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Welfare regimes in Asia: convergent or divergent?

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While existing scholarship predominantly focuses on the evolution of welfare regimes in advanced Western economies, there has been limited investigation into the trajectories of such systems in the Asia-Pacific region. This study presents a nuanced analysis of welfare regimes in 20 Asian countries, examining their transformation since the 2000s through principle component analysis and clustering algorithms. Contrary to the predictions of comparative political economy and international political economy theories, the findings reveal that these nations neither exhibit a strict divergence in welfare patterns nor converge strictly towards market-driven commodification. Instead, they adopt a balanced approach, harmonizing elements of both commodification and decommodification. This flexibility allows them to navigate complex challenges, including productivity competition, external shocks, and internal inequality. The study suggests that this balanced approach may act as a positive feedback mechanism, enabling these countries to adapt to both global economic pressures and domestic social imperatives.

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Introduction

In the realm of social policy analysis, the trajectory of the welfare state has predominantly garnered attention within the context of advanced economies. A substantial body of scholarship delves into the intricate evolution of welfare policies in these well-established domains, often interweaving discussions of development strategies with enhanced productivity (Wibbels and Ahlquist, 2011). However, amid the wealth of discourse surrounding the advancement of welfare states in English-speaking and Western European nations, a notable lacuna emerges—a dearth of research illuminating the developmental pathways and potential of welfare states in regions beyond these confines. This gap not only casts a limited purview, primarily focusing on advanced economies but also reflects an underlying presumption within extant studies. This presumption tacitly suggests that countries and regions outside the advanced economic sphere would inevitably mimic the developmental trajectories of their more economically prosperous counterparts or adhere to preconceived theoretical molds.

Bridging our gaze towards the dynamic Asia-Pacific region, a landscape adorned with robust economic dynamism, a curious paradox emerges. While this region has captivated scholarly attention due to its economic vitality, discussions concerning the genesis of welfare states within its boundaries remain conspicuously sparse. Existing analyses, few and far between, tend to be concentrated on a select handful of East Asian nations (Gough, 2001; Holliday, 2000; Kwon, 2009; Powell and Kim, 2014). A sociological lens, ushered by Esping-Andersen's seminal work (1990, 1997), offers a comparative framework to dissect the fabric of social policies. Notably, Esping-Andersen's classification of Western welfare states unfurls a tapestry of diversity, encompassing the Scandinavian model grounded in multifarious welfare principles, the conservative model, and the liberal model. In this landscape, Japan stands as the sole Asian representative in his analysis, its welfare structure characterized as a hybrid system interweaving conservative precepts with liberal residualism. Yet, within this classification, an intriguing observation emerges—the parallel attributes shared between Japan's welfare paradigm and those observed in other newly industrialized East Asian counterparts, such as South Korea and Singapore. This implicit categorization bestows upon East Asian welfare systems an aura of exceptionality, subtly insinuating a divergence from the conventional tenets underpinning the establishment of independent and indigenous welfare frameworks (Esping-Andersen, 1999).

The present study advances a novel proposition concerning the trajectory of welfare regimes in Asian countries within the Asia-Pacific region. Specifically, it suggests that these countries are gravitating towards a balanced approach between commodification and decommodification, contrary to established theories in comparative political economy (CPE) and international political economy (IPE). CPE, as conceptualized by Esping-Andersen (1990) and Hall and Soskice (2001), largely argues for systematic divergence in welfare regimes. On the other hand, IPE theories, as postulated by scholars like Gilpin (2000) and Wibbels (2006), imply an institutional convergence, particularly in the face of market integration trends.

Existing literature has often sidestepped the nuanced challenges confronting the Asia-Pacific nations, such as escalating productivity competition, periodic external economic shocks, and growing internal inequality. Since the 1980s, although global poverty has decreased and inequality between countries has lessened, inequality within nations has intensified (Bourguignon, 2015; Chancel and Piketty, 2021). While the export-oriented growth strategy has led to significant economic progress, lifting millions out of poverty, countries within the Asia-Pacific region face substantial challenges like periodic external shocks and increasing internal inequality.

This study centers on 20 Asia-Pacific nations from Northeast, Southeast, and South Asia, highlighting their incorporation into the international economic system and their consequent role in the global supply chain. Despite the economic dynamism observed in these countries, with Japan, newly industrialized East Asian countries, and more recently China, India, and other South and Southeast Asian countries witnessing significant economic development, scholarly focus has remained confined to economic growth strategy, largely neglecting transformations in welfare regimes. Given the rich tapestry of economic, political, and cultural factors affecting these nations (Akram and Hassan, 2017; Koehler and Chopra, 2014; Holzer, 2000; Nguyen and Chen, 2017; Tang, 1998), an analysis of the evolving welfare state is imperative.

Building on the framework presented by Dreze and Sen (1989), Esping-Andersen (1990), and Rudra (2007) for the classification of commodification and decommodification features, this study examines how the welfare regimes of Asian countries in the Asia-Pacific region have clustered since the 2000s and how these clusters have transformed over time through principle component analysis (PCA) and clustering algorithms. We can observe the forms and their changes from the 2000s (2000–2009) to the 2010s (2010–2019), and find that countries have formed clusters regardless of the type of political regime and the number of clusters has decreased from five to three. This suggests that Asian nations do not conform to the logic of CPE having highly heterogeneous patterns in favor of systematic divergence. Besides, Asian nations also defy the theoretical expectations set forth by IPE, which posits that countries should converge towards commodification features while moving away from decommodification, especially in the context of market integration trends. That is, during the last two decades, these countries have not changed to the form suggested by either CPE or IPE as they have kept a balance between commodification and decommodification features.

In an era of unavoidable competition for productivity, exposure to external shocks, and internal inequality, many Asian countries have actively engaged with the international economic system for their economic upliftment. The findings underscore that these nations are neither strictly adhering to divergence theories as suggested by CPE nor to convergence theories as indicated by IPE. Instead, these nations seem to navigate a nuanced equilibrium between commodification and decommodification strategies. This equilibrium allows countries to be responsive and adaptive, providing them with the policy flexibility needed to navigate the complex and often contradictory demands posed by global economic integration and domestic social imperatives. This study thereby suggests that the myriad internal and external challenges faced by these nations could serve as positive feedback mechanisms that help maintain this balance.

The study consists of the following sections. The section "Theoretical expectations of patterns of welfare regimes in Asia" explains the theoretical expectations of patterns of welfare regimes in Asia. Section "Methodology" discusses the methodological strategy and data. Section "Analysis results" presents the results, classifying the types of welfare regimes in Asian countries and analyzing the changes from the 2000s to the 2010s. The final section concludes with the implications of the study.

Theoretical expectations of patterns of welfare regimes in Asia

Theoretical expectations from comparative political economy. The conceptual terrain of welfare state development is rich and complex, populated by an array of theories and perspectives that

have evolved over time. Particularly, the interplay of structuralist, rationalist, and culturalist lenses has cultivated a robust field of theoretical inquiry. Structuralists focus on macro-level processes like state-building (Rokkan, 1974) and industrialization (Rimlinger, 1971; Wilensky, 1975), probing how these historical phenomena shape welfare state institutions. The rationalist perspective, on the other hand, navigates the strategic dimensions of social policy, exploring how societal actors bargain and strategize their preferences (Iversen and Soskice, 2006; Kwon and Pontusson, 2010; McManus, 2019; Savage, 2018). The culturalist lens situates welfare state development within the fabric of societal values and norms, thus illuminating the social underpinnings of redistribution policies (Arikan and Bloom, 2015; Holzer, 2000; Weyland, 2007; Wilensky, 1981).

Among these perspectives, the seminal work of Esping-Andersen (1990) serves as a crucial framework that integrates elements from diverse theories on comparative welfare regimes. This framework identifies the extent of decommodification—following an initial phase of successful commodification—as a key variable that characterizes welfare regimes in advanced economies. Decommodification refers to a range of public policies and governmental expenditures aimed at insulating individuals from market-induced uncertainties and vulnerabilities (Dreze and Sen, 1989; Esping-Andersen, 1990).

However, Esping-Andersen's framework presents certain limitations that warrant scrutiny. One of the most significant shortcomings is its restricted geographical focus, which predominantly centers on Anglophone and Western European nations. Consequently, this framework serves more as a historical artifact capturing the state of welfare systems as they existed in the 1980s, rather than as a dynamic model applicable to varying socio-political contexts. This narrow focus substantially limits its applicability to other regions that have undergone significant transformations, such as Asia. Rudra (2007) posits a different mechanism for identifying welfare regimes, particularly in economies that are not fully commodified. According to Rudra (2007), the dynamics between commodification and decommodification in institutional arrangements and historical trajectories existing prior to full commodification can serve as determinants of the welfare regime type in latecomers. Given Asia's considerable socio-economic changes since the 1980s, there is a pressing need to revisit and potentially expand Esping-Andersen's framework. Such an expansion would allow for a more nuanced understanding of welfare regimes, particularly in regions that have not been adequately covered by the existing literature.

The early comparative political economy (CPE) literature posits that the welfare state emerges as a corollary to industrialization and economic development (Cutright, 1965; Wilensky, 1975). A plethora of empirical studies (Afonso et al., 2010; Lindert, 1994; Wilensky, 1981) have substantiated a positive association between economic development and social spending, particularly in the pre- and post-war eras. According to this paradigm, nations that achieve a certain level of economic development tend to converge toward a more or less uniform welfare system. It is worth noting that this suggests that the welfare systems of countries that have not reached a stage of a higher level of development would be highly heterogeneous.

The existing literature on comparative welfare regimes frequently discusses the influence of democratic institutions on the formation and trajectory of welfare policies (Cameron, 1978; Devine, 1985; Stephens, 1979; Franzese, 2002; Hicks and Swank, 1992). Esping-Andersen (1985) argues that the mobilization of political power fundamentally impacts welfare outcomes, while others note the strategic interplay between various political factions (Gamm and Kousser, 2021; Herwartz and Bernd, 2014; Kwon and Pontusson, 2010; McManus, 2019; Savage, 2018). Asia presents an intriguing case due to its diversity of political regimes, which range from democratic to authoritarian.

For non-democratic nations, the trajectory of welfare state development is far from straightforward. Empirical evidence suggests that authoritarian regimes in Asia expand welfare policies to facilitate economic development and ensure political stability (Fan and Sun, 2013; Li et al., 2014; Malesky et al., 2011; Guan, 2005; Huang, 2015; London, 2014; Nguyen and Chen, 2017; Rigen and Ngok, 2017), complicating the narrative that welfare state development is solely the purview of democracies.

Theoretical expectations from international political economy. The international political economy (IPE) framework posits that countries embedded within the global economic fabric are likely to adopt neoliberal policies aimed at capital attraction and export promotion (Gilpin, 2000; Rudra, 2002; Sinn, 1997, Wibbels, 2006). This is especially pertinent for Asian governments as latecomers, which are under significant pressure to adopt policies focusing on commodification in order to maintain global competitiveness. Underpinning this trend is the fluidity of modern globalization; the ease with which corporations can relocate and financial assets can shift across borders effectively disarm governments of their taxation capacities over mobile factors.

Within the framework of IPE, as states progressively deregulate trade, abolish capital account restrictions, and harmonize economic development policies, the traditional barriers that are used to delineate the economic policies of individual countries would be eroding. This homogenization of economic policies creates an environment where competition among states is heightened, leading to downward pressure on tax rates. As governments grapple with these diminishing tax revenues, the inevitable result would be a concomitant reduction in social expenditure, including social welfare budgets.

Furthermore, it is important to underscore that there is limited evidence to suggest that countries can achieve significant economic development in isolation from global markets (Gilpin, 2000). Therefore, engagement with the international economic system becomes almost inevitable for nations seeking economic growth and development. This inexorable process of global integration carries its own set of responsibilities and challenges. Among the most pressing of these is the need for the adoption and meticulous implementation of policies aimed at maintaining or enhancing competitiveness in a highly competitive international landscape. In this context, nations often prioritize investments in areas related to commodification, such as mass education and immunization, as a means to boost productivity and maintain international economic competitiveness in the market. As a result, there tends to be a reduced emphasis on—or even a shift away from—features associated with decommodification, which aim to lessen individuals' dependency on market participation by offering social insurance and assistance.

In this respect, it can be argued that latecomers, including those situated in the Asia-Pacific zone, may demonstrate converging welfare systems. These systems are often marked by a decrease in social spending, prioritized focus on commodification, and diminished emphasis on decommodification. Such trends among Asian governments, which emphasize a focus on commodification grounded in laissez-faire principles instead of moving toward decommodification, can be understood as a response to the uniform pressures imposed by the global economic landscape, which necessitates competitive positioning. This convergence could signify a global move towards a certain universal standard of welfare provision, which may be far from heterogeneous welfare regimes based on the distinct institutional, socio-cultural, and historical backgrounds of individual countries.

Dynamic equilibrium in welfare regimes: navigating the theoretical intersections of CPE and IPE. When considering the dual paradigms of CPE and IPE, two distinct yet interconnected scenarios emerge for countries in the Asia-Pacific region. The first scenario, guided by the principles of CPE, posits that these nations may display considerable heterogeneity in their welfare regimes. This variance can be attributed to disparate institutional frameworks and different stages of economic development. The second scenario, rooted in the principles of IPE, suggests a convergence towards commodification-centric models, driven by the imperatives of global economic competitiveness and capital mobility.

Notwithstanding their ostensible incongruities, both CPE and IPE rest upon a common theoretical cornerstone: the plasticity of national welfare regimes in adapting to diverse internal and external configurations. The present study posits that these regimes are not solely shaped by either intranational or international determinants, but rather exist in a fluid equilibrium influenced by both. From an international vantage point, nations in the Asia-Pacific region grapple with substantial competitive pressures stemming from their engagement in a globalized economic framework. Characterized by unfettered capital flows and the unimpeded exchange of goods and services, this framework predisposes countries toward policies that emphasize a commodification-centric approach grounded in laissez-faire tenets. This inclination is largely a strategic response to the demands of international market competitiveness and integration.

On the other hand, the complexity of analyzing welfare regimes in Asian countries is heightened by the dynamic interplay between external and internal factors. This multifaceted interaction complicates a straightforward assessment of welfare models, as countries have to negotiate between the external pressures for commodification-centric measures and the internal imperatives that may call for decommodification measures. The region's embeddedness in the global economy makes it susceptible to recurrent economic crises, thus increasing the vulnerability of its populace (Rodrik, 1998). To mitigate the impact of such external shocks, nations strive to design and implement protective policies that provide some form of economic insulation (Herwartz and Bernd, 2014; Schulze and Ursprung, 1999; Walter, 2010; Yay and Aksoy, 2018). Simultaneously, a surge in intra-national inequality serves as a significant domestic factor influencing the structure and focus of welfare regimes (Meltzer and Richard, 1981). This rising disparity in wealth and resources within countries compels them to reconsider the laissez-faire approach. It catalyzes the integration of decommodification features into existing welfare models, thereby acting as a counterforce to the prevailing trends. Specifically, this internal driver has the potential to act as a moderating force on welfare regimes that otherwise exhibit characteristics such as reduced social spending, a prioritized focus on commodification, and a diminished emphasis on decommodification measures. In essence, rising internal inequalities could prompt states to recalibrate their welfare models, incorporating elements of decommodification to counterbalance the prevailing commodification-centric approaches.

In synthesis, this study proposes a more nuanced understanding that transcends the binary opposition often ascribed to CPE and IPE. It contends that both external and internal dynamics can coalesce to forge a balanced welfare regime, which harmoniously incorporates elements of both commodification and decommodification. This equilibrium allows countries to be responsive and adaptive, providing them with the policy flexibility needed to navigate the complex and often contradictory demands posed by global economic integration and domestic social imperatives. Thus, the present study enriches the existing academic discourse by offering a holistic framework for understanding the construction of welfare regimes in the Asia-Pacific, effectively capturing the interplay between global economic forces and local social conditions.

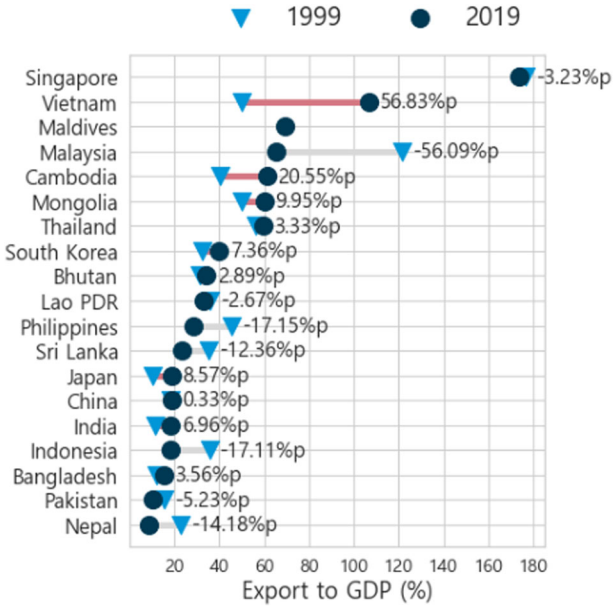

Fig. 1 Export as a percentage of GDP. World Bank (https://data.worldbank.org/).

Multifaceted analysis of Asia-Pacific's diverse economic and political landscape. The limitations of conventional CPE and IPE frameworks emerge when analyzing the complexities of welfare regime paradigms in Asia-Pacific nations. As articulated in this study, a more nuanced comprehension of both external and internal factors is crucial for elucidating the specific features of welfare paradigms in these nations. Such factors provide the policy space for these nations to strike a balance between global economic integration and domestic social imperatives.

The empirical evidence starkly highlights considerable variations in economic metrics across countries in the Asia-Pacific region, with particularly pronounced discrepancies in export-to-GDP ratios and percentages of GDP attributable to Foreign Direct Investment (FDI). As delineated by Figs. 1 and 2, nations such as Singapore and Vietnam boast export-to-GDP ratios that exceed 100%, whereas countries like Pakistan and Nepal trail behind with ratios around 10%. Further disparities in industrial development among these nations are elaborated in Fig. A1 of Appendix A. Complicating this landscape is the divergence in GDP per capita, as showcased in Fig. 3. These variances highlighted by the CPE framework indicate the possible presence of a variety of welfare regime models throughout the region. On the other hand, these data indicate that countries experience varying degrees of engagement with the global economic system. Consequently, these pronounced economic disparities underscore the necessity for a more nuanced comprehension of welfare systems within this economically diverse area.

While much of the existing literature focuses on the welfare systems in democratic regimes (Han, 2022a; Kim, 2015; Peng, 2004; Shim, 2022; Song, 2003), the current study expands the analytical frame to include non-democratic systems as well, as shown in Fig. 4. Over the past three decades, numerous Asian countries have undergone democratization; however, the region continues to exhibit a highly heterogeneous array of political systems. Non-democratic regimes have commonly been

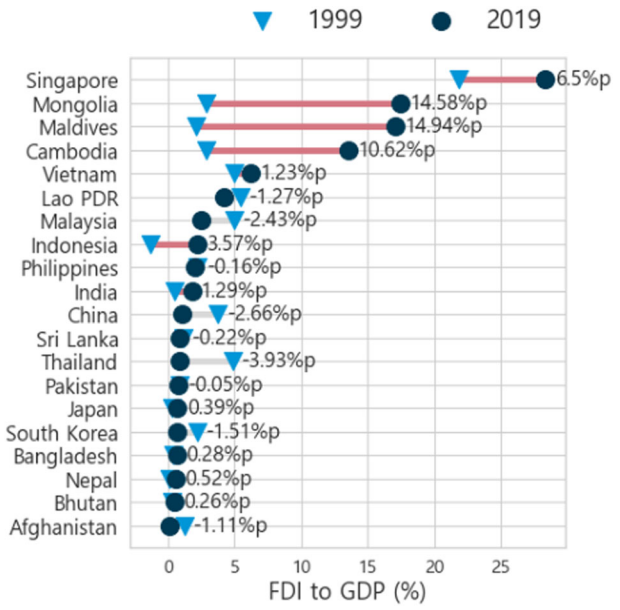

Fig. 2 FDI as a percentage of GDP. World Bank (https://data.worldbank.org/).

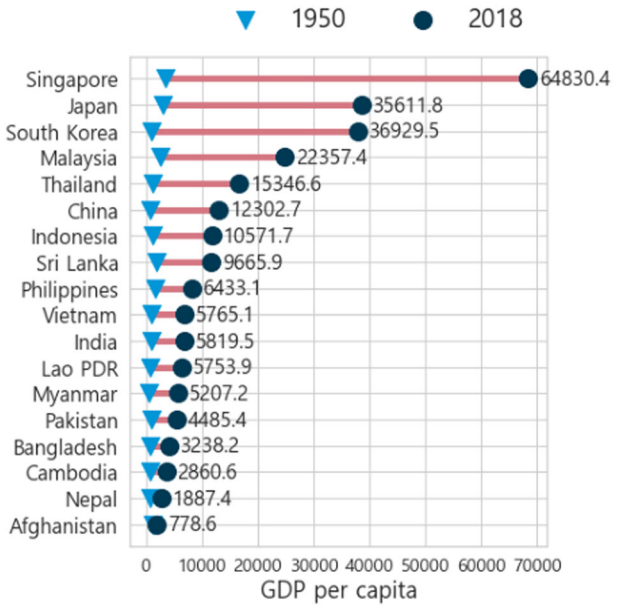

Fig. 3 GDP per capita in Asia (USD). Maddison Project Database (https://www.rug.nl).

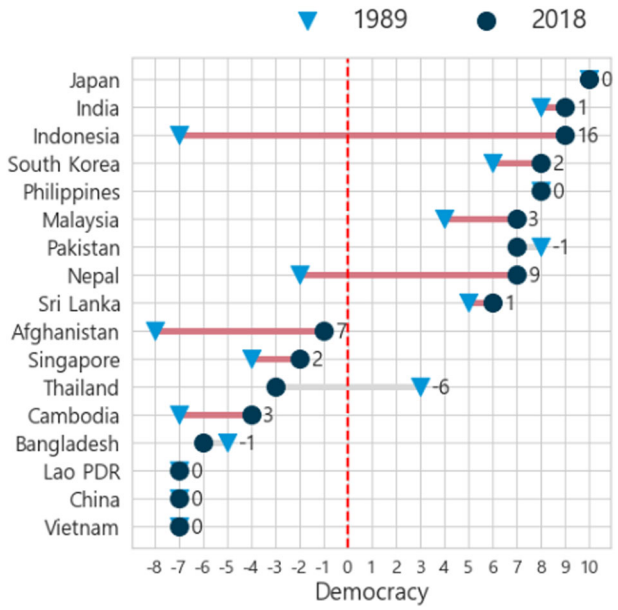

Fig. 4 Political regimes in Asia. Polity IV (http://www.systemicpeace.org).

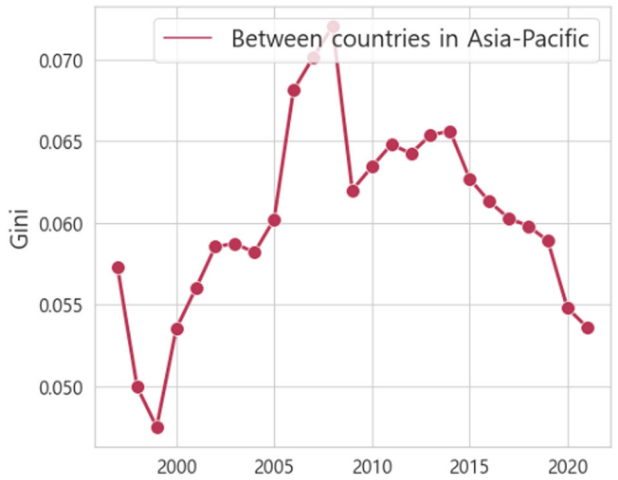

Fig. 5 Inequality between countries. World Bank (https://data.worldbank.org/). Inequality (Gini) between countries based on GDP.

understood as lacking in incentives for welfare expansion, often attributed to an oppressive state apparatus. Contrarily, the literature indicates that authoritarian governments can also utilize welfare programs for economic development and public support maintenance (Fan and Sun, 2013; Huang and Zuo, 2023; Li et al., 2014; Malesky et al., 2011). In this regard, they employ welfare measures as a tool to manage the risks associated with global economic integration (Guan, 2005; Huang, 2015; London, 2014; Nguyen and Chen, 2017; Ringen and Ngok, 2017).

The issue of intra-country inequality further complicates welfare paradigms in the Asia-Pacific region. Global data suggests a narrowing inequality between countries but a rise within countries (Bourguignon, 2015; Chancel and Piketty, 2021; Krugman and Venables, 1995; Milanovic, 2012; Wan et al., 2021). We can find a similar trend in the Asia-Pacific, as visualized in Figs. 5 and 6. The causes of this increasing inequality are multifold and country-specific (Cheong, 2001; Han, 2022b; Kanbur et al., 2014; Kurosaki, 2011; Zhou and Song, 2016), presenting another layer of challenges for nations to balance global economic competition, external shocks, and internal social pressures.

Several nations in East Asia, which includes both Southeast and Northeast Asia—most notably South Korea, Singapore, Indonesia, Malaysia, Thailand, and the Philippines—underwent substantial transformations in their welfare systems in response to external shocks stemming from the 1997 Asian Financial Crisis (Croissant, 2004; Kwon, 2005, 2009; Ramesh and Asher, 2000; Shin, 2000; Song, 2003; Yi and Lee, 2005). In democratic settings, the exacerbation of income inequality has spurred public demands for more equitable welfare distribution, subsequently heightening political pressure to enlarge welfare budgets (Meltzer and Richard, 1981). In hybrid regimes, similar political forces can exert some level of pressure on governments to consider welfare expansion (Weiss, 2014). Countries like China and Vietnam, less affected by the crisis, have also augmented their welfare programs

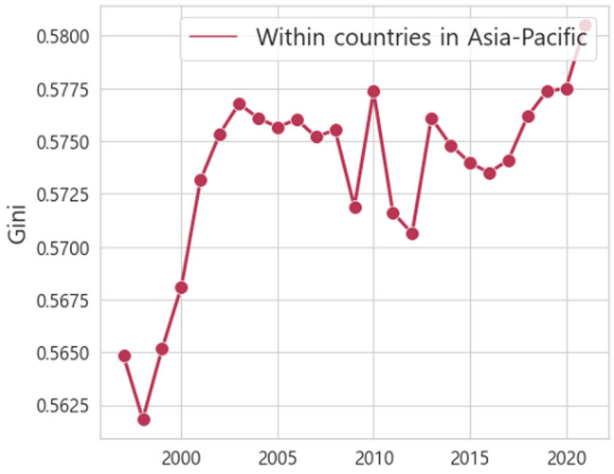

Fig. 6 Inequality within countries. World Inequality Database (https://wid.world/). Inequality within countries is calculated by the average of Gini of countries based on pre-tax income.

Fig. 7 Four steps of empirical analysis.

to mitigate uncertainties arising from global economic integration (Guan, 2005; Huang, 2015; London, 2014; Nguyen and Chen, 2017; Ringen and Ngok, 2017). In these contexts, rising inequality has led to increased public calls for welfare provision, thereby challenging even authoritarian regimes to consider redistributive policies.

Finally, South Asian nations, which are comparatively less globalized (Korwatanasakul, 2015), face unique challenges in welfare expansion. Constraints such as a low share of formal labor and poor tax collection mechanisms limit the governments' capacities to effectively address inequality (Aspalter, 2017; Koehler and Chopra, 2014; Wood and Gough, 2006; Rama et al., 2015). Thus, the multifaceted nature of economic, political, and social dynamics in Asia-Pacific nations necessitates a more nuanced analytical framework for understanding their welfare regimes, one that goes beyond conventional CPE and IPE.

Methodology

This study explains the shape of the welfare regimes through descriptive inference based on data-driven methods to answer the research question. This study classifies welfare regime types of Asian countries and analyzes their changes in the 2000s and 2010 based on a data-driven approach by applying principal component analysis (PCA) algorithm, clustering algorithms, and visualization techniques. The approach in this study considers all aspects of the research questions while enabling visually concise and intuitive interpretation. This study's four-step empirical approach is shown in Fig. 7.

First, the extraction of the implicit characteristics of variables through PCA is not simply data compression; instead, it aims to extract potential factors that can better explain data through dimensionality reduction (Gniazdowski, 2017; Hastie et al., 2009). The strategy of extracting one principal component (PC) from either commodification or decommodification features enables more efficient clustering by removing potential noise resulting from a high correlation between variables. For clustering types of welfare states, Lee and Ku (2007), Minas et al. (2014), Powell and Barrientos (2004), and Sharkh and Gough (2010) pooled expenditure and outcome variables and applied a clustering technique. In these cases, the presence of unnecessary noise in the data means that it is highly unlikely that efficient clustering is achieved. Therefore, it is necessary to create new variables extracting potential factors that can best explain the data. In addition, we can find visually and intuitively interpretable results by reducing multidimensional data through this approach.

Second, clustering techniques are applied using new variables derived through PCA. *K*-means++, the clustering algorithm employed in this study, is a distance-based clustering algorithm that was developed from *K*-means; its core principles are identical except for cluster centroid initialization (Arthur and Vassilvitskii, 2007; Hastie et al., 2009). To ensure robustness, the current study presents results from Hierarchical Clustering, employing the Ward linkage method (Aldenderfer and Blashfield, 1984), and density-based spatial clustering of applications with noise (DBSCAN). Third, based on the clustering results utilizing PCA and *K*-means++, the study evaluates the number of existing clusters and classifies countries accordingly. Lastly, this study analyzes the evolution of these clusters from the 2000s to the 2010s and elucidates the derived findings. Within each methodology subsection, a more in-depth exploration of the particular strategy utilized will be provided.

Principal component analysis. To explore the clustering of Asian countries based on commodification and decommodification attributes, this study implements principal component analysis (PCA) prior to the clustering analysis. PCA is designed to condense the existing data dimensions into those that most aptly capture the inherent characteristics of the data. The analysis draws on data spanning from 2010 to 2019, encapsulating welfare regime traits inclusive of both expenditure and outcome. Relying solely on expenditure or outcome variables may not depict the genuine welfare regime attributes and country commitments accurately (Nelson, 1999; World Bank, 1990). Conversely, employing all these variables concurrently could introduce significant noise due to potential high inter-variable correlations. To address this concern, the study employs PCA. For instance, when considering variables representative of commodification attributes, expenditure variables related to health and education exist alongside outcome variables like literacy rates and immunization rates; this makes a substantial correlation between these variables probable. Hence, it becomes imperative to discern latent factors using PCA.

PCA finds the axis of data with the highest variance and reduces the dimensions to the axis, which becomes the PC. When PCA is interpreted in terms of linear algebra, the covariance matrix of the data is decomposed into eigenvalues, and the data is linearly transformed into the obtained eigenvector in this process. This eigenvector is a PC vector that indicates the direction in which the data dispersion is large. If the covariance matrix of the data is defined as C, the characteristics of the covariance matrix can be simply defined as follows (Gniazdowski, 2017):

$$C = P\sum P^{\mathrm{T}} \tag{1}$$

Here, P is an orthogonal matrix of $n \times n$; $\sum$ is a square matrix of $n \times n$; and P^{T} is a transpose matrix of the matrix P. The above equation corresponds to the eigenvector matrix and the eigenvalue matrix, shown as follows:

$$C = \left[e_1 \cdot \cdot e_n\right] \begin{bmatrix} \lambda_1 & \dots & 0 \\ \dots & \dots & \dots \\ 0 & \dots & \lambda_n \end{bmatrix} \begin{bmatrix} e_1^t \\ \dots \\ e_n^t \end{bmatrix} \tag{2}$$

In other words, the covariance C is decomposed into "eigenvector orthogonal matrix × eigenvalue square matrix × transpose matrix of eigenvector orthogonal matrix"; e_i denotes

the *i*th eigenvector; λ_i denotes the size of the *i*th eigenvector; e_1 is an eigenvector with the largest variance direction; and e_2 is an eigenvector perpendicular to e_1 with the second-largest variance direction. In summary, the covariance matrix of the data can be decomposed into eigenvectors and eigenvalues; PCA is the algorithm that linearly transforms data via the decomposed eigenvectors.

Clustering algorithms. *K*-means++, the canonical clustering algorithm in this study, is a distance-based clustering algorithm that is developed from *K*-means; its core principles are identical, except for cluster centroid initialization (Arthur and Vassilvitskii, 2007; Hastie et al., 2009). *K*-means is considered to be an unsupervised learning method; it selects a cluster centroid and then the data closest to the centroid based on the Euclidean distance (Hastie et al., 2009; Murphy, 2012). *K*-means performs a clustering process by placing random centroids, whereas *K*-means++ does not start by placing *K* centroids in an arbitrary space, but rather, randomly selects one of the data points, which becomes the first centroid. A data point placed as far away from the already designated centroid as possible is designated as the next centroid. This process is repeated until there are *K* centroids. Except for this initial process, the rest of the clustering process is the same as the process of *K*-means.

Hierarchical clustering begins from each data point and combines similar points simultaneously to form hierarchical clusters. In agglomerative hierarchical clustering, the data are grouped recursively to build hierarchies from the bottom up (Murtagh and Contreras, 2011). Compared to *K*-means++, a distance-based approach, the Ward linkage method is applied in hierarchical clustering (Aldenderfer and Blashfield, 1984), merging clusters based on the within-group sum of squares. Unlike *K*-means++, the clustering algorithm can learn without predetermining the number of clusters, *K*, and can analyze clustering results by utilizing a dendrogram, a tree-shaped structure that indicates the order in which objects are combined. Finally, DBSCAN, a density-based clustering algorithm, is applied (Grubesic et al., 2014; Hennig, 2015; Johnstone et al., 2019). The data points located within a specific epsilon are clustered without determining *K* in advance. In terms of the corresponding algorithm, clustering is performed by changing the epsilon size, which is the radius of the core points, and the corresponding minimum number of data points (including themselves).

In this study, the Silhouette Score is employed to determine the optimal value of *K* for *K*-means++ clustering, as suggested by Kaufman and Rousseeuw (1990). Efficient clustering is characterized by significant distances between distinct clusters while ensuring proximity among data points within the same cluster. The silhouette plot offers a visually concise method for assessing parameters such as cluster count. It depicts the degree of proximity of each data point in one cluster to those in neighboring clusters. The silhouette score, which ranges between −1 and 1, acts as a benchmark for cluster quality. A score nearing 1 implies that the data point aligns well with its cluster and is distinct from others. A higher score is indicative of a fitting clustering configuration. On the other hand, a prevalence of low or negative scores can signal an inadequate clustering setup, possibly suggesting an incorrect number of clusters.

Data. In the present study, the framework for classifying commodification and decommodification features draws upon theoretical underpinnings presented by Dreze and Sen (1989), Esping-Andersen (1997), and Rudra (2007). For data collection, this study refers to a series of pertinent studies, including Powell and Barrientos (2004), Rudra and Haggard (2005), Scruggs and Allan (2006), and Sharkh and Gough (2010).

Firstly, the variables used to assess commodification encompass a diverse range of public expenditures and outcomes, which are primarily geared towards augmenting individuals' foundational skills to enhance their competitiveness within the labor market. These variables include public spending on education and healthcare, literacy rates, life expectancy, and immunization rates, all of which are sourced from the World Bank's World Development Indicators (Rudra, 2007; Rudra and Haggard, 2005). Additionally, this study incorporates a gender equality measure from the Human Development Index by the United Nations Development Programme (UNDP) to assess the advancement of women's basic capabilities.

Secondly, the variables selected to operationalize decommodification aim to encompass a diverse array of policies and governmental expenditures that are intended to alleviate the uncertainties and risks that individuals encounter in the market economy (Dreze and Sen, 1989; Esping-Andersen, 1990). These variables are indicative of decommodification measures, including social insurance mechanisms such as pensions, healthcare, and unemployment insurance, as well as other forms of social assistance like cash benefits and in-kind support (Rudra, 2007). The data for these variables are derived from the Asian Development Bank's Social Protection Indicator.

While health-related expenditures could potentially be considered as contributing to decommodification, it is important to clarify that the scope of decommodification in this analysis extends to include specific elements of health insurance and health assistance, as elaborated in Appendix A. In order to maintain analytical rigor and prevent redundancy, expenditures related to general healthcare have been deliberately excluded from the decommodification category. This methodological choice aligns with existing scholarly work, such as that by Rudra (2007), and serves to maintain focus on social insurance and social assistance as more directly indicative measures of decommodifying activities. Additionally, to provide a more comprehensive analytical framework, the number of International Labour Organization (ILO) conventions ratified by each country has been included as a variable. For a complete list of variables considered in this study, please refer to Appendix A.

Lastly, it is pivotal to acknowledge that commodification and decommodification, while conceptually different, are not mutually exclusive. In fact, they may encompass overlapping variables influenced by varying objectives (Dreze and Sen, 1989). As an illustration, labor market programs from the Asian Development Bank's Social Protection Indicator included in this study operate at the intersection of both commodification and decommodification (refer to Table A1 in Appendix A). These programs manifest as state expenditures targeted towards commodification, while simultaneously working to protect workers through public policy interventions like skill development, training, and employment. As shown in Table 1, this study targeted 20 Asian countries of the Asia-Pacific region located in the following three regions: (1) South Asia, (2) Southeast Asia, and (3) Northeast Asia. Some countries (Myanmar (or Burma) and Brunei Darussalam) within the three regions were excluded because data was unavailable.

Analysis results

The PCA results of the commodification and decommodification variables are shown in Fig. 8. The correlations of commodification and decommodification variables with both expenditure and outcome variables can be found in Figs. B1 and B2 in Appendix B. In these figures, the variables show fairly strong correlations,

Table 1 List of countries.

	Regions	Countries	Number
1	South Asia	Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka	8
2	Southeast Asia	Cambodia, Indonesia, Lao PDR, Malaysia, Philippines, Singapore, Thailand, Vietnam	8
3	Northeast Asia	China, Japan, South Korea, Mongolia	4

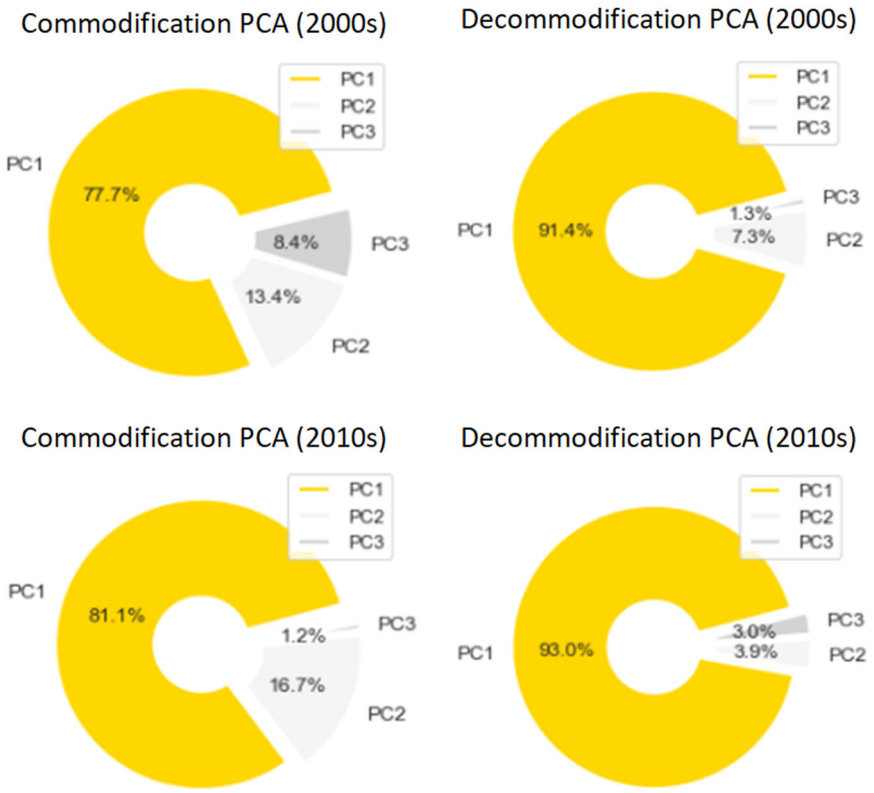

Fig. 8 PCA results.

along with the possibility of much corresponding noise. Variables with high correlations can naturally indicate the variability of these variables, through only a small number of PCs, as follows.

The PCA application aims to reduce the variables into two dimensions, commodification or decommodification PC1, which reflects essential characteristics of the data, can be considered to sufficiently reflect the characteristics of data. Seeing Fig. 8, PC1 in Commofication PCA (2000s) is a new variable that explains 77.7% of the data distribution alone. PC1 explains 91.4% of the data distribution in Decommofication PCA (2000s), 81.1% in Commofication PCA (2010s), and 93% in Decommofication PCA (2010s). Each PC1, a new variable extracted through dimensionality reduction, explains around 80% or more of the data distribution (see Figs. B3 and B4 in Appendix B for PCA results).

The clustering results are analyzed in the following three steps: (1) the evaluation of how many clusters exist; (2) the classification of countries into clusters; (3) the analysis of how the clusters changed over two decades, from the 2000s to the 2010s. The first important step is to confirm the number of clusters in the clustering results of the algorithms. First, in the 2000s, as shown in Fig. 9, in the case of *K*-means++, when countries are clustered into five groups (0.693), the Silhouette score was the largest, compared to *K*, from six (0.569), four (0.651), three (0.661) to two (0.677). Accordingly, Asian countries in the 2000s can be optimally classified into five clusters, as shown in Table 2. Cluster 0 includes 10 countries, including all Northeast Asian countries, four Southeast Asian countries (Malaysia, Singapore, Thailand, and Vietnam), and two South Asian countries (Maldives and Sri Lanka). This cluster is closest to the protective welfare regime type (see Fig. 10). Cluster 3 includes two South Asian countries, Afghanistan and India, and the cluster is closest to the commodification features. The remaining clusters lie between Clusters 0 and 3.

In the 2010s, as illustrated in Fig. 9, *K*-means++ with three clusters ($K = 3$) had the highest Silhouette Score of 0.663. As *K* increases from four (0.627), five (0.597) to six (0.548), the Silhouette Scores gradually decrease. Thus, Asian countries in the 2010s can be optimally classified into three clusters, as shown in Table 3. List of countries in Cluster 1 of the 2010s is the same as Cluster 0 of the clustering result in the 2000s. Cluster 0 includes several countries in Southeast Asia and South Asia, and it lies between the other two clusters. Cluster 2 is closest to the commodification features, including Afghanistan and Pakistan in South Asia (see Fig. 10).

At the outset, it is paramount to unpack the evolving trajectories of cluster composition, as well as the emerging patterns highlighted within this study's dataset. Notably, Fig. 10 portrays a notable reduction in the optimal clusters from five in the 2000s to merely three in the subsequent decade. This suggests an ongoing consolidation, wherein previously discrete clusters are converging into more extensive, unified entities. For illustrative purposes, Cluster 1 presents an eclectic mix of political regimes: from

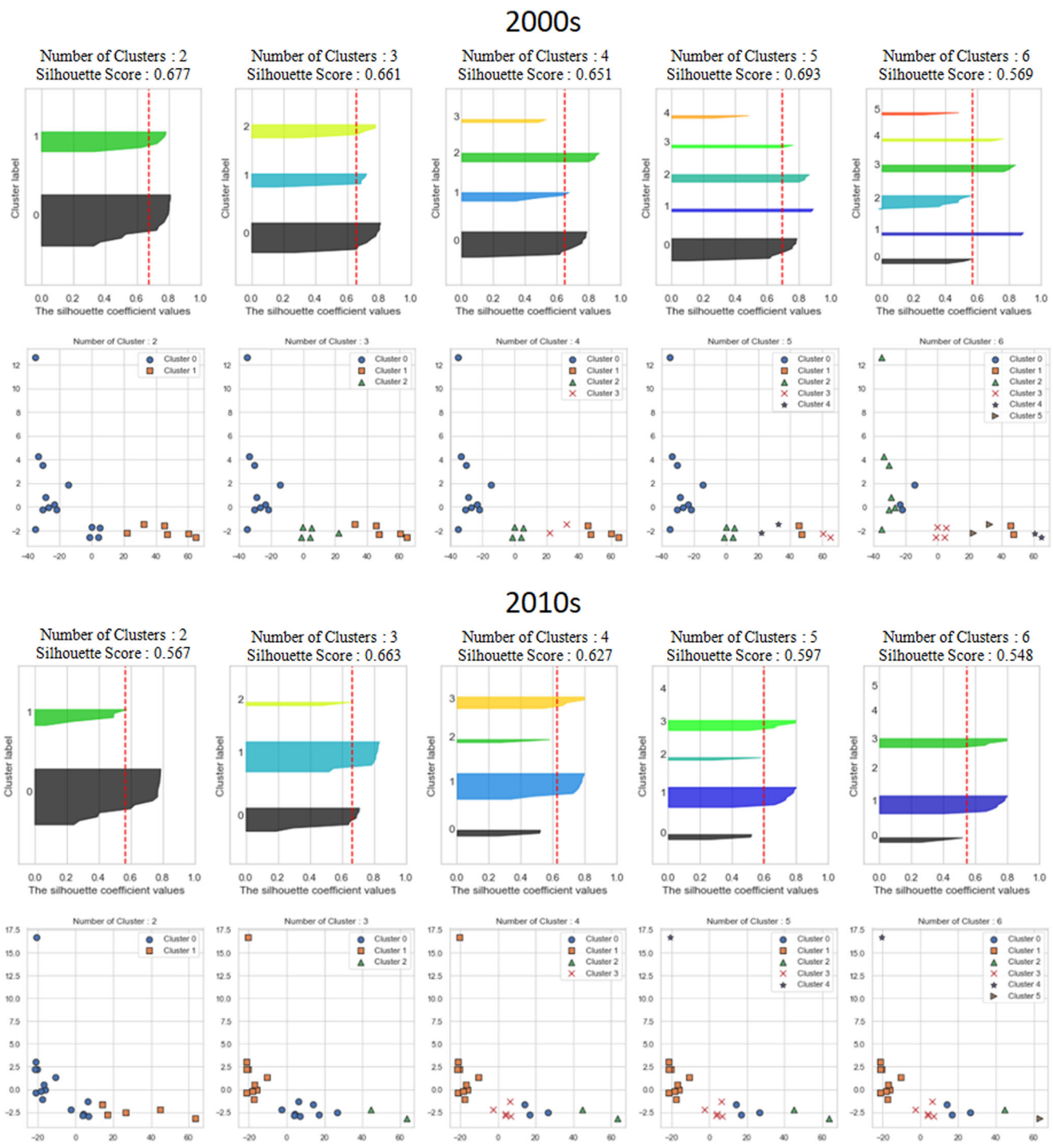

Fig. 9 *K*-means++ clustering results.

Table 2 Clustering results (2000s).

Cluster 0		Cluster 1	Cluster 2	Cluster 3	Cluster 4
China	Singapore	Lao PDR	Bhutan	Afghanistan	Bangladesh
Japan	S. Korea	Pakistan	Cambodia	India	Nepal
Malaysia	Sri Lanka		Indonesia		
Maldives	Thailand		Philippines		
Mongolia	Vietnam				

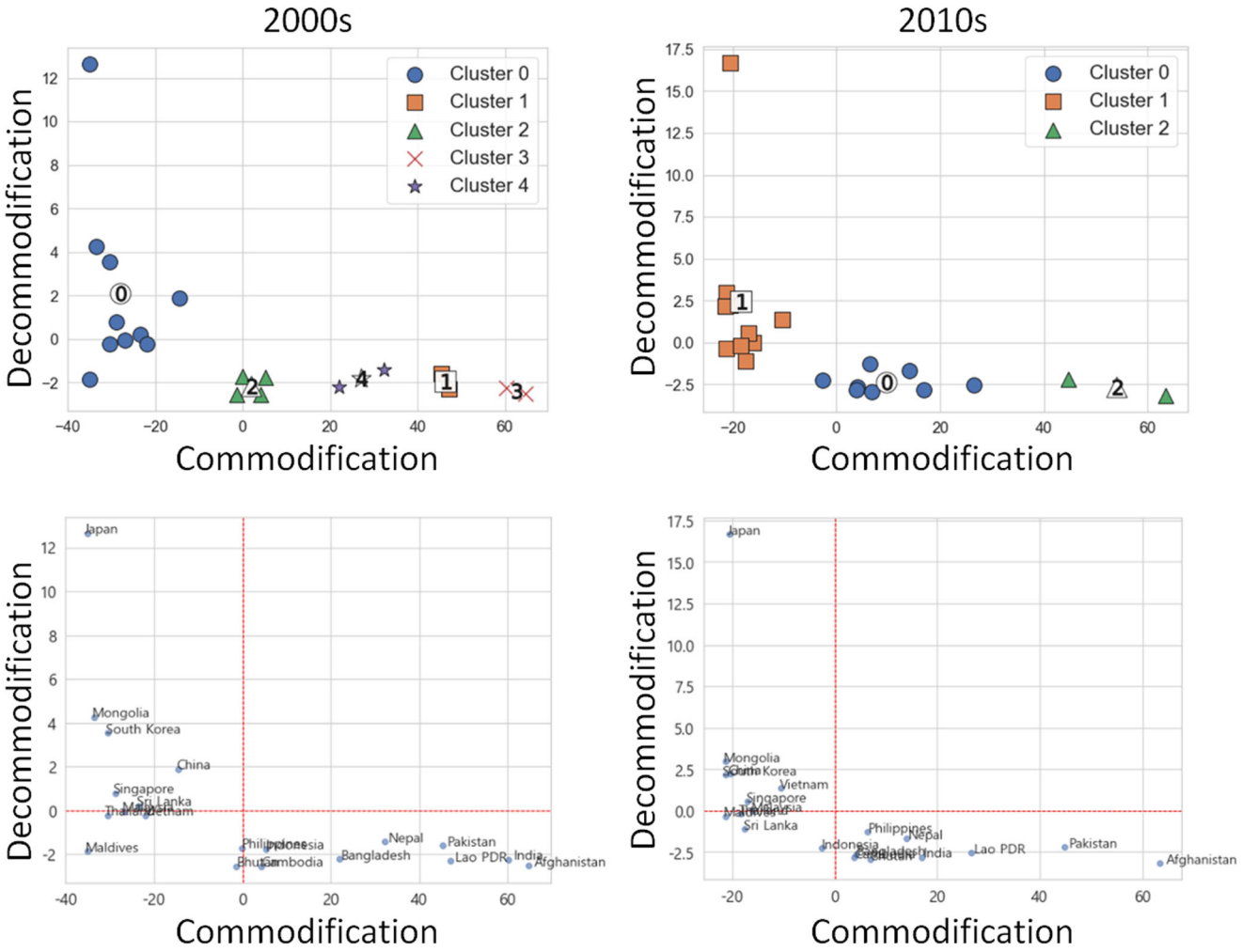

Fig. 10 Optimal clustering results based on the highest Silhouette Score from 2000s to 2010s.

Table 3 Clustering results (2010s).

Cluster 0		Cluster 1		Cluster 2
Bangladesh	Indonesia	China	Singapore	Afghanistan
Bhutan	Lao PDR	Japan	S. Korea	Pakistan
Cambodia	Nepal	Malaysia	Sri Lanka	
India	Philippines	Maldives	Thailand	
		Mongolia	Vietnam	

staunchly authoritarian states like China and Vietnam to the more hybridized systems evident in Singapore and Malaysia, and extending even to democracies such as South Korea and Japan. In a parallel vein, Cluster 0 is emblematic of an intricate blend of diverse political architectures.

Crucially, it appears that the shared attributes among nations within these clusters may not predominantly stem from analogous political governance structures or institutional resemblances. Instead, it is plausible that these similarities manifest due to these nations' shared journeys in grappling with analogous external and internal challenges. Such shared adversities might birth policy initiatives that, even in the face of varied governance models, demonstrate significant overlap. Historical analysis over the past twenty years underscores that nations within these clusters seem to seek a middle ground between commodification and decommodification paradigms. This observable equilibrium challenges some entrenched academic theories that either anticipate a significant tilt towards one paradigm or foresee the sprouting of sharply contrasting clusters. To elaborate, the reduction in cluster count from five to three contests the prevailing narrative suggesting that Asian nations are gravitating towards pronounced diversity, largely premised on the systematic inclination towards CPE. On the flip side, the dearth of evidence indicating a marked drift from decommodification, juxtaposed against the absence of a significant inclination towards commodification, challenges conventional wisdom rooted in the tenets of IPE.

It is pertinent to emphasize, in keeping with CPE tenets, that despite the overarching trends, the individualistic institutional and economic contours of each nation remain salient, giving rise to the observed three distinct clusters. However, a discernible absence of systematic divergent patterns over the course of two decades is evident. The implication here is that countries, while influenced by external and internal determinants, are maneuvering based on their intrinsic strengths and challenges, endeavoring for an equipoise between commodification and decommodification. This nuanced comprehension stands in sharp contrast to traditional theoretical models, which posit either a homogenizing convergence or stark divergence. Instead, the data suggests that nations are charting a balanced trajectory, in tune with both external exigencies and internal imperatives.

To reiterate, Asian nations have grouped into clusters irrespective of their political regimes, and the overall number of such clusters has diminished over the past two decades, which contradicts the expectation of systematic divergent forms. Notably,

there is no observed pattern of convergence towards either commodification or decommodification features. This suggests that these countries are gravitating toward welfare regimes that strike a balance between commodification and decommodification, thereby defying the conventional theoretical expectations posited by both IPE and CPE.

It should be emphasized that belonging to the same cluster does not necessarily imply an equal provision of welfare services. The variables associated with decommodification features are expressed as a percentage of a country's economy. In essence, this characteristic indicates the extent of a country's commitment to welfare services relative to the overall size of its economy, rather than the absolute magnitude of spending. For instance, the fact that Japan and Mongolia are in the same cluster does not imply that they allocate similar financial resources to welfare services. It signifies that they exhibit a comparable level of commitment given their respective stages of economic development, when compared to countries in other clusters. That is, the similarity in cluster assignment does not imply uniformity in the level of welfare services provided by countries within the same cluster due to their differing economic sizes. Rather, it signifies a similar directionality in their commitment to welfare services at their respective levels, in contrast to countries in other clusters. The aim of clustering analysis is to examine how countries are positioned with respect to commodification and decommodification features, as discussed earlier in the context of this study. It seeks to identify clusters of countries based on their proximity to each other in terms of these features, rather than considering their absolute sizes.

To enhance the robustness of the findings, results from both hierarchical clustering and density-based spatial clustering of applications with noise (DBSCAN) have been included in Appendix C. In hierarchical clustering, the *y*-axis serves to quantify the closeness between either individual data points or between clusters. Based on the data at point 85 on the *y*-axis, Fig. C1 illustrates that in the 2010s, clusters were positioned at a lower hierarchical level compared to those in the 2000s. Additionally, all data points converge into a single cluster at a lower hierarchical level in the 2010s, signifying a tighter interconnection between clusters during this period.

The DBSCAN analysis supports this observation. When holding the epsilon value constant, there are fewer clusters in the 2010s compared to the 2000s. Notably, when the epsilon value was set to 15 in the 2010s, all entities formed a single, unified cluster—a phenomenon not observed in the 2000s (as shown in Fig. C2). This suggests a higher density of connections between clusters in the 2010s. Therefore, the data reveals that from the 2000s to the 2010s, the number of clusters formed by countries has decreased without evolving into highly heterogeneous forms.

In summary, the scholarly discourse across various disciplines has acknowledged the intrinsic and instrumental values of both commodification and decommodification in social legislation (Esping-Andersen, 1990; Dreze and Sen, 1989). Against this backdrop, the pivotal question arises: What is the trade-off between commodification and decommodification efforts among Asian countries in the Asia-Pacific region? Statistical analyses indicate that these clusters of countries have neither converged on commodification nor decommodification, nor exhibited noticeable patterns of heterogeneity. Independent of political regime types, countries have grouped into fewer clusters over time, decreasing from five to three.

Such findings challenge existing theoretical frameworks. Specifically, Asian nations neither adhere to the logic of CPE, which would predict highly heterogeneous divergence patterns nor do they align with the expectations of IPE concerning institutional convergence and market integration. In other words, over the past two decades, these countries have not evolved in a manner prescribed by the prevailing logic of either IPE or CPE.

In the pursuit of global competitiveness, countries frequently gravitate toward policies that emphasize commodification at the expense of decommodification. This tilt reflects the prevalent belief in the advantages of market-oriented reforms and deregulation, often sidelining the importance of social safety nets and other decommodifying measures. However, this integration into the international economic system is not without its pitfalls; it frequently produces external shocks that can render the citizens of participating countries vulnerable. Furthermore, while intercountry economic disparity in the Asia-Pacific region appears to be diminishing, inequality within individual nations is escalating. Consequently, it becomes imperative for these countries to strike a balanced approach between commodification and decommodification features, regardless of their political regime types. Such a balanced approach is particularly vital once these nations are firmly entrenched in the global economic network, as it enables them to better manage the vulnerabilities and challenges that arise from both internal and external sources. This equilibrium is not merely a static state but an adaptive response to both internal and external challenges. Such a balance fosters positive feedback mechanisms that sustain this state of equilibrium over time. As a result, Asian nations may form clusters that deviate from both extant theoretical paradigms and the historical trajectories observed in European nations.

Conclusions

The present study undertakes a nuanced analysis of the evolving welfare regimes in Asian countries within the Asia-Pacific region, emphasizing their dynamic clustering and transformations since the early 2000s. While there is an extensive body of research focused on Western welfare states, the Asia-Pacific region—despite its burgeoning economic significance—has been relatively underexamined in scholarly discourse. This study aims to address this gap, thereby enriching the broader understanding of the development trajectories of welfare states in the contemporary era.

The statistical analyses offer several key insights. Firstly, we can find that welfare regimes in Asian countries form clusters that are not strictly bound by the political system in place. Interestingly, the number of these clusters has decreased from five to three over the investigated period. These findings call into question the theoretical frameworks commonly advanced by CPE and IPE. Specifically, the results suggest that Asian nations do not strictly adhere to models of either extreme divergence or convergence in terms of commodification and decommodification.

Instead, in the context of the Varieties of Capitalism (VoC) framework, these countries appear to be navigating a nuanced equilibrium between commodification and decommodification. This nuanced balancing act reflects a complex interplay of capitalist norms and welfare strategies, allowing these nations to adapt and respond to both global economic imperatives and domestic social obligations. This state of dynamic equilibrium affords countries the policy flexibility essential for harmonizing the often conflicting demands of global economic integration with domestic welfare objectives. Therefore, the present study underscores the need to move beyond rigid categorizations to better comprehend the adaptive and fluid nature of welfare regimes in the context of diverse capitalist systems.

However, the present study acknowledges several limitations, including data constraints. For the study of decommodification through social insurance and social assistance measures, data were obtained from the Asian Development Bank's repositories. Information pertaining to commodification was sourced from

multiple international organizations, including the World Bank, the Asian Development Bank, and the United Nations Development Programme. It is worth noting that a more comprehensive analysis would necessitate a broader and longitudinal data set, which is currently constrained by limited access. Despite these inherent data limitations, the risk of working with less-than-perfect data is offset by the unique contribution this study makes to existing research. It serves as an initial exploration that holds the promise of guiding more comprehensive future studies. By attempting to analyze welfare regimes in these less-studied countries, this study not only contributes new insights to the field but also paves the way for subsequent research. These limitations could even serve as starting points for future academic discussions, potentially inspiring more targeted data collection efforts and focused investigations in these under-studied areas.

Moreover, this study encounters methodological limitations in the selection of clustering algorithms and the determination of optimal numbers of clusters (Ahlquist and Breunig, 2012; Foneseca, 2013; Hennig, 2015; Han, 2022c; Venables and Ripley, 2002). Although the study mitigates some of these through the use of PCA and multiple clustering algorithms (Roma et al., 2021; Zelasky et al., 2023), it recognizes these as areas for improvement and further research. Additionally, this study proceeds under the presumption of a positive association between inequality and the expansion of welfare budgets. However, it is important to acknowledge that this assumption is not universally supported in empirical literature. Notable counterexamples include the works of Moene and Wallerstein (2001) and Han (2022a), which challenge the purported positive association between these variables.

Besides, this study does not fully elucidate the reasons behind shifts in the welfare regime in certain countries. For example, this study underscores Japan and Afghanistan as illustrative outliers. Japan demonstrates a pronounced leaning toward decommodification features, whereas Afghanistan manifests tendencies considerably removed from paradigms of nuanced equilibrium. Specifically, Japan's relative socioeconomic advancement, when juxtaposed with other later-developing Asian nations, might elucidate the observable disparities in characteristics, even within analogous clusters (Hall and Soskies, 2001; Powell et al., 2020). Conversely, the welfare regime features of Afghanistan can largely be attributed to its constrained integration into the global economic fabric, a result of persistent conflicts since 2001. Moreover, its protracted state of strife may have culminated in the establishment of less effective and oftentimes incapacitated institutions, rendering the provision of welfare services challenging. Such complexities present fertile grounds for more in-depth investigation in subsequent research endeavors.

Despite these constraints, this study stands as a pioneering effort, consolidating available data from a diverse range of Asian countries, from the least developed, developing to more developed nations. It identifies and illuminates patterns of clustering and their transformations, contributing both to academic discourse and practical policy implications. Policymakers and practitioners designing and implementing welfare programs in the Asia-Pacific region could find the insights valuable for more targeted and effective interventions.

In conclusion, this study enriches our understanding of the development of welfare states in the Asia-Pacific region, offering a nuanced view that challenges conventional theories. While it serves as an initial framework for more in-depth investigations, it also identifies key areas requiring future research. These could further clarify the complex relationships between market integration, inequality, and welfare provisions in Asian countries, thereby facilitating more targeted and effective policy interventions. Overall, this research significantly contributes to the ongoing dialogue concerning welfare regimes in Asia and provides essential guidance for future academic and policy-oriented endeavors.

Data availability

The author confirms that the data supporting the findings of this study are available within the article and its supplementary material (Online Appendix).

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References

Afonso A, Schuknecht L, Tanzi V (2010) Income distribution determinants and public spending efficiency. J Econ Inequal 8:367–389
Ahlquist JS, Breunig C (2012) Model-based clustering and typologies in the social sciences. Political Anal 20(1):92–112
Akram E, Hassan N (2017) Welfare state and Islam: can Pakistan be a welfare state? ISSRA Pap IX:1–14
Aldenderfer MS, Blashfield RK (1984) Cluster analysis. Sage Publications, Beverly Hills, CA
Arikan G, Bloom PB-N (2015) Social values and cross-national differences in attitudes towards welfare. Political Stud 63(2):431–448
Arthur D, Vassilvitskii S (2007) kmeans++: the advantages of careful seeding. In: Gabow H (ed) Proceedings of the eighteenth annual ACM-SIAM symposium on discrete algorithms, New Orleans, LA
Aspalter C (2017) The Indian welfare state system with special reference to social policy and the burden of disease. In: Aspalter C (ed) The Routledge international handbook to welfare state systems. Routledge, New York, NY, pp. 347–364
Bourguignon F (2015) The globalization of inequality. Princeton University Press, Princeton, NJ
Cameron D (1978) The expansion of the public economy: a comparative analysis. Am Political Sci Rev 72(4):1243–1261
Chancel L, Piketty T (2021) Global income inequality, 1820–2020: the persistence and mutation of extreme inequality. J Eur Econ Assoc 19(6):3025–3062
Cheong KS (2001) Economic crisis and income inequality in Korea. Asian Econ J 15(1):39–60
Croissant A (2004) Changing welfare regimes in East and Southeast Asia: crisis, change and challenge. Soc Policy Adm 38(5):504–524
Cutright P (1965) Political structure, economic development, and national social security programs. Am J Sociol 70(5):537–550
Devine JA (1985) State and state expenditure: determinants of social investment and social consumption spending in the postwar United States. Am Sociol Rev 50(2):150–165
Dreze J, Sen A (1989) Hunger and public action. Oxford University Press, Oxford, UK
Esping-Andersen G (1985) Power and distribution regimes. Politics Soc 14(2):223–256
Esping-Andersen G (1990) The three worlds of welfare capitalism. Polity Press, Cambridge, UK
Esping-Andersen G (1997) Hybrid or unique? The Japanese welfare state between Europe and America. J Eur Soc Policy 7(3):179–189
Esping-Andersen G (1999) Social foundation of postindustrial economies. Oxford University Press, Oxford, UK
Fan CC, Sun M (2013) Regional inequality in China, 1978–2006. Eurasian Geogr Econ 49(1):1–18
Foneseca JRS (2013) Clustering in the field of social sciences: that's your choice. Int J Soc Methodol 16(5):403–442
Franzese RJ (2002) Electoral and partisan cycle in economic policies and outcomes. Annu Rev Political Sci 5:369–421
Gamm G, Kousser T (2021) Life, literacy, and the pursuit of prosperity: party competition and policy outcomes in 50 states. Am Political Sci Rev 115(4):1442–1463
Gilpin R (2000) The challenge of global capitalism: the world economy in the 21st century. Princeton University Press, Princeton, NJ
Gniazdowski Z (2017) New interpretation of principal components analysis. Preprint at arXiv: https://arxiv-org-ssl.access.yonsei.ac.kr/abs/1711.10420
Gough I (2001) Globalization and regional welfare regimes: the East Asian case. Global Soc Policy 1(2):163–189
Grubesic TH, Wei R, Murray AT (2014) Spatial clustering overview and comparison: accuracy, sensitivity, and computational expense. Ann Assoc Am Geogr 104(6):1134–1156

Guan X (2005) China's Social Policy: Reform and Development in the Context of Marketization and Globalization. In: Kwon Hj (ed) Transforming the Developmental Welfare State in East Asia. Social Policy in a Development Context. Palgrave Macmillan, London, UK, pp. 231–256
Hall PA, Soskice D (2001) Varieties of capitalism: the institutional foundations of comparative advantage. Oxford University Press, Oxford, UK
Han S (2022a) Inequality, public choice, and the welfare state. Asian J Political Sci 30(2):119–139
Han S (2022b) Identifying the roots of inequality of opportunity in South Korea by application of algorithmic approaches. Humanit Soc Sci Commun 9:18
Han S (2022c) Spatial stratification and socio-spatial inequalities: the case of Seoul and Busan in South Korea. Humanit Soc Sci Commun 9:23
Hastie T, Tibshirani R, Friedman J (2009) The elements of statistical learning: data mining, inference and prediction. Springer, New York, NY
Hennig C (2015) What are the true clusters? Pattern Recognit Lett 64:53–62
Herwartz H, Bernd T (2014) Partisan influence on social spending under market integration, fiscal pressure and institutional change. Eur J Political Econ 34:409–424
Hicks AM, Swank DH (1992) Politics, institutions, and welfare spending in industrialized democracies, 1960–82. Am Political Sci Rev 86(3):658–674
Holliday I (2000) Productivist welfare capitalism: social policy in East Asia. Political Stud 48(4):706–723
Holzer B (2000) Miracles with a system: the economic rise of East Asia and the role of sociocultural patterns. Int Sociol 15(3):455–478
Huang X (2015) Four worlds of welfare: understanding subnational variation in Chinese social health insurance. China Q 222:449–474
Huang X, Zuo C (2023) Bread or roses: how economic inequality affects regimes support in China. Political Stud 71(3):869–892
Iversen T, Sosckice D (2006) Electoral institutions and the politics of coalitions: why some democracies redistribute more than others. Am Political Sci Rev 100(2):165–181
Johnstone B, Jones A, Kruger C (2019) Applied unsupervised learning with Python: discover hidden patterns and relationships in unstructured data with Python. Packt Publishing Ltd, Birmingham, UK
Kanbur R, Rhee C, Zhuang J (2014) Inequality in Asia and the Pacific. Routledge, London, UK
Kaufman L, Rousseeuw PJ (1990) Finding groups in data. Wiley, Hoboken, NJ
Kim S (2015) NGOs and social protection in East Asia: Korea, Thailand and Indonesia. Asian J Political Sci 23(1):23–43
Koehler G, Chopra D (2014) Development and welfare policy in South Asia. Routledge, New York, NY
Korwatanasakul U (2015) Time to look east: lessons from revisiting Asian economic integration. Asian Development Bank Institute Working Paper 1110
Krugman P, Venables AJ (1995) Globalization and the inequality of nations. Q J Econ 110(4):857–880
Kurosaki T, Jha R (2011) Economic inequality in South Asia. Routledge Handbook of South Asian Economics. Routledge, London, UK, pp. 61–75
Kwon H (2005) Transforming the developmental welfare state in East Asia. Dev Change 36(3):477–497
Kwon H (2009) The reform of the developmental welfare state in East Asia. Int J Soc Welf 18(s1):S12–S21
Kwon HY, Pontusson J (2010) Globalization, labour power and partisan politics revisited. Socio-Econ Rev 8(2):251–281
Lee Y-J, Ku Y (2007) East Asian welfare regimes: testing the hypothesis of the developmental welfare state. Soc Policy Adm 41(2):197–212
Li S, Wan H, Zhuang J, Kanbur R, Rhee C, Zhuang J (2014) Income inequality and redistributive policy in the People's Republic of China. Inequality in Asia and the Pacific. Routledge, London, UK, pp. 329–350
Lindert PH (1994) The rise of social spending, 1880–1930. Explor Econ Hist 31(1):1–37
London JD (2014) Welfare regimes in China and Vietnam. J Contemp Asia 44(1):84–107
Malesky E, Abrami R, Zheng Y (2011) Institutions and inequality in single-party regimes: a comparative analysis of Vietnam and China. Comp Politics 43(4):409–427
Meltzer A, Richard S (1981) A rational theory of the size of government. J Political Econ 89(5):914–927
McManus IP (2019) The re-emergence of partisan effects on social spending after the global financial crisis. J Common Market Stud 57(6):1274–1291
Milanovic B (2012) Global inequality by the numbers: in history and now policy research. World Bank Working Paper 6259
Minas C, Jacobson D, Antoniou E, McMullan C (2014) Welfare regime, welfare pillars and southern Europe. J Eur Soc Policy 24(2):135–149
Moene KO, Wallerstein M (2001) Inequality, social insurance, and redistribution. Am Political Sci Rev 95(4):859–874
Murphy KP (2012) Machine Learning: A Probabilistic Perspective. The MIT Press, Cambridge, MA
Murtagh F, Contreras P (2011) Algorithms for hierarchical clustering: an overview. WIREs Data Mining and Knowledge Discovery 2(1):86–97. https://wires-onlinelibrary-wiley-com-ssl.access.yonsei.ac.kr/doi/full/10.1002/widm.53
Nelson JM (1999) Reforming Health and Education: The World Bank, The IDB, and Complex Institutional Change. Overseas Development Council. Johns Hopkins University Press, Baltimore, MD
Nguyen MTN, Chen M (2017) The caring state? On rural welfare governance in post-reform Vietnam and China. Ethics Soc Welf 11(3):230–247
Peng I (2004) Postindustrial pressures, political regime shifts, and social policy reform in Japan and South Korea. J East Asian Stud 4(3):389–425
Powell M, Barrientos A (2004) Welfare regimes and the welfare mix. Eur J Political Res 43(1):83–105
Powell M, Kim K (2014) The 'Chameleon' Korean welfare regime. Soc Policy Adm 48(6):626–646
Powell M, Kim K, Kim S (2020) The puzzle of Japan's welfare capitalism: a review of the welfare regimes approach. J Int Comp Soc Policy 36(1):92–110
Rama M, Beteille T, Le Y, Mitra PK, Newman JL (2015) Addressing inequality in South Asia. The World Bank, Washington, DC
Ramesh M, Asher MG (2000) Welfare capitalism in Southeast Asia. St. Martin's Press, Inc, New York, NY
Rimlinger GV (1971) Welfare policy and industrialization in Europe, America, and Russia. Wiley, New York, NY
Ringen S, Ngok K (2017) What kind of welfare state is emerging in China? In: Yi I (ed.) Towards universal health care in emerging economies. Palgrave Macmillan, London, UK, pp. 213–237
Rodrik D (1998) Why do more open economies have bigger governments? J Political Econ 106(5):997–1032
Roma AD, Lucena-Sánchez E, Sciavicco G, Vaccaro C (2021) An intelligent clustering method for devising the geochemical fingerprint of underground aquifers. Heliyon 7(5):E07017
Rokkan S (1974) Entries, voices, exits: towards a possible generalization of Hirschman mode. Soc Sci Inf 13(1):39–53
Rudra N (2002) Globalization and the decline of the welfare states in less developed countries. Int Organ 56(2):411–445
Rudra N (2007) Welfare states in developing countries: unique or universal? J Politics 69(2):378–396
Rudra N, Haggard S (2005) Globalization, democracy, and 'effective; welfare spending in the developing world. Comp Political Stud 38(9):1015–1049
Savage L (2018) The politics of social spending after the great recession: the return of partisan policy making. Governance 32(1):123–141
Schulze GG, Ursprung HW (1999) Globalisation of the economy and the nation state. World Econ 22(3):295–352
Scruggs L, Allan J (2006) Welfare-state decommodification in 18 OECD countries: a replication and revision. J Eur Soc Policy 16(1):55–72
Sharkh M, Gough I (2010) Global welfare regimes: a cluster analysis. Global Soc Policy 10(1):27–58
Shim J (2022) Overpromising social welfare benefits? Electoral competition and welfare politics in Taiwan. J East Asian Stud 22(1):99–123
Shin DM (2000) Financial crisis and social security: the paradox of the Republic of Korea. Int Soc Secur Rev 53(3):83–107
Sinn HW (1997) The selection principle and market failure in systems competition. J Public Econ 66(2):247–274
Song H (2003) The birth of a welfare state in Korea: the unfinished symphony of democratization and globalization. J East Asian Stud 3(3):405–432
Stephens J (1979) The transition from capitalism to socialism. Macmillan, London, UK
Tang KL (1998) Colonial state and social policy: social welfare development in Hong Kong 1842–1977. University Press of America, Lanham, MD
Venables WN, Ripley BD (2002) Modern applied statistics with S, 4th edn. Springer, New York, NY
Walter S (2010) Globalization and the welfare state: testing the microfoundations of the compensation hypothesis. Int Stud Q 54(2):403–426
Wan G, Wang C, Zhang X (2021) The poverty–growth–inequality triangle: Asia 1960s to 2010s. Soc Indic Res 153:795–822
Weiss ML (2014) Of inequality and irritation: new agendas and activism in Malaysia and Singapore. Democratization 21(5):867–887
Weyland K (2007) Bounded rationality and policy diffusion: social sector reform in Latin America. Princeton University Press, Princeton, NJ
Wibbels E (2006) Dependency revisited: international markets, business cycles, and social spending in the developing world. Int Organ 60(2):433–468
Wibbels E, Ahlquist JS (2011) Development, trade, and social insurance. Int Stud Q 55(1):125–149
Wilensky HL (1975) The welfare state and equality: structural and ideological roots of public roots of public expenditure. University of California Press, Berkley, CA
Wilensky H (1981) Leftism, catholicism, and democratic corporatism: the role of political parties in recent welfare state development. In: Flora P, Heidenheimer A (eds) The development of the welfare states in Europe and American. Transaction, New Brunswick, NJ, pp. 345–382
Wood G, Gough I (2006) A comparative welfare regime approach to global social policy. World Dev 34(10):1696–1712
World Bank (1990) World Development Report 1990. Oxford University Press, New York, NY

Yay GG, Aksoy T (2018) Globalization and the welfare state. Qual Quant 52:1025–1040
Yi I, Lee B (2005) Development strategies and unemployment policies in Korea. In: Kwon H (ed) Transforming the developmental welfare state in East Asia. Palgrave Macmillan, London, UK, pp. 143–169
Zelasky S, Martin CL, Weaver C, Baxter LK, Rappazzo KM (2023) Identifying groups of children's social mobility opportunity for public health applications using *k*-means clustering. Heliyon 9(9):E20250
Zhou Y, Song L (2016) Income inequality in China: causes and policy responses. China Econ J 9(2):186–208

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