rok}^{t+}, s_{o(kh)_l out}^{t}, s_{ok_l good}^{(t,t+1)}} \frac{\sum_{t=1}^{T} W^t \left[\sum_{k=1}^{K} w^k \left[1-\frac{1}{m_k}\left(\sum_{i=1}^{m_k} \frac{s_{iok}^{t-}}{x_{iok}^{t}}\right)\right]\right]}{\sum_{t=1}^{T} W^t \left[\sum_{k=1}^{K} w^k \left[1+\frac{1}{r_k+link_k+good_k}\left(\sum_{r=1}^{r_k} \frac{s_{rok}^{t+}}{y_{rok}^{t}}+\frac{s_{ok}^{t(b+)}}{b_{ok}^{t}}+\sum_{(kh)_l=1}^{link_k} \frac{s_{o(kh)_l}^{t,out}}{z_{o(kh)_l}^{t,out}}+\sum_{k_l=1}^{good_k} \frac{s_{ok_l}^{(t,t+1)}}{z_{ok_l}^{(t,t+1)}}\right)\right]\right]} \quad (8)$$

s.t. (2), (2′), (3), (4), (5), (6), (7)

where W^t represents the weight of term; w^k represent the weight of stage, and satisfied

$$\sum_{t=1}^{T} W^t = 1, \quad \sum_{k=1}^{K} w^k = 1, \quad W^t \geq 0\ (\forall t), \quad w^k \geq 0\ (\forall k)$$

The final term $\frac{s_{ok}^{t(b+)}}{b_{ok}^{t}}$ incorporates the undesirable final output, where an increase in HICP leads to efficiency deterioration.

Term and Stage Efficiency

a. Term Efficiency (2015–2023)

$$\theta_o^{t*} = \frac{\sum_{k=1}^{K} w^k \left[1 - \frac{1}{m_k}\left(\sum_{i=1}^{m_k} \frac{s_{iok}^{t-}}{x_{iok}^{t}}\right)\right]}{\sum_{k=1}^{K} w^k \left[1 + \frac{1}{r_k + link_k + good_k}\left(\sum_{r=1}^{r_k} \frac{s_{rok}^{t+}}{y_{rok}^{t}} + \frac{s_{ok}^{t(b+)}}{b_{ok}^{t}} + \sum_{(kh)_l=1}^{link_k} \frac{s_{o(kh)_l}^{t,out}}{z_{o(kh)_l}^{t,out}} + \sum_{k_l=1}^{ngood_k} \frac{s_{ok_l}^{(t,t+1)}}{z_{ok_l}^{(t,t+1)}}\right)\right]} \ (\forall t) \qquad (9)$$

b. Stage Efficiency

$$\theta_{ok}^{*} = \frac{\sum_{t=1}^{T} W^t \left[1 - \frac{1}{m_k}\left(\sum_{i=1}^{m_k} \frac{s_{iok}^{t-}}{x_{iok}^{t}}\right)\right]}{\sum_{t=1}^{T} W^t \left[\left[1 + \frac{1}{r_k + link_k + good_k}\left(\sum_{r=1}^{r_k} \frac{s_{rok}^{t+}}{y_{rok}^{t}} + \frac{s_{ok}^{t(b+)}}{b_{ok}^{t}} + \sum_{(kh)_l=1}^{link_k} \frac{s_{o(kh)_l}^{t,out}}{z_{o(kh)_l}^{t,out}} + \sum_{k_l=1}^{good_k} \frac{s_{ok_l}^{(t,t+1)}}{z_{ok_l}^{(t,t+1)}}\right)\right]\right]} \ (\forall k) \qquad (10)$$

Term and Stage Efficiency

c. **Term-Stage Efficiency**

$$\theta_{ok}^{t*} = \frac{1-\frac{1}{m_k}\left(\sum_{i=1}^{m_k}\frac{s_{iok}^{t-}}{x_{iok}^{t}}\right)}{1+\frac{1}{r_k+link_k+good_k}\left(\sum_{r=1}^{r_k}\frac{s_{rok}^{t+}}{y_{rok}^{t}}+\frac{s_{ok}^{t(b+)}}{b_{ok}^{t}}+\sum_{(kh)_l=1}^{link_k}\frac{s_{o(kh)_l}^{t,out}}{z_{o(kh)_l}^{t,out}}+\sum_{k_l=1}^{good_k}\frac{s_{ok_l}^{(t,t+1)}}{z_{ok_l}^{(t,t+1)}}\right)} \quad (\forall k;\ \forall t) \qquad (11)$$

- The carryover term $(t-1\rightarrow t)$ is not included in Equation (11) because its inclusion would cause double-counting. Specifically, if the $(t-1\rightarrow t)$ carryover were incorporated into the denominator of θ_{ok}^{t*}, the same carryover would also appear in $\theta_{ok}^{(t+1)*}$ as part of the $(t\rightarrow t+1)$ carryover term. To maintain consistency and avoid duplication, Equation (11) excludes the $(t-1\rightarrow t)$ term. Nevertheless, as indicated by the continuity constraint (Equation (4)), the $(t-1\rightarrow t)$ carryover still influences the weights λ^t, and therefore indirectly affects the slack terms in period t.

Malmquist Productivity Index (MPI)

- **TEC (Technical Efficiency Change)**: how much a country moves closer to the efficiency frontier.

$$TEC = \frac{\theta_o^{t+1}\left(x^{t+1}, y^{t+1}\right)}{\theta_o^{t}\left(x^{t}, y^{t}\right)} \quad (12)$$

- **TC (Technological Change):** improvements in technology, innovation, or structural upgrading.

$$TC = \sqrt{\frac{\theta_o^{t}\left(x^{t+1}, y^{t+1}\right)}{\theta_o^{t+1}\left(x^{t+1}, y^{t+1}\right)} \cdot \frac{\theta_o^{t}\left(x^{t}, y^{t}\right)}{\theta_o^{t+1}\left(x^{t}, y^{t}\right)}} \quad (13)$$

- **MPI (Malmquist Productivity Index)**: overall productivity change

$$MPI = \sqrt{\frac{\theta_o^{t}\left(x^{t+1}, y^{t+1}\right)}{\theta_o^{t}\left(x^{t}, y^{t}\right)} \cdot \frac{\theta_o^{t+1}\left(x^{t+1}, y^{t+1}\right)}{\theta_o^{t+1}\left(x^{t}, y^{t}\right)}} = TEC \times TC \quad (14)$$

Empirical Results

Table 3. Descriptive Analysis of Inputs, Outputs, Link and Carryover Variables

	Input			**Link**		**Output**		**Carryover**
	Employment	***COFOG***	***Working hours***	***Import trade***	***Export trade***	***HCIP***	***Self health***	***Area***
Max	313.3	15804	42.2	3850085	3500677	166.86	53.4	549060
Min	0.7	9.6	30.4	5849	133	93.36	0	315
Average	48.09	1942.21	37.96	525408.54	555806.53	110.51	23.29	153324.20
St Dev	66.04	2906.72	2.35	700678.53	819524.10	13.00	10.64	157190.98

Note: *COFOG (Government expenditure on recreation, culture, and sports), HICP (Harmonised Index of Consumer Prices)*

The descriptive statistics reveal substantial cross-country differences in sports-related inputs, trade variables, and welfare output.

Empirical Results-DNSBM Efficiency

Table 4. Descriptive Analysis of Overall Efficiency, Sport Industry Efficiency and Social Welfare Efficiency (2015–2023)

	2015	2016	2017	2018	2019	2020	2021	2022	2023	Average
Overall										
Average	0.596	0.670	0.710	0.743	0.737	0.720	0.747	0.727	0.760	0.681
Max	1	1	1	1	1	1	1	1	1	1
Min	0.003	0.007	0.013	0.171	0.177	0.004	0.199	0.200	0.164	0.011
St Dev	0.325	0.315	0.313	0.295	0.288	0.317	0.273	0.270	0.269	0.298
Sport Industry										
Average	0.585	0.626	0.695	0.711	0.720	0.721	0.731	0.689	0.738	0.691
Max	1	1	1	1	1	1	1	1	1	1
Min	0.002	0.003	0.006	0.077	0.098	0.002	0.093	0.102	0.084	0.098
St Dev	0.375	0.348	0.351	0.334	0.339	0.362	0.334	0.319	0.327	0.317
Social Welfare										
Average	0.761	0.838	0.847	0.860	0.863	0.859	0.863	0.850	0.867	0.845
Max	1	1	1	1	1	1	1	1	1	1
Min	0.200	0.242	0.163	0.247	0.216	0.225	0.387	0.279	0.332	0.261
St Dev	0.248	0.207	0.208	0.197	0.196	0.207	0.189	0.214	0.193	0.187

Empirical Results-

DNSBM Efficiency

No.	Country	*Sports Industry*	Rank	*Social Welfare*	Rank	*Overall Score*	Rank
1	Belgium	1	1	1	1	1	1
2	Bulgaria	0.920	12	0.952	13	0.865	11
3	Czechia	0.608	21	0.832	17	0.695	16
4	Denmark	1	1	0.703	25	0.819	13
5	Germany	1	1	0.999	7	0.999	3
6	Estonia	0.833	13	0.926	16	0.764	14
7	Ireland	1	1	0.995	9	0.998	6
8	Greece	0.617	20	0.999	3	0.638	19
9	Spain	0.286	25	0.782	22	0.457	23
10	France	0.999	9	0.999	3	0.999	5
11	Croatia	0.650	18	0.783	21	0.631	20
12	Italy	0.619	19	0.754	24	0.678	17
13	Cyprus	0.988	10	0.999	3	0.994	8
14	Latvia	0.669	17	0.261	30	0.327	25
15	Lithuania	0.798	16	0.615	28	0.598	21
16	Luxembourg	1	1	0.995	10	0.997	7
17	Hungary	0.184	27	0.771	23	0.259	26
18	Malta	1	1	1	1	1	1
19	Netherlands	1	1	0.803	20	0.884	10
20	Austria	1	1	0.999	7	0.999	3
21	Poland	0.530	22	0.813	19	0.648	18
22	Portugal	0.397	24	0.408	29	0.399	24
23	Romania	0.462	23	0.830	18	0.598	22
24	Slovenia	0.801	15	0.661	26	0.701	15
25	Slovakia	0.816	14	0.939	14	0.861	12
26	Finland	0.149	28	0.649	27	0.231	27
27	Sweden	0.098	30	0.929	15	0.211	28
28	Iceland	0.243	26	0.985	11	0.011	30
29	Norway	0.942	11	0.999	3	0.968	9
30	Switzerland	0.105	29	0.978	12	0.200	29

Table 5. Overall Efficiency, Sport Industry Efficiency and Social Welfare Efficiency for 30 European countries

Empirical Results-MPI

Table 6. Malmquist Productivity Index Descriptive Statistics for Sports Industry and Social Welfare (2015–2023)

	2015→ 2016	2016→ 2017	2017→ 2018	2018→ 2019	2019→ 2020	2020→ 2021	2021→ 2022	2022→ 2023	Geometric mean
Sports Industry									
Average	1.269	1.060	6.207	0.997	0.999	6.278	1.043	0.969	1.051
Max	4.315	2.153	155.259	2.261	1.525	151.033	1.535	1.592	1.884
Min	0.278	0.467	0.198	0.269	0.006	0.195	0.277	0.572	0.552
St Dev	0.732	0.345	28.155	0.360	0.274	27.352	0.237	0.185	0.205
Social Welfare									
Average	1.191	1.012	1.030	1.004	1.003	1.031	0.977	1.035	1.022
Max	2.890	1.523	1.510	1.158	1.313	1.978	1.079	1.433	1.142
Min	0.792	0.676	0.945	0.877	0.452	0.795	0.626	0.923	0.970
St Dev	0.468	0.124	0.098	0.056	0.126	0.200	0.091	0.096	0.038

Empirical Results-MPI

Frontier-shift (TC) Differences

- TC>1 → Technological progress
- TC<1 → Technological regress

There are 15 out of the 30 European countries including Czechia, Denmark, Estonia, Ireland, Greece, Croatia, Latvia, Lithuania, Luxembourg, Hungary, Romania, Slovenia, Slovakia, Norway, and Switzerland that experienced sport industry stage technological regress.

		Sport Industry				*Social Welfare*			
No.	Country	TEC	TC	MPI	Rank	TEC	TC	MPI	Rank
1	Belgium	1	1.022	1.022	21	1	1	1	17
2	Bulgaria	1.173	1.034	1.213	2	1.072	1	1.072	3
3	Czechia	1.035	0.995	1.029	18	1.063	1	1.063	6
4	Denmark	1	0.962	0.962	27	1.019	1	1.019	13
5	Germany	1	1.108	1.108	8	1	1	1	17
6	Estonia	1.196	0.896	1.072	11	1.142	1	1.142	1
7	Ireland	1	0.703	0.703	29	1.006	1	1.006	16
8	Greece	1.181	0.933	1.102	10	1	1	1	17
9	Spain	1.024	1.092	1.118	6	0.997	1	0.997	26
10	France	1.000	1.128	1.127	5	1	1	1	17
11	Croatia	1.183	0.955	1.129	4	1.037	1	1.037	10
12	Italy	0.987	1.122	1.107	9	1.010	1	1.010	14
13	Cyprus	1.001	1.172	1.174	3	1	1	1	17
14	Latvia	1.181	0.887	1.047	14	1.066	1	1.066	5
15	Lithuania	0.964	0.861	0.830	28	1.087	1	1.087	2
16	Luxembourg	1	0.976	0.976	24	1	1	1	17
17	Hungary	1.021	0.948	0.968	26	1.046	1	1.046	7
18	Malta	1	1.015	1.015	22	1	1	1	17
19	Netherlands	1	1.024	1.024	20	0.970	1	0.970	30
20	Austria	1	1.043	1.043	16	1	1	1	17
21	Poland	1.048	1.066	1.117	7	1.040	1	1.040	9
22	Portugal	1.018	1.008	1.026	19	1.045	1	1.045	8
23	Romania	1.007	0.996	1.003	23	1.029	1	1.029	11
24	Slovenia	1.091	0.979	1.068	12	1.029	1	1.029	12
25	Slovakia	1.043	0.992	1.034	17	1.067	1	1.067	4
26	Finland	1.053	1.000	1.053	13	0.973	1	0.973	29
27	Sweden	1.033	1.014	1.047	15	0.975	1	0.975	28
28	Iceland	1.887	1	1.884	1	1.008	1	1.008	15
29	Norway	1	0.552	0.552	30	1	1	1	17
30	Switzerland	0.997	0.977	0.975	25	0.991	1	0.991	27

Table 7. Malmquist Productivity Index values for 30 European countries

No.	DMU	DEA score	Rank	MPI	Rank
1	Belgium	1	1	1.011	20
2	Bulgaria	0.865	11	1.141	2
3	Czechia	0.695	16	1.046	15
4	Denmark	0.819	13	0.990	25
5	Germany	1.000	3	1.053	11
6	Estonia	0.764	14	1.107	3
7	Ireland	0.998	6	0.841	29
8	Greece	0.638	19	1.050	13
9	Spain	0.457	23	1.056	10
10	France	1.000	5	1.062	7
11	Croatia	0.631	20	1.082	5
12	Italy	0.678	17	1.057	8
13	Cyprus	0.994	8	1.084	4
14	Latvia	0.327	25	1.056	9
15	Lithuania	0.598	21	0.950	28
16	Luxembourg	0.997	7	0.988	26
17	Hungary	0.259	26	1.006	23
18	Malta	1	1	1.007	22
19	Netherlands	0.884	10	0.997	24
20	Austria	1.000	3	1.021	17
21	Poland	0.648	18	1.078	6
22	Portugal	0.399	24	1.035	16
23	Romania	0.598	22	1.016	18
24	Slovenia	0.701	15	1.048	14
25	Slovakia	0.861	12	1.051	12
26	Finland	0.231	27	1.012	19
27	Sweden	0.211	28	1.011	21
28	Iceland	0.011	30	1.378	1
29	Norway	0.968	9	0.743	30
30	Switzerland	0.200	29	0.983	27
Average		0.681		1.051	

Table8. Comparison of DEA and MPI Ranks for 30 European Countries

MPI ranking shows which countries improved the most across the study period.

- MPI > 1 → Productivity improvement (TC progress or TEC gain).
- MPI < 1 → Productivity decline (TC regress or TEC loss).
  - Iceland (MPI=1.378, rank 1) shows the highest productivity growth despite having the lowest static efficiency.
  - Norway (MPI=0.552, rank 30) shows the largest productivity decline.

High DEA, Low MPI

These countries are efficient now but not improving:

- Ireland (DEA rank 6, MPI rank 29)
- Luxembourg (DEA rank 7, MPI rank 24)
- Norway (DEA rank 9, MPI rank 30)

Discussion

- The Dynamic Network SBM–MPI framework distinguishes productivity changes into efficiency change (TEC) and technological change (TC), allowing us to identify whether improvements come from better management or structural progress.
- According to Elmose-Østerlund et al. (2020), European countries differ in: welfare traditions and redistribution systems, sport policy implementation intensity, and institutional and infrastructural conditions of sport clubs.
- Sport infrastructure provides an essential foundation for public welfare contributions, but it is not sufficient on its own. In Hungary, despite infrastructure improvement programs (Elmose-Østerlund et al., 2020), the sports industry stage remained inefficient, suggesting that infrastructure expansion alone cannot guarantee effective sport-to-welfare transformation.

Discussion-Hungary

Hungary shows very low efficiency in the Sports Industry=0.184 (Rank 27). In contrast, the Social Welfare performs substantially =0.771 (Rank 23).

Table9. Divisional Efficiency Scores of Hungary (2015–2023)

	2015	2016	2017	2018	2019	2020	2021	2022	2023	Average	Rank
Sports Industry	0.297	0.205	0.217	0.104	0.101	0.087	0.119	0.170	0.352	0.184	27
Social Welfare	0.594	0.699	0.673	0.714	0.802	0.829	0.860	0.922	0.851	0.771	23
Overall	0.412	0.321	0.336	0.186	0.197	0.169	0.218	0.317	0.563	0.259	26

Table10. Malmquist Productivity Index (MPI) Decomposition of Hungary (2015–2023)

	2015 →2016	2016 →2017	2017 →2018	2018 →2019	2019 →2020	2020 →2021	2021 →2022	2022 →2023	Geometric Mean	Rank
Sports Industry										
MPI	0.762	1.104	0.437	0.977	0.857	1.374	1.298	1.405	0.968	26
TEC	0.689	1.061	0.477	0.977	0.857	1.374	1.428	2.068	1.021	14
TC	1.106	1.040	0.917	1	1	1	0.910	0.679	0.948	24
Social Welfare										
MPI	1.178	0.963	1.060	1.123	1.034	1.037	1.072	0.923	1.046	7
TEC	1.178	0.963	1.060	1.123	1.034	1.037	1.072	0.923	1.046	7
TC	1	1	1	1	1	1	1	1	1	1

Although the TEC = 1.021 suggests some managerial improvement, the TC = 0.948 reflects technological regress and structural limitations.

Since frontier-shift values remain equal to 1, productivity growth is mainly driven by TEC rather than TC.

→ In Hungary, these results suggests that infrastructure investment alone does not automatically improve sport-to-welfare transformation efficiency without corresponding technological advancement and effective managerial practices.

Conclusion

This study examines how the European sport industry transforms long-term resource investment and industrial development into social welfare outcomes, using a **network dynamic efficiency framework** to evaluate intertemporal welfare creation.

- **Large efficiency gap between sports and welfare**
  → Social Welfare stage consistently performs better
- **Sports industry shows room for improvement**
  → Several countries experience technological regress

Contribution

Policy Implications

1. Effective Allocation of Public Resources

- Governments need to manage sports-related public investments efficiently to maximize social welfare and long-term sustainability.
- European countries faces a trade-off between efficiency and equity, as outcomes differ across member states.

2. Contribution of Sports to Social Welfare

- Evaluating how sports spending impacts social welfare is an important policy and research agenda.
- This study provides cross-country efficiency analysis, filling a gap in empirical evidence.

Contribution

Theoretical Implications

1. Innovative and Integrated Framework

- Developed a framework linking sports industry inputs with social welfare outcomes.
- Tracks the conversion from sports investments → intermediate outputs → welfare outcomes, bridging gaps in prior research.

2. Dynamic and Network DEA Approach

- Uses Dynamic Network SBM-DEA + MPI to capture efficiency changes over 2015–2023.
- Analyzes efficiency in both the sports phase and welfare phase, offering deeper insight into resource transformation.

Limitation & Suggestion

1. Geographical & Temporal Scope

- Only 30 European countries/regions included, limits generalizability to other countries.
- 2015–2023 period only, cannot infer trends outside these years.

→ Future studies could include more countries and more recent observation periods to improve wider relevance and better capture evolving long-term trends.

2. Data & Variable Constraints

- Relied on EuroStat for consistent, long-term data across all countries.
- Self-perceived health (ideal output), HICP (non-ideal output) may not fully capture social welfare.
- Large differences in sports inputs, trade variables, and welfare outputs → efficiency frontiers may be highly country-specific.

→ Future research may incorporate broader welfare indicators, such as mental health, social inclusion, quality of life to better capture multidimensional social welfare outcomes.

NATIONAL TAIWAN NORMAL UNIVERSITY

A Dynamic Measure of Social Welfare in the European Sport Industry

Thank you!
Comments and Suggestion are welcome.

Pin-Hsuan (Michelle) Sung

Graduate Institute of Sport, Leisure, and Hospitality Management,

National Taiwan Normal University

Email: michellesung8@gmail.com