MOVING TOWARD DEGROWTH: IS IT POSSIBLE FOR THE G20?

Hussain Mohammed Alobaid AND *Fakhri Issaoui**

1. Introduction

Since the 1980s, a growing and persistent awareness has taken root in the collective human consciousness regarding the urgent need to halt the environmental degradation of the past two centuries—degradation so severe that it has

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*Professor Hussain M. Alobaid is a Full Professor of Economics and Chair of the Economics Department at the College of Business, King Khalid University in Saudi Arabia (Asir–Abha, P.O. Box 960 – Postal Code 61421). He received his Ph.D. in Economics from Colorado State University (USA), an M.S. in Economics from Western Illinois University (USA), and an M.S. in Human Resources Studies from Colorado State University (USA). He is also a member of the Board of Trustees at the University of Business and Technology (Saudi Arabia). His research interests include energy economics, economic development, labor economics, consumer behavior, and welfare economics. Dr. Alobaid has published several articles in journals such as the *Journal of Infrastructure*, *Policy and Development*, *International Journal of Economics and Financial Issues*, *International Journal of Research in Business and Social Science*, *International Journal of Economics and Finance Studies*, and *Cahiers Économiques*. Email: halobaid@kku.edu.sa

Professor Fakhri Issaoui is a Full Professor of Economics and Management in the College of Business at King Khalid University (Asir–Abha, P.O. Box 960 – Postal Code 61421) and an affiliate of the Research Laboratory of Prospective, Stratégies et Développement Durable (PS2D) at the University of Tunis El Manar. He received his Ph.D. in Economics from the University of Tunis El Manar (Tunisia). His research interests include public and labor economics, economic development, economic

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raised genuine fears about the very survival of life on Earth. This awareness signaled the decline of the old neoclassical growth model, which measured success solely in terms of material wealth, often at the expense of moral and ethical values. The model's underlying logic—rooted in the maximization of individual utility and self-interest—prioritized profit above all else, rejecting any constraints that might hinder it. As a consequentialist framework, it glorified profit accumulation, even when this meant degrading the environment and destabilizing ecological systems.

The first cracks in this paradigm began to appear in the early 1970s, when scholars and policymakers—albeit cautiously—started questioning its justice and fairness. This shift coincided with the emergence of normative critiques of economic positivism, driven in part by the influential publication of John Rawls' *A Theory of Justice* (1971), which placed concepts of fairness and equity at the forefront of economic thought. The movement gained further momentum through Amartya Sen's work on poverty, inequality, and intergenerational justice, which underscored the ethical dimensions of economic policy.

This growing moral and ecological awareness broke the longstanding dogma of growth as the unquestioned centerpiece of economic strategy. Two arguments were central to this shift. First, unlimited economic growth, while increasing present-day material wealth, inevitably compromises future prosperity by depleting the natural resources upon which all production depends. The more growth relies on non-renewable or hard-to-replace inputs, the more it undermines the very foundations of life. Second, as Sen (1987) argued, the real economic challenge lies not in resource scarcity, but in the unjust distribution of those resources.

Today, following decades of debate, there is broad recognition that the current capitalist model of "destructive growth" cannot be sustained indefinitely, cannot endure in a finite world, and cannot ensure planetary survival. The mounting evidence is visible in unprecedented phenomena: extreme climate events, accelerating global warming, water and air pollution, deforestation, and the alarming extinction of animal and plant species. In response, alternative paradigms—such as sustainable development, intergenerational equity, and particularly Degrowth—have emerged to challenge the ideological dominance of neoclassical economics.

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justice, macroeconomics, and growth in transitioning economies. Dr. Issaoui has published more than 100 articles in journals such as *Water Resources Management*, *Sustainable Futures*, *International Journal of Teacher Education and Professional Development (IJTEPD)*, *Challenges in Sustainability*, *Panoeconomicus*, *The Journal of Energy and Development*, *Journal of Cyber Warfare and Terrorism*, *Journal of the Knowledge Economy*, *International Journal of Computational Economics and Econometrics*, *African Sociological Review*, *International Journal of Green Computing*, *Economic Research Guardian*, and *International Journal of Sustainable Economies Management*, among others. Email: faisaoui@kku.edu.sa

Degrowth, alco called *décroissance*, offers an ethical and economic alternative, advocating for enhanced well-being through reduced production, fairer income distribution, and a commitment to reducing inequality. It is within this context that our article asks: Given the growing collective will—reflected in governments and international institutions such as the United Nations—to protect the planet, is there a corresponding shift within the economic sphere toward adopting the Degrowth model? What is the current state of this transition within the G20, a group that bears primary responsibility for global environmental challenges and thus a moral obligation to lead change? Our focus on the G20 rests on three factors: their dominant role in global trade, their accounting for over 85% of global GDP, and their considerable monetary and political influence, as highlighted in the 2018 G20 report.

2. Historical Context of the Emergence of the Economic Degrowth Logic

For methodological clarity, it is important to note that the term *Degrowth* does not simply denote the semantic opposite of growth. Rather, it refers to a distinct philosophical and normative framework that extends beyond economic contraction. Degrowth emphasizes non-profit and human-centered objectives, including the preservation of life, equitable resource distribution, the right to inhabit unpolluted environments, and the rational use of natural resources for the collective benefit of present and future generations. Understanding this concept requires situating it within its historical development, clarifying its objectives, and defining its scope.

Although the term *Degrowth* is relatively recent, the logic underpinning it emerged in public debate in the late 1960s and early 1970s. This period witnessed the rise of reflective models advocating reduced consumption and moderated economic growth, with the aim of ensuring the sustainable use of natural resources, environmental preservation, and the promotion of social well-being through more equitable distribution.

A pivotal moment came in 1972 with the publication of *The Limits to Growth* by the Club of Rome, authored by Meadows et al. The report warned that the pursuit of unlimited economic expansion to meet ever-growing human demands would inevitably lead to intensified ecological degradation. It underscored the biophysical limits of the Earth and the inherent unsustainability of the prevailing economic model. Among its recommendations was the dismantling of the “growth myth” and the introduction of measures to moderate demand. The report argued that short-term, unrestricted growth results in the overexploitation of non-renewable resources, producing severe long-term environmental consequences. In doing so, it indirectly revived David Ricardo’s notion of the “stationary state,” converging toward the idea of an equilibrium economy.

At roughly the same time, Nicholas Georgescu-Roegen's seminal work (*The Entropy Law and the Economic Process*, 1971) introduced a bioeconomic perspective by integrating thermodynamic principles into economic analysis. He demonstrated that indefinite material growth is impossible because it relies on irreversible processes of energy transformation, inevitably increasing entropy and degrading the environment. Georgescu-Roegen argued that the economy is inseparably linked to the biosphere, and therefore subject to its ecological and resource limits. This bioeconomic approach, later expanded (1995, 2006), stressed that recycling—while valuable—cannot fully offset the entropic effects of extraction and transformation, as industrial societies continue to consume large quantities of polluting, non-renewable energy. Consequently, economic systems must be reoriented to operate within the Earth's geophysical boundaries, giving greater weight to ethical and moral considerations rather than short-term utilitarian profit maximization.

The debate over growth limits and the compounding of ecological and social crises was advanced by influential thinkers such as André Gorz (1992), Serge Latouche (2001, 2003, 2007), Robert Costanza et al. (2015), and Giorgos Kallis et al. (2020). Collectively, their work critiques the promises of abundance, prosperity, and peace associated with economic growth, noting that these are frequently undermined by environmental degradation and social inequality. They advocate for an economic model that prioritizes long-term sustainability and equity over immediate financial gain. This critique exposes a central paradox: rather than alleviating poverty and inequality, continued economic growth often exacerbates them while accelerating resource depletion, climate change, biodiversity loss, and environmental disasters. In light of these realities, there is a growing call for systemic change toward practices that ensure societal well-being while preserving ecological integrity.

3. The Institutional Objective of Degrowth

As noted earlier, the concept of *Degrowth* has often been misinterpreted as synonymous with "negative growth," a purely economic term denoting a decline in Gross Domestic Product (GDP). However, for its proponents, Degrowth represents a normative and strategic societal objective—a vision for a "post-growth" or "post-development" future. The first formal institutional definitions emerged at the 2008 Conference on Economic Degrowth for Ecological Sustainability and Social Equity in Paris. These definitions framed Degrowth both as (i) a strategy for rebalancing prosperity within the most affluent nations and globally, and (ii) a deliberate transition toward a fair, cooperative, and ecologically respectful society.

At its core, Degrowth challenges the ecological consequences of the relentless pursuit of economic expansion. The acceleration of production and consumption exerts mounting pressure on ecosystems, reshaping and degrading them at unsustainable rates. Within this dynamic, it is impossible to maintain both unrestrained growth and environmental integrity. To preserve the vital balance of Earth, global economic activity must decelerate. This requires reducing resource extraction, transforming production processes, and moderating consumption. In effect, Degrowth calls for the construction of an alternative economic model and way of life that rejects the entrenched belief that perpetual growth is synonymous with prosperity. Instead, it places sustainability and collective well-being at the center of development objectives.

The framework of *Sustainable Degrowth* specifically advocates for a deliberate reduction in production and consumption designed to enhance individual well-being while improving environmental conditions both locally and globally, in the short and long term. This perspective prioritizes ecological balance, equitable distribution, and community resilience over the narrow metric of economic output. By fostering mindful consumption, sustainable resource use, and innovative socio-economic practices, Degrowth seeks to create societies in which quality of life is improved through environmental stewardship, social equity, and the redefinition of prosperity beyond material accumulation.

4. The State of Play in the G20

From an economic perspective, excessive carbon dioxide (CO_2) emissions are largely attributable to the heavy dependence on fossil fuel-based energy sources that underpin the pursuit of unlimited economic growth. This reliance has positioned the G20 as the most polluting economic bloc globally, as demonstrated by Pao and Chen (2019). Their analysis of the relationship between CO_2 emissions and economic growth in the G20 from 1991 to 2016 identified an Environmental Kuznets Curve, revealing two key findings: first, G20 countries have been principal contributors to environmental degradation (see Table 1), and second, they are increasingly aware of the necessity of transitioning from the traditional growth paradigm to an ecologically sustainable development model. Recognizing this, environmental sustainability has become a central strategic priority on the G20 agenda (Uddin et al., 2017; Kasman & Duman, 2015). Similarly, Landrigan et al. (2018) further warn that without the adoption of effective CO_2 mitigation strategies, environmental degradation will intensify, manifesting in water pollution, soil erosion, solid waste accumulation, global warming, and deforestation. Addressing these challenges requires immediate, coordinated action by G20 members to integrate sustainable practices and policies. Failure to do so not only jeopardizes biodiversity but also poses significant risks to global public health, economic resilience, and long-term ecological stability.

Table 1
CO_2 EMISSIONS BY INDUSTRY SECTOR FOR G20 COUNTRIES IN 2014

	Primary Sector	**Secondary Sector**		**Tertiary Sector**	
G20 Member	**Other Sectors Including Agriculture (%)**	**Electricity and Heat Production (%)**	**Manufacturing Industries and Construction (%)**	**Transport (%)**	**Residential Buildings and Commercial and Public Services (%)**
Argentina	14.46%	24.17%	16.87%	38.04%	6.47%
Brazil	4.29%	44.75%	20.60%	26.31%	4.05%
China	5.36%	8.60%	31.72%	52.25%	2.07%
Indonesia	5.49%	11.48%	26.41%	53.61%	3.02%
India	5.11%	30.81%	18.40%	44.25%	1.43%
Mexico	5.32%	35.09%	13.45%	44.07%	2.07%
Russia	9.17%	16.24%	12.32%	61.11%	1.15%
Saudi Arabia	0.82%	25.92%	24.10%	49.16%	0.00%
Turkey	15.16%	19.83%	14.62%	46.69%	3.71%
South Africa	5.47%	12.05%	12.58%	67.48%	2.42%
Average	7.07%	22.89%	19.11%	48.30%	2.64%
Australia	3.72%	24.74%	11.49%	58.36%	1.69%
Canada	14.52%	31.79%	12.04%	38.73%	2.91%
Germany	17.67%	21.37%	12.44%	48.47%	0.05%
France	23.40%	42.41%	15.70%	13.80%	4.70%
UK	19.06%	28.45%	9.60%	41.93%	0.96%
Italy	18.07%	32.95%	11.19%	35.56%	2.23%
Japan	9.98%	17.54%	19.18%	53.10%	0.21%
South Korea	8.13%	16.28%	13.66%	60.49%	1.45%
USA	11.01%	33.40%	8.66%	45.99%	0.94%
Average	13.95%	27.66%	12.66%	44.05%	1.68%

Source: Yan, K., R. Gupta, and V. Wong. “CO_2 Emissions in G20 Nations through the Three-Sector Model.” *Journal of Risk and Financial Management* 15, no. 9 (2022): 394. https://doi.org/10.3390/jrfm15090394.

5. Literature Review: What is the Relationship Between Economic Growth and the Ecosystem in the G20?

While starting from the assumption that the G20 countries have contributed significantly to the deterioration of environmental quality, as many studies have indicated, researchers have sought to test this hypothesis and to determine whether this group aims to change its economic behavior by moving toward a new model that is more ecological and less polluting.

Yin et al. (2022) analyzed both economic and non-economic determinants of environmental sustainability, with a focus on CO_2 emission reduction, using G20 panel data for the period 1995–2016. Employing an Environmental Kuznets Curve (EKC) framework, the study incorporated additional explanatory variables, including internet usage, renewable energy consumption, and services trade. The findings reveal an inverted U-shaped relationship between GDP per capita and CO_2 emissions in G20 countries, with the turning point occurring at a GDP per capita of USD $38,340. A similar inverted U-shaped relationship was observed between internet usage and CO_2 emissions, with a turning point at 44% internet penetration. Comparative analysis shows that this pattern exists only in advanced economies, where the turning points are USD $42,356 for GDP per capita and 27% for internet usage. Moreover, the effects of renewable energy adoption and services trade on reducing CO_2 emissions were found to be stronger in advanced economies than in developing ones.

Chen et al. (2020) confirm that the G20 is largely responsible for global pollution and greenhouse gas emissions, framing this as an inevitable consequence of the group's rapid economic growth. Within an expanded Environmental Kuznets Curve (EKC) framework, they investigated the role of income distribution in influencing CO_2 emissions during periods of economic growth, employing simultaneous quantile regression analysis. Their findings indicate that a more equitable distribution of income within the G20 leads to a reduction in per capita CO_2 emissions. This supports the Degrowth argument that the core challenge lies in resource distribution rather than production. The results also validate the EKC hypothesis for the G20. Based on their analysis, the authors emphasize the need to reduce income inequality in developing G20 countries and advocate for the bloc as a whole to pursue a sustainable development trajectory.

Kumar and Datta (2023) highlight that ecological sustainability and energy transition have gained significant prominence in the G20 policy agenda during the 21st century, driven by the long-term interdependence between environmental quality and economic performance. Using PMG/ARDL estimation techniques for the period 1990–2018, they reassessed the impact of key economic variables—real GDP, foreign direct investment (FDI), urban population, and energy consumption—on both ecological footprint (EF) and CO_2 emissions. Their results show that real GDP growth and non-renewable energy consumption are the main drivers of EF and CO_2 emissions in both the short and long term. FDI reduces EF but contributes to air pollution over the long term. Urban population growth appears to improve environmental quality in the long term, while renewable energy consumption is associated with reduced CO_2 emissions in both the short and long term.

Alam et al. (2012) and Apergis and Payne (2009) found no direct relationship between energy consumption and economic growth in the production process, in contrast to the link observed between capital and labor. Tsadiras et al. (2020) examined the environmental consequences of economic activity, noting that energy plays a critical role in development. Their findings suggest that increasing the share of renewable energy in the energy mix of the seven G20 countries studied could contribute significantly to pollution reduction.

Kusumawardani and Dewi (2020) explored the relationship between income inequality and CO_2 emissions in Indonesia, integrating the economic, social, and environmental dimensions of sustainable development. In a related vein, McDowall et al. assessed the growing influence of technology companies in the EU energy sector, highlighting that advances in the solar industry have contributed to a 7% reduction in global CO_2 emissions.

Focusing on country groupings, Cai et al. (2018) analyzed energy savings and greenhouse gas emissions in G7 member states using ARDL models with structural breaks, enabling a nuanced exploration of causal relationships. Their results revealed a distinctive economic-environmental dynamic, including a link between Japan's economic expansion and Germany's carbon emissions. Notably, Germany exhibits a complex relationship with its carbon footprint, as higher energy consumption there appears to be associated with lower CO_2 emissions.

Earlier research has also addressed the broader relationship between economic growth and environmental degradation. Grossman and Krueger (1995), using panel data from 39 industrialized and emerging economies, found evidence consistent with the Environmental Kuznets Curve: environmental degradation tends to worsen in the early stages of economic growth before improving at higher income levels.

6. Methodology

The present study investigates the relationship between CO_2 emissions and economic growth in selected major G20 countries, with particular attention to their influence on environmental policy decisions. The methodological approach follows that employed in our earlier works, including Ammouri and Issaoui (2018) and Issaoui et al. (2023).

6.1. Econometric Specification: Wavelet analysis is a valuable tool for examining business cycles, as it enables data to be decomposed into distinct frequency components, each analyzed at a resolution appropriate to its scale. Correlations between two variables can be evaluated through two main approaches: (i) the traditional time-domain method and (ii) spectral analysis. The transformation of causality analysis from the time domain to the frequency domain has been advanced by Y. Hosoya, J. Breitung, and B. Candelon, as well as F. Yao and Y. Hosoya. According to L. Aguiar-Conraria et al., wavelet methods are particularly effective in capturing and internalizing the transitory dynamics between economic and financial variables. By integrating cross-wavelet and wavelet coherence techniques, researchers can measure both the degree of linear relationship between two time series and the associated phase difference. Wavelet analysis thus considers both time and frequency domains simultaneously and is often superior to classical econometric methods in detecting transitory effects. This approach has been applied to the study of numerous economic relationships, including those involving economic growth, oil price returns, inflation, industrial production, the Feldstein–Horioka puzzle, financial stress, and overall economic activity.

We illustrate this with a vector autoregressive (VAR) model involving two variables, following the approaches of J. Breitung and B. Candelon, M. Dhamala et al., and O. Olayeni, in equation (1):

$$A(L)Y(t)=\epsilon(t) \tag{1}$$

where $A(L)$ is a polynomial lag operator, $Y(t) = [x(t).y(t)]^{tr}$ is the vectors of endogenous variables, and $\epsilon(t)$ is the error terms with a variance-covariance matrix given by:

$$\Sigma=\begin{bmatrix}\Sigma_{xx} & \Sigma_{yx}\\ \Sigma_{xy} & \Sigma_{yy}\end{bmatrix}$$

Equation (1) can be written:

$$\begin{bmatrix}I-A_{xx}(L) & A_{yx}(L)\\ A_{xy}(L) & I-A_{yy}(L)\end{bmatrix}\begin{bmatrix}x(t)\\ y(t)\end{bmatrix}=\begin{bmatrix}\varepsilon_x(t)\\ \varepsilon_y(t)\end{bmatrix} \tag{2}$$

Then, assuming that $A(L)$ is invertible and its inverse is denoted by $B(L)$, we have equation (3):

$$Y(t)=B(L)\epsilon(t) \tag{3}$$

It follows that the Fourier transform of equation (3) is:

$$Y(\omega)=B(\omega)\Sigma\tilde{B}(\omega) \tag{4}$$

with

$$B(\omega)=\begin{bmatrix}B_{xx}(\omega) & \tilde{B}_{yx}(\omega)\\ B_{yx}(\omega) & \tilde{B}_{yy}(\omega)\end{bmatrix} \tag{5}$$

where $Y(\omega)$ is the power spectral of variable (Y), $B(\omega)$ is a transfer function between the variables x and y, and $\tilde{B}(\omega)$ is the complex conjugate of $B(\omega)$. Then the Granger-Geweke causality in frequency domain is given by equation (6):

$$G_{y\rightarrow x}(\omega)=log\left[\frac{Y_{xx}(\omega)}{Y_{xx}(\omega)-\left\{\Sigma_{xx}-\Sigma_{xy}^{2}/\Sigma_{xx}\right\}\left|B_{xy}(\omega)\right|^{2}}\right] \tag{6}$$

where $Y_{xx}(\omega)$ is the spectral power of variable x at frequency ω and Σ_{xx} are the variance-covariance matrices of the errors. $\{\Sigma_{xx}-\Sigma^{2}{}_{xy}/\Sigma_{xx}\}|B_{xy}(\omega)|^{2}$ is the causal contribution (intrinsic power).

The extension of Granger–Geweke causality to non-parametric modeling in the time–frequency domain—specifically, the analysis of the power distribution of Granger causality—requires the factorization of the spectral matrix. This factorization is achieved using Wilson's algorithm:

$$\int_{-\pi}^{\pi} log\left\{det[Y(\omega)]\right\}\ dw>-\infty$$

The convergence limitations of the Wilson algorithm were addressed by M. Dhamala et al., who incorporated the Wavelet transform into the Geweke–Granger framework to overcome these shortcomings. Their formulation in equation (7) corresponds closely to equation (6):

$$G_{y\rightarrow x}(\omega.b)=log\left[\frac{W_{xx}(\omega.b)}{W_{xx}(\omega.b)-\left\{\Sigma_{xx}-\Sigma_{xy}^{2}/\Sigma_{xx}\right\}\left|B_{xy}(\omega.b)\right|^{2}}\right] \tag{7}$$

where $W_{xx}(a.b)$ is the wavelet spectral power of variable x in frequency (ω).

A. Rua proposed a measure of the correlation by the continuous Wavelet transform noted by $\rho_{xy}(a.b)$:

$$\rho_{xy}(a.b)=\frac{\xi\left\{a^{-1}\left|\Re(W_{xy}^{m}(a.b)\right|\right\}}{\xi\left\{a^{-1}\sqrt{\left|W_{x}^{m}(a.b)\right|^{2}}\right\}\xi\left\{a^{-1}\sqrt{\left|W_{y}^{m}(a.b)\right|^{2}}\right\}} \tag{8}$$

where ξ is a time-scale smoothing operator. The coherence wavelet has a difference to the correlation wavelet, noted by $R_{xy}(a.b)$ in equation (9):

$$R_{xy}(a.b)=\frac{\xi\left\{a^{-1}\left|(W_{xy}^{m}(a.b)\right|\right\}}{\xi\left\{a^{-1}\sqrt{\left|W_{x}^{m}(a.b)\right|^{2}}\right\}\xi\left\{a^{-1}\sqrt{\left|W_{y}^{m}(a.b)\right|^{2}}\right\}} \tag{9}$$

A. Rua's proposed analysis does not address the direction of information flow among the variables. To remedy this, O. Olayeni modified equations (8) and (9) by incorporating the concept of phase difference between variables, drawing on the phase-difference circle introduced by L. Aguiar-Conraria and M. Soares. Building on this framework, O. Olayeni proposed a Granger causality formulation that augments Rua's wavelet correlation formula with an indicator function. Specifically, predictive information is considered to flow from y to x as expressed in equation (10), or from x to y as shown in equation (11):

$$G_{x\to y}(a.b)=\frac{\xi\left\{a^{-1}\left|\Re(W_{xy}^{m}(a.b)\ I_{x\to y}(a.b)\right|\right\}}{\xi\left\{a^{-1}\sqrt{\left|W_{x}^{m}(a.b)\right|^{2}}\right\}\xi\left\{a^{-1}\sqrt{\left|W_{y}^{m}(a.b)\right|^{2}}\right\}} \tag{10}$$

$$G_{y\to x}(a.b)=-\frac{\xi\left\{a^{-1}\left|\Re(W_{xy}^{m}(a.b)\ I_{y\to x}(a.b)\right|\right\}}{\xi\left\{a^{-1}\sqrt{\left|W_{x}^{m}(a.b)\right|^{2}}\right\}\xi\left\{a^{-1}\sqrt{\left|W_{y}^{m}(a.b)\right|^{2}}\right\}} \tag{11}$$

with

$$I_{y\to x}(a.b)=\begin{cases}1.\ if\ \ \phi_{xy}(a.b)\in\ J\\ 2.\ otherwise\end{cases} \tag{12}$$

where $\phi_{xy}(a.b)$ is the phase-difference function and J is intervals:

$$\left\{\left[0.\frac{\pi}{2}\right].\left[-\pi.-\frac{\pi}{2}\right] and\ \left[0.\frac{\pi}{2}\right]\cup\left[-\pi.-\frac{\pi}{2}\right]\right\}.$$

Chart Figures: The cross-wavelet coherency of the standardized X and Y time series is displayed, with the 5% significance level against yellow noise indicated by a thick contour line. The cone of influence, which marks the region affected by edge effects, is shown outside the black boundary line. Coherency values are represented by a color scale ranging from dark grey (low, close to 0) to light gray (high, close to 1). Phase differences between the two variables are depicted by arrows: arrows pointing to the right indicate that the series are in phase; arrows pointing to the right and upward show that Y is lagging, while arrows pointing to the right and downward indicate that Y is leading. Conversely, arrows pointing to the left indicate that the variables are out of phase; arrows pointing to the left and upward show that Y is leading, while arrows pointing to the left and downward indicate that Y is lagging. An in-phase relationship suggests that the variables exert cyclical effects on one another, whereas an out-of-phase (or anti-phase) relationship implies anti-cyclical effects.

6.2 Data: In this paper, we analyze the co-movement between growth rate and CO_2 emissions for seven countries: the United States, the Kingdom of Saudi Arabia (KSA), India, France, Germany, Mexico, and Brazil from 1990–2018. The results and analyses are presented in the following section.

6.3 Analysis and Interpretations of the Graphs:

The Case of the United States: According to Figure 1, in the case of the United States, a strong correlation between CO_2 emissions and GDP is observed within the cone of influence, particularly between 2005 and 2010. The arrows point to the right, indicating that the two variables are in phase—economic growth in the U.S. occurs simultaneously with increases in CO_2 emissions. This pattern reflects the country's long-standing dependence on polluting, non-renewable energy sources throughout much of its economic history. However, beginning around 2010, this trend appears to weaken, suggesting the early stages of a transition toward a new economic logic in which reliance on pollutants becomes just one option among others. This shift seems to reflect the influence of civil society's political pressure on the U.S. government, contributing to the emergence of an alternative development path aligned with the principles of Degrowth.

The Case of the India: In the case of India (Figure 2), the country remains far removed from any logic of Degrowth—a situation that is understandable given its significant demographic pressures and the immense costs associated with an energy transition. Such a transition risks failing to generate sufficient goods to meet the basic needs of its vast population. Within the cone of influence, we observe a strong causal relationship (indicated by the light grey color) between economic growth and CO_2 emissions, although the stability of this link fluctuates over time.

Figure 1
THE CAUSALITY RELATIONSHIP BETWEEN CO_2 EMISSIONS AND GDP
IN THE UNITED STATES

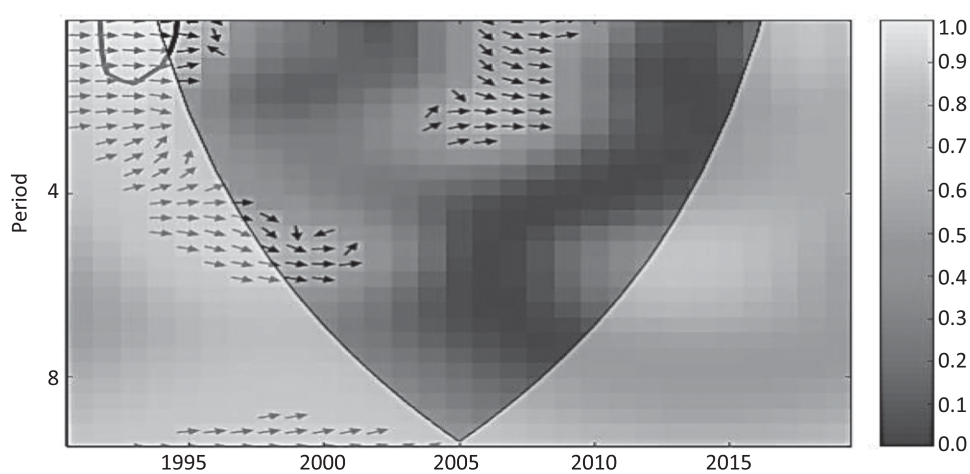
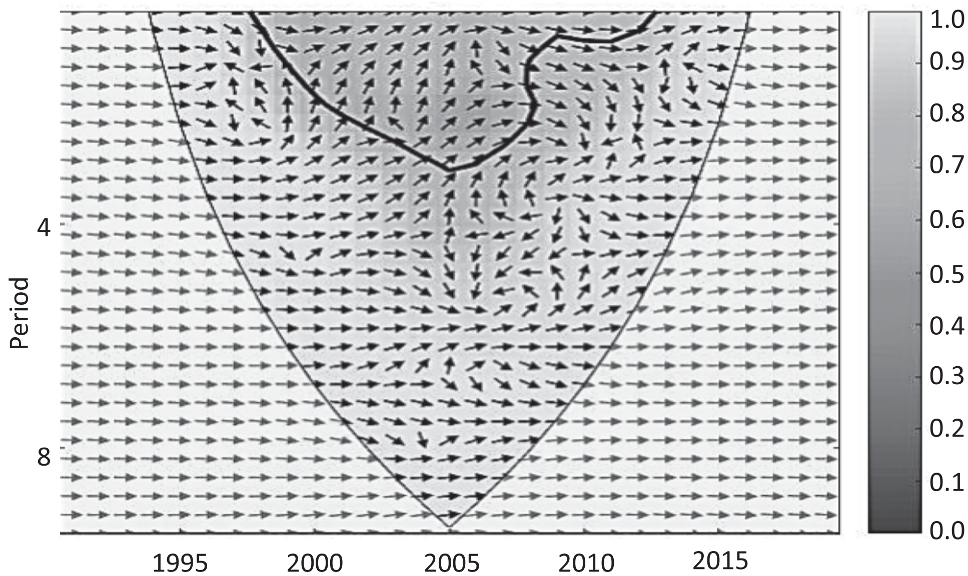


Figure 2
THE CAUSALITY RELATIONSHIP BETWEEN CO_2 EMISSIONS AND GDP IN INDIA

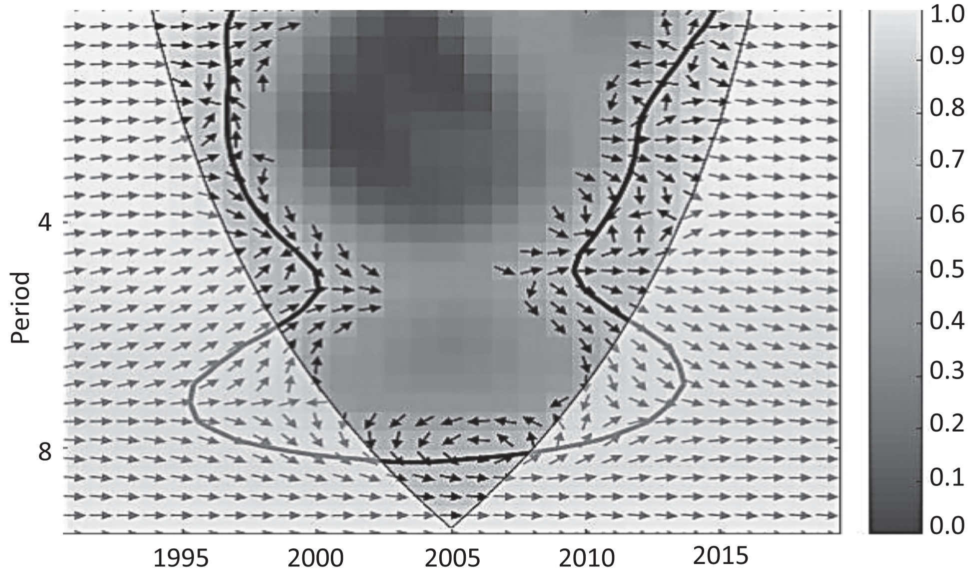


The arrows predominantly point to the right, signifying that growth and emissions are in phase. In other words, as India's economy expands, CO_2 emissions rise correspondingly. This confirms that the prevailing economic model remains firmly entrenched, and that Degrowth, in the Indian context, remains a distant and unlikely prospect.

The Case of the Saudi Arabia: From Figure 3, we observe that, in the case of Saudi Arabia, two distinct dynamics appear to reflect two different realities. The first is indicated within the cone of influence, where the dominant dark grey color suggests that Saudi Arabia's economic model has undergone a profound shift in both logic and structure. This transformation is consistent with the country's forward-looking development strategy, Vision 2030, which seeks to diversify sources of wealth creation and reduce dependence on oil rents. Such a transition is feasible given Saudi Arabia's substantial initial endowments in non-oil natural resources, including geographical and ecological diversity, strong financial reserves, and relative socio-economic stability. If effectively leveraged, these assets could foster the emergence of new, globally competitive service sectors.

The second dynamic appears at the far right of the cone of influence, where the light grey coloration and arrows pointing predominantly to the right—and occasionally downward—indicate, first, a causal relationship between economic growth and CO_2 emissions, and second, that growth is either in phase with emissions or

Figure 3
THE CAUSALITY RELATIONSHIP BETWEEN CO_2 EMISSIONS AND GDP
IN SAUDI ARABIA



leads them. Taken together, the coexistence of these two dynamics suggests that Saudi Arabia is in the midst of a transitional movement toward a more ecological economic model. This transition involves an initial effort to reduce dependence on energy rents by diversifying revenue streams and developing renewable and sustainable energy alternatives. At this stage, it can be cautiously concluded that the Degrowth movement may indeed be feasible in Saudi Arabia in the coming years.

The Cases of Brazil and Mexico: It is worth noting that the cases of Brazil (Figure 4) and Mexico (Figure 5) are examined together due to their strong similarities. In both countries, the influence cones are dominated by the light grey color, reflecting a strong correlation between economic growth and carbon emissions. This finding highlights the continued weight of the traditional economic model, which still appears likely to prevail. In other words, the prospect of Degrowth remains distant in both Brazil and Mexico, as well as across much of Latin America.

For both countries, the arrows predominantly point to the right (with only rare exceptions), indicating that the two variables move in phase and operate simultaneously. Put differently, the prevailing growth model in each country remains heavily reliant on polluting energy sources—economic expansion depends on increased use of non-renewable and environmentally harmful energy. However, despite the dominance of the neoclassical growth model, there are also signals of

Figure 4
THE CAUSALITY RELATIONSHIP BETWEEN CO_2 EMISSIONS AND GDP IN BRAZIL

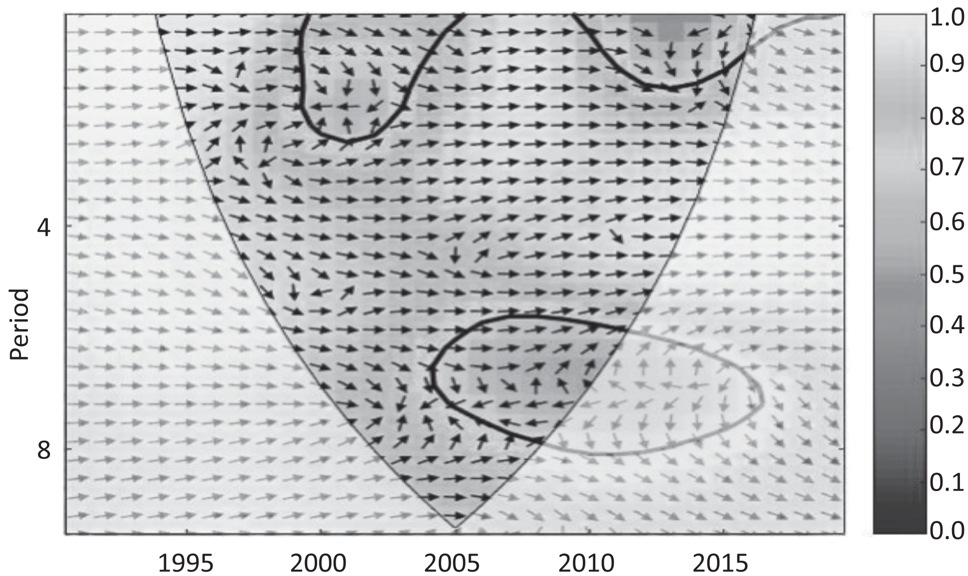
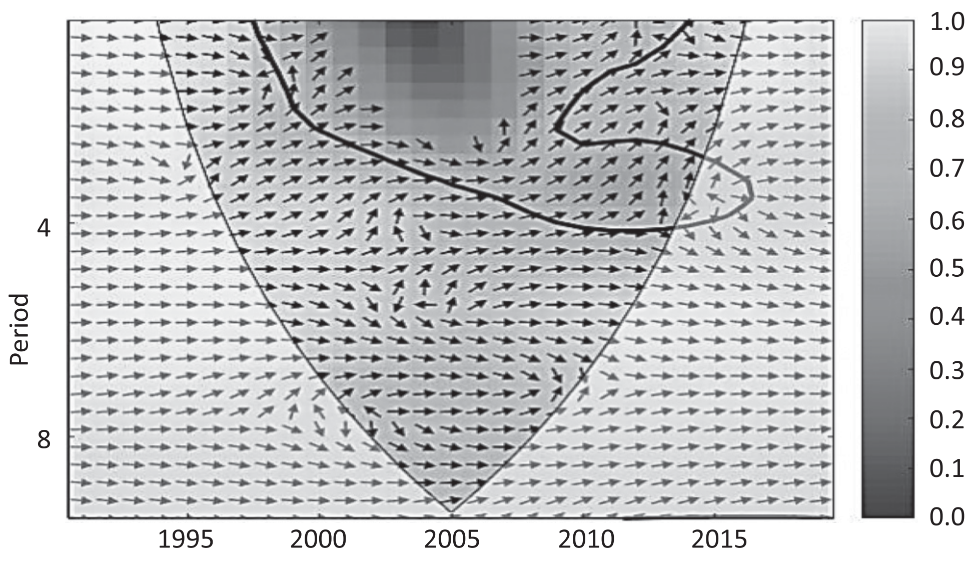


Figure 5
THE CAUSALITY RELATIONSHIP BETWEEN CO_2 EMISSIONS AND GDP IN MEXICO



emerging awareness regarding the need for a long-term transition to a more sustainable framework. This is reflected in the darker grey areas outlined in dark black. In Brazil, three such areas are identifiable, with arrows that lack directional stability, while in Mexico a single, larger, and darker grey area is evident. Taken together, these patterns suggest that Mexico may be somewhat further advanced than Brazil in progressing toward an energy transition.

The Cases of Germany and France: From the graphs, we can conclude that both France (Figure 6) and Germany (Figure 7) are undergoing an energy transition, as indicated by the dominance of dark grey within the cone of influence. This prevalence of darker grey suggests the absence of a strong correlation between carbon emissions and economic growth. Outside the cone of influence, particularly to the right hand side (more recent years), the arrows point leftward, signifying that the variables are not in phase. This indicates that the causal relationship between growth and emissions is not immediate, and that production is no longer entirely dependent on CO_2 output. These findings support the view that a transition toward a Degrowth model is not only possible in these countries but is already in progress.

7. Marginal Productivity of CO_2 Emissions in the Case of G20

To assess the marginal effect of CO_2 emissions on the economic growth of the G20, we estimated a model that stratifies emissions by quartiles. In this approach, the proportions of carbon emissions are successively introduced to evaluate their

Figure 6

THE CAUSALITY RELATIONSHIP BETWEEN CO_2 EMISSIONS AND GDP IN FRANCE

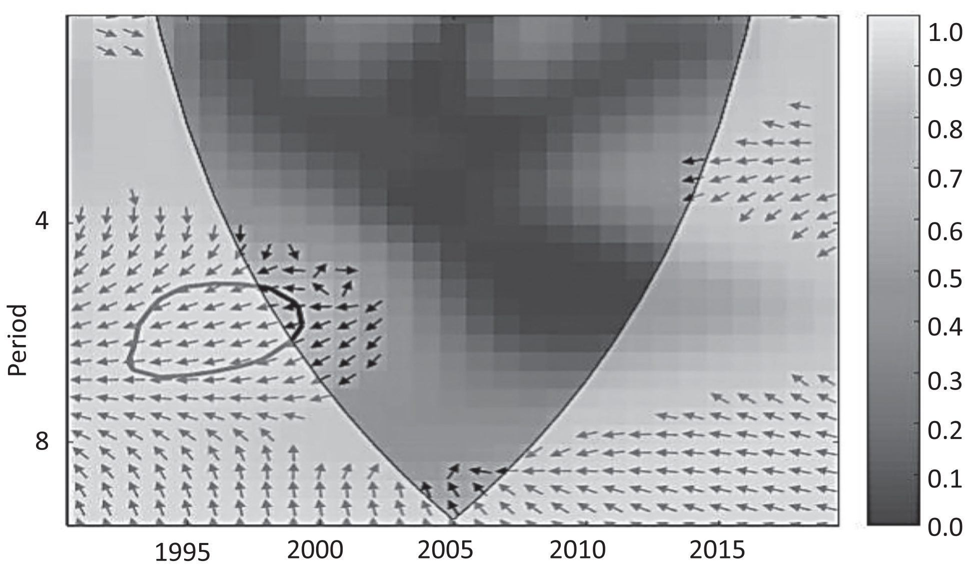
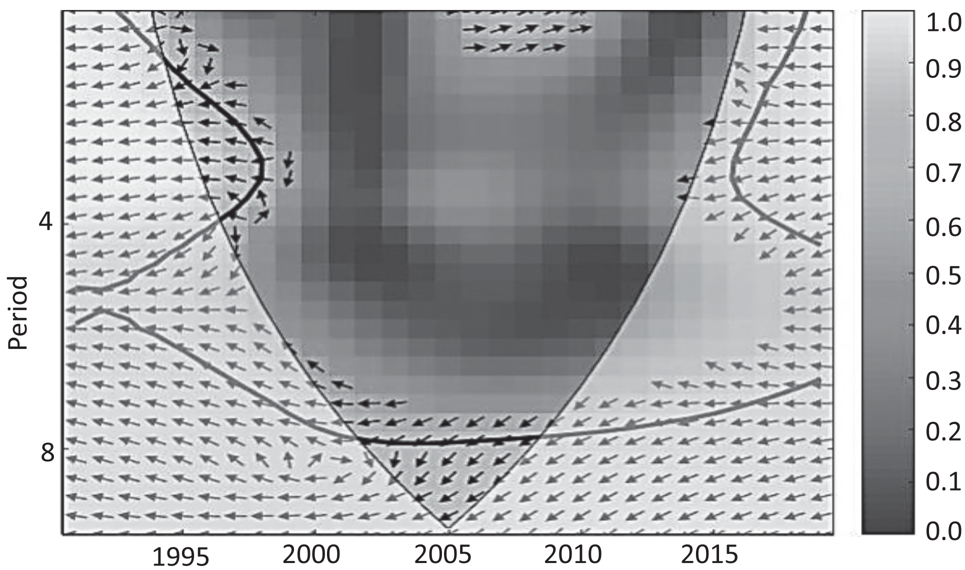


Figure 7
THE CAUSALITY RELATIONSHIP BETWEEN CO_2 EMISSIONS AND GDP IN GERMANY



impact on economic growth. This method makes it possible to identify the marginal effect associated with each decile of CO_2 emissions.

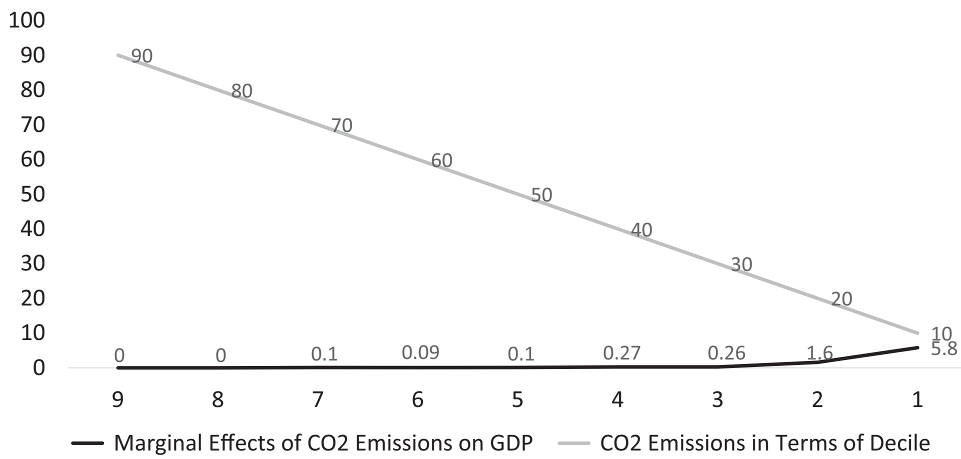
The key insight from Figure 8 is that the marginal productivity of carbon is diminishing, reaching zero when consumption reaches 80% of its total volume. In other words, once carbon use is reduced to 80% of its current level, the countries in our sample achieve their maximum economic growth. The remaining 20% of emissions represent an excess, as the associated environmental costs far exceed their marginal contribution to growth.

To examine how this productivity dynamic has evolved over time within the G20, we turn to Figure 9.

Panel A: 1969–1978: The graphic shows that during this period, the effect of economic growth on pollutant emissions was both positive and significant across all deciles. This pattern reflects the dominance of the prevailing growth model in the G20 during the 1980s—one in which there was little evidence of willingness to reduce pollution.

Panel B: 1979–2008: In this phase, no significant dependence is observed between GDP and CO_2 emissions, suggesting a decline in the marginal productivity of carbon over time. In the earlier post-war period, the neoclassical growth model—anchored in polluting, non-renewable energy sources—had generated high returns as G20 economies rebuilt their infrastructure devastated by World War II.

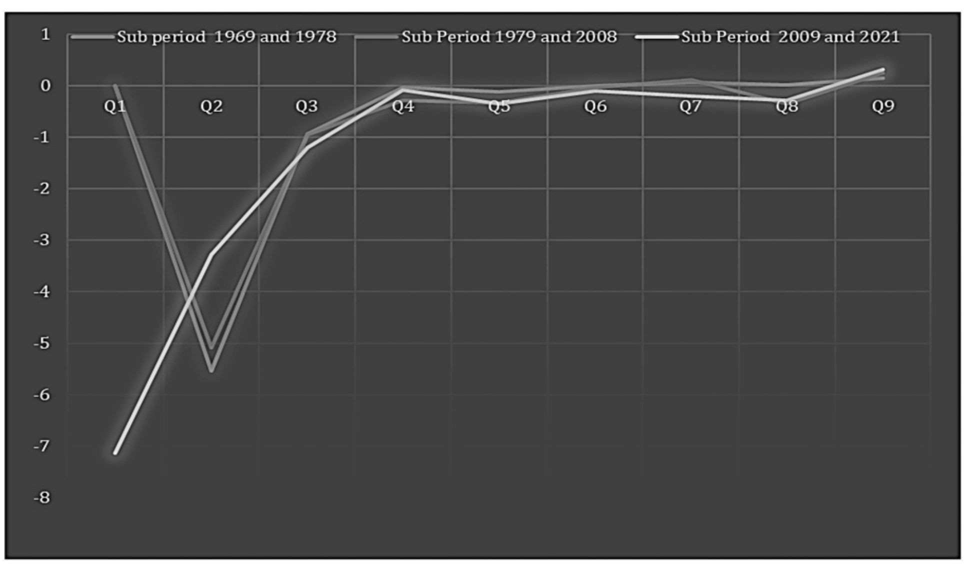
Figure 8
MARGINAL EFFECTS OF CO_2 EMISSIONS ON GDP IN G20



Source: Based on authors' computations.

However, beginning in the late 1970s, the context shifted. The rapid growth achieved during the 1950s and 1960s had already raised living standards and expanded infrastructure, thereby reducing the marginal returns of continued investment during 1979–2008.

Figure 9
MARGINAL EFFECTS OF CO_2 EMISSIONS ON GDP IN G20 BY SUB PERIOD



Panel C: 2009–2021: In the most recent period, a long-term negative causal relationship emerges between CO_2 emissions and economic growth. Although counterintuitive, this finding reflects an important reality: industrialized economies no longer derive growth from pollutant emissions or non-renewable energy. Instead, there is a collective shift toward replacing traditional energy sources with cleaner and more sustainable alternatives, signaling a structural transition in the growth model.

8. Conclusion

The main objective of this study was to assess whether the G20 is moving toward a less polluting, more ecological model of Degrowth. The answer, however, is far from straightforward, as the group is no longer homogeneous and its growth models differ significantly from one country to another.

Using wavelet theory and analyzing the graphs of selected countries, two distinct outcomes emerge. First, in countries facing demographic pressures, high poverty, and inequality—such as India, Mexico, and Brazil—the transition to a new economic model remains difficult, if not currently impossible. The high costs of adopting ecological technologies make their integration into production structures prohibitively expensive, resulting in price increases that could be socially disastrous in low-income contexts, as seen in India.

By contrast, in advanced industrial economies such as France, Germany, and the United States, the transition appears more feasible. Evidence suggests that these countries are already on a trajectory toward Degrowth, with structural changes underway that reduce reliance on polluting and non-renewable energy sources.

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