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Weighted Composite Diversification Index: A New Measure of Economic Diversification in Resource-Dependent Economies

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Abstract

This note introduces a Weighted Composite Diversification Index (WCDI) for resource-dependent economies that integrates fiscal, trade, and output diversification into a single measure, weighted by their relative economic size. Unlike existing indices, the WCDI endogenizes weights according to the macroeconomic structure: fiscal diversification is weighted by government size, trade diversification by export dependence, and output diversification by domestic demand as a share of GDP. To reflect the vulnerabilities of resource-dependent economies, the WCDI incorporates a penalty term that penalizes resource shares within each subindex, providing a context-sensitive gauge of diversification.

Keywords

Economic diversification; composite index; endogenous weights; entropy; penalty term; resource dependence

JEL Codes

C43; Q32; O57

1. Introduction

Economic diversification policy is widely recognized as critical for the sustainability and stability of resource-dependent economies (Delechat et al., 2024). When output, exports, or fiscal revenues are concentrated in or derived from a small number of sources (such as oil rents), economies are vulnerable to outside shocks that could threaten their growth (Briguglio et al., 2014; Mano & Combary, 2025). Measuring economic diversification, however, is far from straightforward (Lashitew et al., 2021). Scholars have developed indicators reflecting different definitions of diversification. Some focus on a single aspect, such as export concentration (Lederman & Maloney, 2007) or fiscal revenue sources (Ouedraogo et al., 2020), while others combine components into a composite score (Prasad et al., 2023). Yet no consensus exists on how to weight or aggregate these dimensions, leaving policymakers with limited guidance. This note introduces a context-sensitive Weighted Composite Diversification Index (WCDI), that endogenizes weights according to the macroeconomic structure and penalizes excessive resource dependence.

2. Existing Measures and Limitations

The literature offers several indices for measuring economic diversification, but these differ in emphasis, purpose, and methodology. The Global Economic Diversification Index

(GEDI), developed by Prasad et al. (2023), is the most prominent composite measure to date. GEDI combines three components: output diversification (i.e., sectoral breadth), trade diversification (i.e., export concentration), and government revenue diversification (i.e., tax mix and reliance on commodities). Each component is constructed using principal component analysis, and the three subindices are aggregated into a single composite score using equal weights (Prasad et al., 2024, p. 19). GEDI thus represents an advance beyond single-dimension measures. However, as a global index, it assumes that output, trade, and fiscal diversification are of equal importance across all countries, regardless of economic structure. It also does not penalize resource dependence, as its focus is comparability rather than the vulnerabilities of resource-dependent economies.

Other methodologies include the Economic Complexity Index (ECI), which links export structure to long-term potential but focuses only on trade (Hidalgo & Hausmann, 2009). The more general composite Mazziotta–Pareto Index can be applied to diversification, but it is non-compensatory, penalizing imbalance across components rather than rewarding diversification away from resource dependence (Mazziotta & Pareto, 2016). Conventional metrics such as the Herfindahl–Hirschman Index and entropy indices are widely used in trade analysis (Mikic & Gilbert, 2009) and can be adapted for output and fiscal measures, but on their own they cannot capture diversification across multiple dimensions.

In contrast to the GEDI, the WCDI proposed here differs not in the choice of components, which largely overlap, but in the method of weighting and scoring diversification. Unlike the GEDI, the WCDI does not assign equal weights; rather, weights are endogenous. Fiscal diversification is assessed by government size, trade diversification by export dependence, and output diversification by private domestic demand, encompassing household consumption

and private capital formation. Since diversification is not an end in itself, particularly for resource-dependent economies, the WCDI also applies a penalty for excessive resource dependence, ensuring the index rewards diversification away from resource dependence rather than breadth alone. The WCDI is not intended as a universal ranking tool, but is made for resource-dependent economies, where exposure to external volatility is especially pronounced and diversification is a persistent priority.

Before turning to the formal construction of the index, it is useful to clarify why weighting and resource dependence adjustments matter. The objective of diversification is to reduce dependence on a narrow set of activities, lowering susceptibility to exogenous shocks (Delechat et al., 2024). Yet vulnerabilities differ according to macroeconomic structure. If government expenditure constitutes 40% of GDP while exports are 30%, fiscal diversification represents the greater vulnerability. Equal weighting obscures this context, implying that a one-percent shift in fiscal diversification has the same relevance as a one-percent shift in export diversification. Similarly, the fiscal subindex may overstate diversification if resource and non-resource revenues are split evenly, since entropy rewards balance without recognizing resource dominance. Endogenizing weights to macroeconomic shares aligns the index with each economy's vulnerabilities, while penalizing excessive resource dependence ensures that diversification reflects reduced vulnerability rather than variety alone.

Equal weighting is often justified as a way of facilitating cross-country comparisons and sidestepping judgments about relative importance (Prasad et al., 2024). Yet the notion of neutrality is false, as any weighting scheme reflects assumptions (Becker et al., 2017). Equal weights assume all components matter equally, while endogenous weights proposed in the WCDI make assumptions explicit and dynamic. Moreover, most indices reward diversification quantity

rather than quality. The WCDI incorporates a penalty term, down-weighting resource contributions once they exceed a threshold in any subcomponent. Comparability is not the WCDI's purpose. Instead, it is meant to serve as a policy instrument to assess diversification relative to GDP shares and its effectiveness in reducing dependence. This context-sensitivity limits its role as a global benchmark but makes it more informative for policymakers.

3. Methodology

The WCDI is proposed as a weighted sum of export, output, and fiscal diversification subindices. Its expanded operational form, given below, details the construction of each subindex, the endogenously determined weights, and the term that penalizes excessive resource dependence within each subindex.

$$WCDI_t = \underbrace{\frac{\frac{X_t}{Y_t}}{S_t}}_{\text{Export weight}} \cdot \underbrace{\left[\left(-\frac{1}{\ln(N_{EXP})}\sum_{x=1}^{N_{EXP}}\left(\frac{exp_{x,t}}{EXP_t}\right)\ln\left(\frac{exp_{x,t}}{EXP_t}\right)\right).P_{r,t}^{EXP}\right]}_{\text{Export Diversification Index penalized for resource dependence}}$$

$$+ \underbrace{\frac{\frac{C_t + I_t}{Y_t}}{S_t}}_{\text{Output weight}} \cdot \underbrace{\left[\left(-\frac{1}{\ln(N_{OUT})}\sum_{k=1}^{N_{OUT}}\left(\frac{y_{k,t}}{Y_t}\right)\ln\left(\frac{y_{k,t}}{Y_t}\right)\right).P_{r,t}^{OUT}\right]}_{\text{Output Diversification Index penalized for resource dependence}} \quad (1)$$

$$+ \underbrace{\frac{\frac{G_t}{Y_t}}{S_t}}_{\text{Fiscal weight}} \cdot \underbrace{\left[\left(-\frac{1}{\ln(N_{FISC})}\sum_{f=1}^{N_{FISC}}\left(\frac{rev_{f,t}}{REV_t}\right)\ln\left(\frac{rev_{f,t}}{REV_t}\right)\right).P_{r,t}^{FISC}\right]}_{\text{Fiscal Diversification Index penalized for resource dependence}}$$

Following prior studies that apply entropy indices to assess various forms of economic diversification (Attaran & Zwick, 1987; Siegel et al., 1995; Wasylenko & Erickson, 1978), each

WCDI subindex is constructed using a modified entropy index, normalized by the number of categories (N). Export, output, and fiscal diversification are defined analogously: $exp_{x,t}$, $y_{k,t}$, and $rev_{f,t}$ denote exports of product x, value added of sector k, and revenue from source f, with totals given by $EXP_t = \sum_x exp_{x,t}$, $Y_t = \sum_k y_{k,t}$, $REV_t = \sum_f rev_{f,t}$, respectively. Note that the output subindex covers the full composition of GDP by activity, whereas the export and fiscal subindices capture single expenditure components; still all three are anchored to GDP shares to ensure comparability. Imports are excluded by design, as they reflect consumption dependence rather than economic diversification.

To normalize the endogenous weights, the term S_t is given by:

$$S_t = \frac{X_t}{Y_t} + \frac{C_t + I_t}{Y_t} + \frac{G_t}{Y_t}$$

and each share is then divided by S_t to ensure that the three weights are comparable and sum to unity. Export-to-GDP ratios weight export diversification, so an economy exporting half its output is more exposed than one exporting little. Domestic demand, measured as household consumption plus private capital formation as a share of GDP, determines the weight of output diversification, while government current and capital expenditures relative to GDP determine the weight of fiscal diversification.

The penalty term is defined as:

$$P_{r,t} = 1 - \left(max \left\{ 0, \frac{\theta_{r,t} - \tau}{1 - \tau} \right\} \right)^{\gamma}$$

where $\theta_{r,t}$ denotes the resource share within each component of diversification at time t (e.g., hydrocarbon exports relative to total exports). The threshold parameter $\tau \in [0,1]$ is set

exogenously to reflect the importance of reducing resource dependence. For instance, $\tau = 0.3$ forgives dependence below 30% but penalizes anything higher. This design makes the index customizable, allowing economies to specify how strongly resource dependence should be penalized according to their own diversification objectives. The curvature parameter $\gamma \geq 1$ is also set exogenously and determines penalty severity. Higher values (e.g., $\gamma \geq 2$) produce a convex penalty curve that is mild just above the threshold but increasingly severe at higher resource shares, while values closer to 1 make the penalty nearly linear. Setting $\gamma \geq 2$ is economically intuitive, treating moderate dependence leniently but penalizing heavy dependence sharply. This formulation follows the standard form of penalty functions in constrained optimization, where violations above a threshold are raised to a power (Bryan & Shibberu, 2005). $P_{r,t}$ equals 1 when the resource share does not exceed the threshold τ but progressively reduces the contribution of the subindex as resource shares rise above τ.

The WCDI incorporates three subindices of diversification, each weighted by its structural importance and penalized for resource dependence. These endogenous weights capture macroeconomic structures and exposure, while the penalty term ensures scores reflect genuine, diversification away from resource dependence rather than breadth alone.

4. Illustrative Application

The six Gulf Cooperation Council (GCC) economies—Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates (UAE)—provide a prime example of the utility of the WCDI, as defined in equation (1). Although increasingly diversified, these relatively homogeneous economies have historically relied heavily on resource-based exports, government

revenues, and output (namely oil, natural gas, and their non-value-added derivatives). Table 1 applies the WCDI to the GCC, with endogenous weight and a convex penalty ($\gamma = 2$). The index places Bahrain at the top of the ranking, followed by Saudi Arabia and the UAE, then Oman, Qatar, and Kuwait (See Appendix A, Table A1 for an alternative linear penalty and comparison to equal weight and no penalty indices).

Table 1. WCDI, Subindices, Weights, Resource Shares, and Penalties, 2019

Subindex / Component	Bahrain	Kuwait	Oman	Qatar	Saudi Arabia	UAE
Export subindex	0.51	0.12	0.36	0.17	0.26	0.43
Weight	0.29	0.34	0.33	0.33	0.25	0.55
Resource share	0.42	0.91	0.69	0.86	0.77	0.55
Penalty	0.97	0.24	0.69	0.36	0.56	0.88
Output subindex	0.87	0.75	0.88	0.83	0.86	0.91
Weight	0.54	0.43	0.36	0.43	0.50	0.29
Resource share	0.15	0.46	0.32	0.36	0.27	0.23
Penalty	1	0.95	1	0.99	1	1
Fiscal subindex	0.96	0.86	0.79	0.74	0.94	1.00
Weight	0.16	0.22	0.31	0.25	0.24	0.16
Resource share	0.61	0.72	0.76	0.79	0.64	0.53
Penalty	0.80	0.64	0.57	0.51	0.76	0.89
WCDI	0.74	0.44	0.53	0.46	0.65	0.62

Note. Author's calculations based on data from UN Statistics Division (UNSD), UN Comtrade, IMF, and Saudi Arabia's General Authority for Statistics (GaStat). WCDI and subindices are normalized to $[0,1]$; higher values indicate greater diversification. Parameters $\tau = 0.30$, $\gamma = 2$. Subindices: $N_{EXP} = 98$, $N_{FISC} = 2$, $N_{OUT} = 6$.

These subindex results underscore that the GCC's seemingly homogenous economies face distinct diversification challenges. For the UAE, export diversification carries the greatest weight and remains its highest resource share, making it the key area for policy focus. In Bahrain, by contrast, fiscal revenue has the largest resource share, but with the smallest weight, the more urgent task is diversifying exports and output. The WCDI thus makes clear that one size does not fit all: the policy levers for diversification differ markedly across these hydrocarbon-rich economies. An avenue for refinement for the WCDI would be to endogenize the tolerance parameter τ using additional resilience metrics (e.g., fiscal wage-bill coverage relative to non-resource revenues), although this would trade strict comparability for policy relevance.

5. Conclusion

An equal weighting in composite economic diversification indices presumes that fiscal, trade, and output diversification are of equal consequence, a presumption rarely substantiated in practice. Towards this end, this note proposes an endogenously weighted composite index, which also measures diversification away from resource dependence within each subindex, instead of treating all diversification as equally meaningful. By endogenizing weights and penalizing resource dependence, the WCDI corrects the distortions of the conventional equal weighted measurement approach by recognizing that diversification is crucial where vulnerability is greatest. The WCDI is not a universal benchmark but a context-sensitive tool to assess whether economies are diversifying in the areas that matter most, and away from the resources on which they seek to reduce their dependence.

Disclaimer

This research was conducted independently. The analysis expressed is the author's own and does not necessarily reflect the views of the author's employer or affiliated organization.

Data availability

Data are sourced from the UNSD, UN Comtrade, IMF, and the Saudi General Authority for Statistics. The compiled dataset and Stata do-files used in the illustrative application are openly available in Zenodo at: https://doi.org/10.5281/zenodo.17147944

Declaration of competing interests

The author has nothing to declare.

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Appendix A. Diversification Scores Under Alternative Penalty Curvature and Benchmark Indices

For comparison, Table A1 reports an intermediate version of the index without the penalty term, alongside the conventional equal-weight index. This comparison illustrates how the penalty matters: it prevents economies with high resource concentration from appearing more diversified than they truly are. GEDI, which assigns equal weights to the three components and does not penalize resource concentration, most closely mirrors the equal-weight index in Table A1, but in 2019 it produced a different ranking: UAE (most diversified), followed by Bahrain, Saudi Arabia, Qatar, Oman, and Kuwait (least diversified).

Table A1 also shows results for the WCDI under an alternative penalty curvature. With $\gamma = 2$ (convex penalty), as used in Table 1 in the main text, the index is relatively forgiving of moderate resource reliance in the GCC, imposing harsher adjustments only at very high resource shares (e.g., Kuwait and Qatar's export dependence). By contrast, $\gamma = 1$, as seen in Table A1, applies a linear and heavier penalty, reducing scores more uniformly across the board. As a result, all economies record lower diversification scores under $\gamma = 1$, with Kuwait and Qatar showing the steepest declines and Bahrain the smallest. Despite these level differences, the relative ranking of GCC economies remains unchanged, underscoring that the main findings are robust to alternative penalty specifications.

Table A1. Diversification Scores for GCC Economies: WCDI and Alternative Approaches, 2019

Economy	WCDI (weighted & penalty) ($\gamma = 1$)	Weighted (no penalty)	Equal weights (no penalty)
Bahrain	0.68	0.78	0.78
Kuwait	0.34	0.56	0.58
Oman	0.44	0.68	0.68
Qatar	0.39	0.59	0.58
Saudi Arabia	0.57	0.73	0.69
UAE	0.53	0.66	0.78

Note. Author's calculations based on data from UNSD, UN Comtrade, IMF, and GaStat.

References

Attaran, M., & Zwick, M. (1987). Entropy and Other Measures of Industrial Diversification. *Quarterly Journal of Business and Economics*, 17–34. https://www.jstor.org/stable/40472898.

Becker, W., Saisana, M., Paruolo, P., & Vandecasteele, I. (2017). Weights and importance in composite indicators: Closing the gap. *Ecological Indicators*, *80*, 12–22. https://doi.org/10.1016/j.ecolind.2017.03.056.

Briguglio, L., Cordina, G., Farrugia, N., & Vella, S. (2014). Economic Vulnerability and Resilience: Concepts and Measurements. In *Measuring vulnerability in developing countries* (pp. 47–65). Routledge. https://www.taylorfrancis.com/chapters/edit/10.4324/9781315874371-3/economic-vulnerability-resilience-concepts-measurements-lino-briguglio-gordon-cordina-nadia-farrugia-stephanie-vella.

Delechat, C. C., Melina, G., Newiak, M., Papageorgiou, C., Wang, K., & Spatafora, N. (2024a). Economic Diversification in Developing Countries – Lessons from Country Experiences with Broad-Based and Industrial Policies. *Departmental Papers*, *2024*(006). https://doi.org/10.5089/9798400240201.087.

General Authority for Statistics (Saudi Arabia). (2024). *Gross Domestic Product Statistics*. GaStat. https://dp.stats.gov.sa/.

Hidalgo, C. A., & Hausmann, R. (2009). The Building Blocks of Economic Complexity. *Proceedings of the National Academy of Sciences*, *106*(26), 10570–10575. https://doi.org/10.1073/pnas.0900943106.

International Monetary Fund. (2021a). Oman: 2021 Article IV Consultation-Press Release; Staff Report; and Statement by the Executive Director for Oman. *IMF Staff Country Reports*, *2021*(206). https://doi.org/10.5089/9781513596020.002.

International Monetary Fund. (2021b). Saudi Arabia: 2021 Article IV Consultation-Press Release; and Staff Report. *IMF Staff Country Reports*, *2021*(149). https://doi.org/10.5089/9781513587424.002.

International Monetary Fund. (2021c, March 22). *IMF Executive Board Concludes 2021 Article IV Consultation with The Kingdom of Bahrain*. IMF. https://www.imf.org/en/News/Articles/2021/03/22/pr2175-bahrain-imf-executive-board-concludes-2021-article-iv-consultation.

International Monetary Fund. (2022a). Kuwait: 2021 Article IV Consultation-Press Release; Staff Report; and Statement by the Executive Director for Kuwait. *IMF Staff Country Reports*, *2022*(089). https://doi.org/10.5089/9798400205736.002.

International Monetary Fund. (2022b). Qatar: 2022 Article IV Consultation-Press Release; and Staff Report. *IMF Staff Country Reports*, *2022*(175). https://doi.org/10.5089/9798400213342.002.

International Monetary Fund. (2022c). United Arab Emirates: 2021 Article IV Consultation-Press Release; and Staff Report. *IMF Staff Country Reports*, *2022*(050). https://doi.org/10.5089/9798400202834.002.

Lashitew, A. A., Ross, M. L., & Werker, E. (2021). What Drives Successful Economic Diversification in Resource-Rich Countries? *The World Bank Research Observer*, *36*(2), 164–196. https://doi.org/10.1093/wbro/lkaa001.

Lederman, D., Maloney, W.F. (2007). Trade Structure and Growth, in: *Natural resources: neither curse nor destiny* (pp. 15–39). Stanford University Press and The World Bank.

Mano, H., & Combary, O. S. (2025). Effects of Export Diversification on Economic Vulnerability: The Case of Waemu Countries. *The Journal of International Trade & Economic Development*, *0*(0), 1–21. https://doi.org/10.1080/09638199.2025.2482542.

Mazziotta, M., & Pareto, A. (2016). On a Generalized Non-compensatory Composite Index for Measuring Socio-economic Phenomena. *Social Indicators Research*, *127*(3), 983–1003. https://doi.org/10.1007/s11205-015-0998-2.

Mikic, M., & Gilbert, J. (2009). *Trade Statistics in Policymaking—A Handbook of Commonly Used Trade Indices and Indicators (Revised Edition)*. United Nations Economic and Social Commission for Asia and the Pacific. https://artnet.unescap.org/publications/books-reports/trade-statistics-policymaking-handbook.

Ouedraogo, R., Tapsoba, R., Sow, M., & Compaoré, A. (2020). Fiscal Resilience Building: Insights from a New Tax Revenue Diversification Index. *IMF Working Papers*, *2020*(094). https://doi.org/10.5089/9781513546032.001.A001.

Prasad, A., Refass, S., Saidi, N., Salem, F., & Shepherd, B. (2023). Global Economic Diversification Index 2023. *Global Economic Diversification Index Series*. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4682950.

Prasad, A., Subramani, K., Refass, S., Saidi, N., Salem, F., & Shepherd, B. (2024). *Global Economic Diversification Index 2024: Exploring the Impact of Digital Trade on Economic Diversification* (SSRN Scholarly Paper No. 4805080). Social Science Research Network. https://papers.ssrn.com/abstract=4805080.

Siegel, P. B., Johnson, T. G., & Alwang, J. (1995). Regional Economic Diversity and Diversification. *Growth and Change*, *26*(2), 261–284. https://doi.org/10.1111/j.1468-2257.1995.tb00171.x.

UN Comtrade. (2025). *UN Comtrade Database* [Dataset]. https://comtradeplus.un.org/

United Nations Statistics Division. (2024a). *GDP by Type of Expenditure at Current Prices—National Currency* [Dataset]. https://data.un.org/Data.aspx?q=expenditure&d=SNAAMA&f=grID%3a101%3bcurrID%3aNCU%3bpcFlag%3a0.

United Nations Statistics Division. (2024b). *Table 2.4 Value Added by Industries at Current Prices (ISIC Rev. 4)* [Dataset]. https://data.un.org/Data.aspx?q=Gross+domestic+product&d=SNA&f=group_code%3a204%3bitem_code%3a26.

Wasylenko, M. J., & Erickson, R. A. (1978). "On Measuring Economic Diversification": Comment. *Land Economics*, *54*(1), 106–109. https://doi.org/10.2307/3146208.