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Bridging the Gap Between Immediate and Ultimate Investors - Operationalizing *BPM7* Ultimate Investor Economy Recommendations Using Firm-Level Intelligence and Probabilistic Models

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Abstract

This paper proposes a hybrid methodology for compiling Direct Investment (DI) statistics by Ultimate Investor Economy (UIE), consistent with *Integrated Balance of Payments and International Investment Positions Manual, Seventh Edition* (*BPM7*) recommendations. Conventional statistics by Immediate Investing Economy (IIE) often mask the true source of investment due to conduit jurisdictions and Special Purpose Entities (SPEs). The approach integrates redesigned enterprise surveys, AI-assisted ownership tracing, and probabilistic network models, with Flow-Based Propagation, PageRank Diffusion, and Stochastic Simulation selected for robustness and interpretability. Using global Coordinated Direct Investment Survey (CDIS) data, the modeling estimated reverse investment from conduit jurisdictions and was then applied to Sri Lanka. Results show that over 40 percent of reported inward DI stock in 2024 originated from conduit economies, with reallocations lowering their shares significantly while increasing those of traditional partner countries. The findings confirm the feasibility and policy relevance of UIE-based DI statistics, offering a replicable model for *BPM7* implementation.

1. Introduction

The compilation of DI statistics by UIE as supplementary data represents a significant conceptual and operational advancement in *BPM7*. Recognizing the limitations of traditional DI statistics based solely on the immediate investing economy, *BPM7* recommends the incorporation of ultimate investor data to better reflect actual financial and economic linkages between countries. This approach enhances transparency by tracing the origin of investment through intermediate entities and identifying the entity that ultimately controls the direct investment enterprise (DIE).

The study aims to introduce a hybrid methodology tailored to countries that compile firm level DI databases based on the IIE. The methodology adjusts and reallocates such data to produce statistics by UIE, consistent with *BPM7*. This approach combines: (i) Firm level data collected through redesigned DI surveys, (ii) automated AI chatbots and relevant administrative sources; and (iii) a model-based reallocation framework grounded in probabilistic network analysis and absorbing Markov chains, supplemented by advanced propagation and simulation techniques.

While the conceptual case for UIE statistics is well established, operationalizing them presents empirical and methodological challenges, particularly for countries lacking complete ownership chain data and the ability to systematically track SPEs. To address this gap, the hybrid framework introduced in this study follows a sequential approach. First, high priority firms, representing the majority of the DI stock, are surveyed for direct UIE information. Next, unresolved cases are examined using AI assisted searches and administrative records. Finally, for firms for which UIE remains unknown, model-based reallocation methods are applied.

Five methodological approaches were evaluated for statistical reallocation: the absorbing Markov chains model by Casella (2017), an empirical allocation based on IMF's Coordinated Direct Investment Survey (CDIS) distributions, and three alternative methods: a flow-based propagation model, a PageRank-like diffusion algorithm, and a stochastic simulation of ownership transitions. While all five methods were implemented to ensure completeness, the final analysis focuses on the three most robust approaches: the flow-based, PageRank, and stochastic models.

Sri Lanka offers a practical case study for implementing this hybrid methodology. The Central Bank of Sri Lanka (CBSL) maintains a firm level DI database, which, although being compiled by IIE, offers sufficient granularity to support transformation to UIE. By integrating firm-level data and probabilistic modeling, the study demonstrates a scalable approach for compiling DI statistics aligned with *BPM7*, with potential applicability to developing countries that maintain firm-level DI databases based on IIE.

2. Literature Review

The compilation of DI statistics by UIE has gained attention due to the limitations of traditional DI data based on IIE basis. The literature broadly identifies two main methodological approaches to address this challenge: (i) firm level tracing, and (ii) model-based estimation.

Casella (2017) introduced a model using Markov chains to probabilistically estimate ultimate investor relationships, treating conduit jurisdictions, identified via SPE reporting, high DI-to-GDP ratios, or tax haven features, as transitional nodes in a matrix system. Probabilities are then computed for the investment to be ultimately absorbed in destination economies. Casella, Borga, and Wacker (2023) expanded for scalable UIE matrices suitable for data-constrained countries. Damgaard, Elkjaer, and Johannesen (2019) distinguished “real” DI from “phantom” DI, estimating that around 40 percent of global DI consists of pass-through capital routed via financial centers. Their work highlights how reassigning DI to ultimate investors improves the explanatory power DI statistics.

Complementing this stream, Borga and Caliandro (2018) proposed a nationality-based approach to consolidate DI statistics by tracing multinational enterprise (MNE) control structures. Their method emphasizes multinational enterprise nationality over residence, relying on control thresholds and sectoral data to identify ultimate investors, even in countries without SPE breakdowns. This approach is particularly useful for compilers with access to rich firm-level datasets.

Flow-based propagation models have also gained increasing traction as effective tools for reallocation when ownership data is incomplete. These models redistribute DI stocks and/or influence through indirect relationships captured by weighted connectivity matrices. Casella et al. (2023) extended their Markov framework using expressions such as Q+$Q2R$, where Q represents conduit-to-conduit transitions and R represents denotes final absorption into ultimate economies. These propagation methods enable multi-step reallocation and preserve the topological features of economic networks, thereby capturing second-order effects absent in direct bilateral statistics.

Similar techniques have long been applied in trade and value-added statistics. For example, Wang, Wei, and Zhu (2013) decomposed gross exports using Leontief-type multipliers to trace value added content across borders. Cerina et al. (2015) applied propagation methods to international trade networks to measure systemic economic risk, demonstrating how shocks propagate via indirect routes. In tax-related studies, Garcia-Bernardo et al. (2017) traced profit flows through corporate ownership networks using recursive matrix operations, highlighting the effectiveness of the utility of flow-based models for DI reallocation.

PageRank-based propagation models provide a recursive method useful for tracing ownership. Originally developed by Brin and Page (1998) to rank web pages, PageRank measures centrality based on both direct connections and the importance of linked nodes. Garcia-Bernardo et al. (2017) applied a similar metric to global corporate ownership, showing that countries like the Netherlands and Luxembourg are central not because of their size but their role in ownership chains. The Organization for Economic Co-operation and Development (OECD) (2020) used this approach to model how multinational enterprises allocate profits, highlighting key jurisdictions in complex networks. In finance and economics, recursive metrics outperform simple totals in identifying systemically important players. For example, Battiston et al. (2012) used PageRank to study vulnerabilities in banking networks, and De Domenico et al. (2015) extended it to multi-layered economic networks. PageRank methods are especially helpful in estimating UIE statistics when data are incomplete or noisy, as their iterative logic stabilizes results and reveals hidden intermediaries.

Stochastic simulation provides another estimation framework, especially useful when dealing with uncertainty or partial data. These methods simulate ownership paths multiple times to generate distributions of likely UIE outcomes. Although Casella’s (2017) original Markov model is deterministic, its structure is readily adaptable for Monte Carlo simulations that generate probabilistic reallocation scenarios. This extension enables compilers to produce confidence intervals and test model sensitivity across varied assumptions.

Damgaard et al. (2019) implemented probabilistic filtering based on global patterns of phantom DI to estimate plausible reallocations through SPE-intensive jurisdictions. Beyond DI, stochastic simulations are widely used in financial contagion studies (e.g., Battiston et al., 2016; Gai and Kapadia, 2010), where transitions across network nodes help map systemic exposure. In the trade literature, Borin and Mancini (2019) used stochastic methods to simulate value-added transformations across global value chains. These studies reinforce the possibility of adopting stochastic simulation for UIE estimations as well. Key advantages include flexibility, the ability to assess model uncertainty, and compatibility with hybrid approaches that integrate both direct and inferred data.

3. Methodology

To operationalize the *BPM7* recommendation for compiling DI statistics by UIE, this study employs a structured three-stage methodology. First, the largest and most economically significant firms are surveyed directly to obtain UIE information. Second, for firms with incomplete or missing UIE data, auxiliary intelligence is gathered through AI-assisted search tools and administrative records. Finally, for the remaining unresolved cases, probabilistic model-based reallocations are performed using network-based approaches such as flow propagation, PageRank diffusion, and stochastic simulation. This sequential approach ensures comprehensive coverage and methodological rigor in transitioning from immediate to ultimate investor statistics.

3.1 Use of DI Survey to Ascertain the Ultimate Investor

In line with the *BPM7* recommendations and the guidance outlined in the updated Compilation Guide for improving DI statistics, CBSL has developed and implemented redesigned enterprise surveys, though a modular and visual design, to support the identification of the UIE in inward DI statistics. The Sri Lankan experience demonstrates that intuitive, graphics-based survey instruments can serve as a practical means of operationalizing UIE data collection in line with international standards. This visual survey format is in the process of being introduced by the IMF's Capacity Development Office in Thailand (CDOT), through its External Sector Statistics project to selected technical assistance recipients in the Southeast Asia region and Pacific Island Countries.

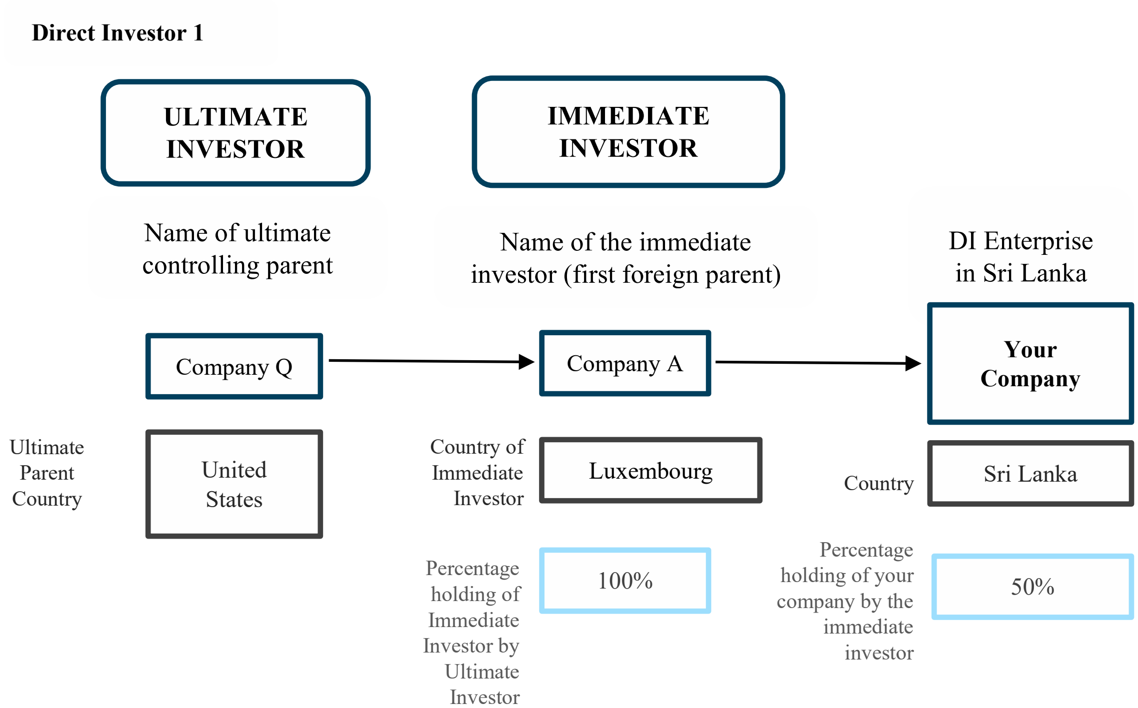
Figure 1 – An extract of Sri Lanka's Annual International Investment Survey

1. Additional details of Direct Investors (including Fellows)

Direct Investor (termed Immediate Investor in this section)	**Name of Direct Investor (termed 'Immediate Investor')**	**Country of Immediate Investor**	**Percentage shareholding of the company as at end Dec 2024**
Direct Investor 1	Company A	Luxembourg	50%

Direct Investor 2	Individual X	France	25%

1.1 For each of the Immediate Investors above mentioned, do you have additional information on the ultimate ownership of the investment? If yes, please fill in the section below.
note - 'Direct Investor in Sri Lanka on the far-right column is automatically filled.



Source: Annual International Investment Survey 2024 - CBSL

3.2 Use of Web-Based Searching via a Customized ChatGPT Model

To supplement direct data collection, this study utilized a customized version of ChatGPT to conduct targeted web searches for Sri Lankan companies, with a focus on identifying foreign ownership, International Standard Industrial Classification of all economic activities (ISIC) Revision 4, and other relevant company information. Upon entering a company name, the GPT model follows a standardized retrieval protocol, verifying foreign investors, determining country of origin, and extracting ISIC codes and descriptions. It also compiles publicly available contact details, including registered addresses, emails, and phone numbers, along with the names and designations of key executives. An Excel worksheet is generated, with missing fields left blank if verifiable information is unavailable, thereby ensuring data reliability. To ensure the accuracy of the GPT based searches, the outputs are cross-referenced with administrative data, such as audited financial statements and administrative records. A sample GPT prompt used for these AI-assisted searches, along with the retrieved output for a publicly available Sri Lankan company, is provided in Appendix I for illustration.

3.3 Model-Based Estimation of Ultimate Investor Economy

The third stage—Model-Based Estimation of the Ultimate Investor Economy—is employed only when both direct and web-sourced ownership information are unavailable. The primary objective of this approach is to minimize the number of companies requiring model-based reallocation by first exhausting all feasible direct and indirect data sources. In the case of Sri Lanka, all firms in the DI database were individually searched online, with findings validated for plausibility against previous survey data and administrative records. The Model-Based Estimation of the Ultimate Investor Economy serves as a last resort to ensure completeness of the UIE transformation by using probabilistic models to reallocate DI positions based on network structures and conduit economy patterns. It enables statistically grounded estimation in data-sparse contexts, preserving analytical integrity while minimizing reliance on unverifiable assumptions.

3.3.1 Selection of Conduit Countries

The identification of conduit jurisdictions is pivotal to the UIE transformation process, as these economies primarily serve as routes for DI driven by tax optimization or regulatory arbitrage rather than genuine economic activity. Following Casella (2017), conduit economies are classified into four categories: (i) Tax Havens, typically small jurisdictions whose outward DI is almost entirely conduit in nature; (ii) SPE Reporters, countries that formally disclose the share of outward investment routed through SPEs; and (iii) Estimated Investment Hubs, where conduit behavior is inferred from abnormally high DI-to-GDP ratios and known financial intermediation roles, despite the absence of SPE-specific reporting; and (iv) Additional empirical additions by the authors include the Marshall Islands, Curaçao, and Sint Maarten in the final list of conduit economies due to their disproportionately high levels of DI relative to their GDP.

Table 1 - Classification of Conduit and SPE-Intensive Jurisdictions Based on CDIS Stock, GDP, and DI-to-GDP Ratios (End-2023)

Group	Country	CDIS Value as at end 2023 (USD mn)	GDP (USD bn)	DI-to-GDP Ratio
1) Tax Havens	British Virgin Islands (BVI)	1,119,960	1.1	1018.1
	Cayman Islands	1,061,346	5.8	183.0
	Bermuda	615,694	7.6	81.0
	Barbados	118,281	5.5	21.5
	Seychelles	1,069	1.6	0.7
	Isle of Man	128,803	10.0	12.9
	Guernsey	52,124	4.9	10.6
	Liechtenstein	12,193	7.7	1.6
	Jersey	153,295	7.9	19.4
	Gibraltar	26,052	2.6	10.0

	Bahamas	132,761	12.5	10.6
	Luxembourg	2,857,642	89.0	32.1
	Malta	480,030	22.0	21.8
2) SPE Reporters	Cyprus	459,791	32.0	14.4
	Mauritius	336,189	15.0	22.4
	Panama	62,195	76.0	0.8
	Hungary	330,587	212.3	1.6
3) Large financial intermediaries that play a major role as financial conduits	The Netherlands	3,703,201	1,154	3.2
	Singapore	2,352,706	515.0	4.6
	Hong Kong	2,038,815	370.0	5.5
	Ireland	1,259,757	530.0	2.4
	Switzerland	998,470	885.0	1.1
	United Kingdom	2,619,212	3,380	0.8
4) Additional Empirical Inclusions	Curaçao (Netherlands)	45,181	3.4	13.3
	Sint Maarten (Netherlands)	7,808	0.6	13.0
	Marshall Islands	13,586	0.3	45.3

Source: CDIS, World Development Indicators – World Bank

Although the United Kingdom is recognized as a major financial intermediary and conduit in global DI networks, it was not classified as a conduit economy in the Sri Lanka-specific modeling. In the case of Sri Lanka, due to its historical and economic ties with the United Kingdom, reassigning ultimate investor status away from the United Kingdom in such cases may misrepresent underlying ownership relationships. In applying the model globally, it is advisable to incorporate country-specific considerations, especially for jurisdictions with close historical or economic linkages to the compiling economy. When such countries serve as immediate investors, compilers should apply thorough analytical criteria regarding their historical direct investment background (similar to Sri Lanka case) and exhaust all alternative sources, including surveys, administrative data, and web-based searches, before reallocating them as conduits to avoid misrepresenting genuine investment relationships. Table 1 below summarizes the full classification, showing the assigned group, CDIS DI positions, GDP, and derived DI-to-GDP ratios.

3.3.1 Markov Properties and Derivation of the P, Q and R Matrices

Markov property and its significance

The Markov property, in simple terms, assumes that the next state of a process depends only on the current state, not on the sequence of events that preceded it. Mathematically, for a Markov chain with states S = {s1,s2,...,sn}, this property is expressed as:

$$P\,(X_{t+1}=s_j \mid X_t = s_i\,, X_{t-1} = s_k, \ldots) = P\,(X_{t+1}=s_j \mid X_t=s_i)$$

This memoryless characteristic makes Markov chains particularly suitable for modeling the probabilistic behavior of DI ownership transitions, where investment often flows through intermediate economies (conduits) before being absorbed in ultimate destination economies.

Transition Matrix (P)

A transition matrix is a tabular representation of the probability of moving from one state (economy) to another. In DI modeling, it captures the likelihood of capital moving between jurisdictions in a global network of DIEs. Each row of the matrix represents the probability distribution of transitions from a given origin economy to possible destination economies.

The full transition matrix, denoted as P, captures all possible transitions in the Markov model. It is typically partitioned into four submatrices:

- ***Q***: transitions among transient states (e.g., conduit economies)
- ***R***: transitions from transient to absorbing states (i.e., UIE)
- ***I***: identity matrix representing permanence in absorbing states
- ***0***: zero matrix indicating no transitions from absorbing to transient states

The transition matrix ***P*** forms the basis for several probabilistic and network-based models used to reallocate DI positions to ultimate investor economies. In absorbing Markov chain models, ***P*** is partitioned as described (***Q***, ***R***, ***I***, and ***0***), enabling the estimation of final absorption probabilities and reallocation paths. In PageRank-style models, ***P*** captures the likelihood of traversing a network of economies using link-based weights and a damping factor, modeling the long-run distribution of influence, interpreted as ultimate ownership likelihood. Flow-based models use ***P*** as a propagation mechanism, redistributing DI based on observed bilateral ratios until equilibrium. Similarly, stochastic simulation models apply ***P*** as a transition kernel in Monte Carlo simulations to explore ownership chains under uncertainty. In all cases, ***P*** provides a coherent framework for transforming immediate investor data into ultimate investor estimates, aligned with *BPM7* guidance.

Q Matrix

The ***Q*** matrix captures the transition probabilities among transient states, which are typically conduit economies that intermediate DI flows without ultimately absorbing them. It is a submatrix of the full transition matrix ***P*** and is central to absorbing Markov chain models, where it determines how capital circulates among conduits before reaching an absorbing (ultimate investor) state. Mathematically, ***Q*** enables the computation of the fundamental matrix $N = (I-Q)-1$, which estimates the expected number of transitions among conduit economies before absorption. The entries in ***Q*** are derived from normalized DI relationships among conduit jurisdictions, based on CDIS data. In broader modeling frameworks, such as flow-based or stochastic simulations used in this paper, ***Q*** serves as a routing mechanism that governs the redistribution of DI across intermediary economies. Regardless of the approach, ***Q*** is critical for capturing the behavior of pass-through capital in the global DI network.

R Matrix

In the absorbing Markov chain framework applied to DI network analysis, the R matrix captures the transition probabilities from transient states (i.e., conduit economies) to absorbing states (i.e., final destination or UIE). This matrix is essential for modeling how capital originating or passing through conduit jurisdictions ultimately reaches real economic destinations.

While the transition matrix itself provides a data-driven basis for populating both ***Q*** (transient-to-transient) and ***R*** (transient-to-absorbing) submatrices, the empirical coverage of bilateral DI data often suffers from gaps, asymmetries, and classification inconsistencies—particularly when attempting to distinguish pass-through capital from ultimate ownership or control. Moreover, the probabilistic redistribution of DI positions may produce sparse or diluted linkages in the ***R*** matrix when relying solely on observed transition flows.

To address these limitations, a manual ***R*** structure was developed based on known economic linkages and observable global patterns. For each identified conduit economy, a curated list of absorbing (ultimate investor) countries was defined, using CDIS inward stock data to guide selection. For each conduit economy, only economies that account for at least 1 percent of the global inward DI stock (excluding conduit economies themselves) based on CDIS inward data were retained as absorbing candidates. This criterion ensures that the ***R*** matrix reflects realistic and economically significant redirection paths while minimizing noise from marginal flows or reporting anomalies.

To illustrate the manual construction of the ***R*** matrix, consider the case of Singapore—a globally recognized financial intermediary and conduit economy. Singapore holds a substantial position in global DI networks, yet its role is often as a transit jurisdiction, with a significant portion of inward DI ultimately controlled by entities outside the country. Consequently, Singapore is treated as a transient state in the ***Q*** matrix and is excluded from the absorbing states in the ***R*** matrix. To determine realistic absorbing destinations for capital routed through Singapore, the study rely on inward DI data from the CDIS. Specifically, countries accounting for at least 1 percent of the inward DI stock to Singapore and are not in the list of conduit economies in the ***Q*** matrix were only considered as absorber countries to be included in the ***R*** matrix as detailed in Table 2 below.

Table 2 - Selection of countries to be represented in the R manual matrix for Singapore

Country	CDIS Stock as at end 2023 (USD mn)	Share of source country as a percentage of total CDIS position	Conduit Classification
United States	573,552	25%	Absorber
Cayman Islands	241,780	10%	Conduit (Excluded)
Japan	144,924	6%	Absorber
British Virgin Islands	143,041	6%	Conduit (Excluded)
United Kingdom	117,473	5%	Absorber
Bermuda	103,316	4%	Conduit (Excluded)
Luxembourg	87,583	4%	Conduit (Excluded)
China, People's Republic of	87,113	4%	Absorber
Hong Kong SAR	78,162	3%	Conduit (Excluded)
Canada	74,269	3%	Absorber
Netherlands	65,336	3%	Conduit (Excluded)
Switzerland	65,268	3%	Conduit (Excluded)
Malaysia	65,066	3%	Absorber
Taiwan Province of China	46,575	2%	Absorber
Korea, Republic of	44,489	2%	Absorber
Indonesia	37,607	2%	Absorber
France	36,438	2%	Absorber
India	35,594	2%	Absorber
Ireland	24,331	1%	Conduit (Excluded)

Country	CDIS Stock as at end 2023 (USD mn)	Share of source country as a percentage of total CDIS position	Conduit Classification
Australia	21,879	1%	Conduit (Excluded)
Mauritius	21,824	1%	Conduit (Excluded)
Germany	17,047	1%	Absorber
Thailand	15,898	1%	Conduit (Excluded)
Belgium	15,480	1%	Absorber
Denmark	14,310	1%	Absorber
Cyprus	9,218	0.4%	Below 1% [Excluded]
Malta	8,658	0.4 %	Below 1% [Excluded]
…….	*All countries below 1% of inward share in the CDIS inflows to Singapore were excluded from the R matrix to minimise noise.*		

Source: CDIS

Based on the above analysis, around 15 economies were selected as absorbing states in Singapore's manual ***R*** matrix. This list is neither exhaustive nor fixed in scope; rather, it represents a pragmatic selection of economically significant economies that met the inclusion threshold at the time of compilation. As data coverage improves and ownership structures evolve, this set may be refined accordingly. A similar methodology was applied across all identified conduit (transient) economies when constructing the entries of the unified manual ***R*** matrix. This process ensures that each row of the ***R*** matrix reflects plausible and meaningful capital redirection pathways. This approach enhances the fidelity of DI reallocation by addressing the potential overrepresentation of unlikely sources in the probabilistic modeling process. Table 3 below presents the manually selected absorbing economies for each conduit jurisdiction included in the R matrix.

Table 3: Manually selected absorbing economies based on CDIS data for each conduit economy for the construction of the *R* matrix

Conduit Economy	Selected Absorbing Economies
Luxembourg	United States, United Kingdom, Germany, Canada, Belgium, France, Spain, United Arab Emirates, Italy, Brazil
The Netherlands	United States, United Kingdom, Germany, Belgium, France, Japan, Sweden, Canada, Israel, Saudi Arabia, Italy, Austria, Turkiye
Ireland	United States, United Kingdom, France, Japan, China, Germany
Switzerland	United States, United Kingdom, Japan, Belgium, Germany, France, Austria, Sweden, Russia, Hungary
Singapore	United States, Japan, United Kingdom, China, Canada, Malaysia, Taiwan, Korea, Indonesia, France, India, Ireland, Australia, Germany, Thailand, Belgium, Denmark
Hong Kong SAR, China	China, United Kingdom, United States, Canada, Japan, Taiwan, Thailand, France
Cyprus	Russia, United States, Ukraine, United Kingdom, Germany, Israel, Czech Republic, Greece, Sweden, Slovak Republic
Mauritius	United States, India, United Kingdom, South Africa, Thailand, France, Canada, Japan, Malaysia, Nigeria, China
British Virgin Islands	China, Brazil, Canada, United Kingdom, Thailand

Conduit Economy	Selected Absorbing Economies
Cayman Islands	United States, China, Brazil, Canada, Korea, United Kingdom, Japan, Malaysia, Thailand, Hungary, Kuwait
Bermuda	United States, Canada, France, China, United Kingdom
Bahamas	Brazil, United States, Canada, China, United Kingdom, Spain, Chile
Malta	United Kingdom, Germany, United States, Turkiye
Seychelles	Russia, United States, United Kingdom, France, China, India, South Africa, Italy, Japan, Hungary
Isle of Man	United Kingdom, Canada
Jersey	United Kingdom, Canada, South Africa, Korea, Turkiye, Germany
Guernsey	United Kingdom, Korea, Canada, China, Germany, Norway, Czech Republic
Gibraltar	United States, Brazi, Spain
Panama	United States, Colombia, United Kingdom, Taiwan Province of China, Brazil, Spain, Canada, México, Ecuador, Venezuela, Costa Rica, Italy, Jamaica,
Barbados	Canda, United States, Trinidad and Tobago
Liechtenstein	Czech Republic, Brazil, Austria, Germany, Poland, Kazakhstan, United States
Curaçao	United States, Brazil
Sint Maarten	United Kingdom.
Marshall Isl.	Korea, United States.

Source: CDIS end 2023 data

3.3.3 Implementation of Five Reallocation Methods

(1) Absorbing Markov Chains Method (Casella 2017)

This method models the DI network as an absorbing Markov chain, where conduit (transient) economies are linked probabilistically to one another through the Q matrix, and to ultimate (absorbing) investors through the R matrix. The reallocation is computed using the fundamental matrix $\boldsymbol{N}=(\boldsymbol{I}-\mathbf{Q})^{-1}$, which represents the expected number of visits to each transient state before absorption. The ultimate investor probability matrix is then derived as:

$$\boldsymbol{U}= \boldsymbol{N} \,.\, \boldsymbol{R}$$

This approach provides a mathematically rigorous framework to estimate the final destinations of DI originating from conduit heavy jurisdictions. In the paper, this method served as the reference benchmark for reallocation performance due to its close alignment with the probabilistic rationale proposed in *BPM7* guidance and its prior adoption in Casella's global DI network estimations.

(2) Manual CDIS (Empirical Allocation)

This empirical approach uses the bilateral CDIS inward data as a baseline to reallocate investments from known conduit economies to plausible ultimate destinations based on mirror data and/or expert judgment. Unlike the previous method, it does not employ a formal transition matrix. Instead, each conduit's outflows are redistributed using manually constructed weights derived from historical patterns in CDIS data. The empirical allocation is represented as:

$$\widehat{F}_{i,j} = \sum_{k \in C} w_{k \to j} \cdot F_{i,k}$$

While relatively less robust than model-based methods, it allowed for intuitive adjustments in country cases such as those with limited CDIS participation or known asymmetries in immediate vs. ultimate investor linkages.

(3) Flow-Based Propagation: Q·R + Q²·R

This method applies a recursive formula to simulate how DI propagates through the network of conduit economies over multiple steps. It relies on the transition matrices ***Q*** and ***R***, with investment being passed forward iteratively. The result after two rounds of propagation is:

$$\mathbf{U = Q.R + Q^2 .R}$$

By limiting the propagation to the second order, the method balances computational efficiency with sufficient depth to capture indirect DI routing. Within the study's hybrid framework, it provides an analytically tractable middle ground between empirical assumptions and fully absorbing models, making it suitable for mid-sized economies with moderate conduit exposure.

(4) PageRank-like Propagation

Inspired by the PageRank algorithm, this method models the DI network as a weighted graph where capital "flows" across nodes (economies) with probabilities determined by the link structure. A damping factor α is introduced to allow capital to randomly reassign to any absorbing state with probability 1−α, ensuring convergence. The iterative update rule is:

$$\mathbf{U^{(t+1)} = \alpha.Q.U^{(t)}+(1-\alpha).R}$$

This approach emphasizes the long-run steady-state of capital redirection, reflecting persistent ownership linkages in a globalized economy. In this study, this method proved particularly valuable in capturing network centralities and preferential flows that align with firm-level indicators.

(5) Stochastic Simulation

This method conducts multiple randomized simulations of DI paths through the global network using ***P*** as the transition probability matrix. For each simulation, investment from a source country is allowed to "walk" through conduit economies until it is absorbed. Results are averaged across many simulations to estimate expected reallocation probabilities. Formally, the estimated probability is:

$$\widehat{U}_{i,j} = \frac{1}{S} \sum_{s=1}^{S} \mathbb{I}(Path_i^{(s)} \to j)$$

This model explicitly incorporates randomness and ownership uncertainty, making it especially useful when firm-level ownership chains are incomplete or ambiguous. Within this implementation, the stochastic approach served as a robustness check, confirming that estimated UIE patterns were consistent across probabilistic trajectories rather than being artifacts of deterministic methods.

3.3.4 Selection of Preferred Models for Final Allocation

Following the implementation of five distinct modeling approaches for reallocating DI from immediate to UIE, a structured evaluation was conducted to identify the most suitable models for final allocation. The selection criteria included interpretability (ease of explanation and justification to statistical users and policymakers), tractability (ease and stability of implementation given real-world data limitations), and robustness (consistency and plausibility of results across varying input assumptions). Based on these criteria, three methods were retained: the Flow-Based Propagation model, the PageRank-like algorithm, and the Stochastic Simulation approach. These methods balanced theoretical rigor with operational feasibility, demonstrating a strong ability to realistically capture indirect ownership patterns while remaining adaptable to firm-level intelligence—particularly when ultimate investor chains are partially observed or fragmented.

In contrast, the Absorbing Markov Chains method (Casella, 2017), while theoretically robust and foundational, was ultimately dropped from final implementation. Its heavy reliance on a full and well-conditioned **Q** matrix—specifically the inverse of this matrix—resulted in instability during computation when applied to real-world CDIS data. Similarly, the manual CDIS-based empirical allocation was excluded due to its limited scalability and lower methodological consistency. Although useful in early prototyping, particularly for identifying broad patterns in the absence of full firm-level chains, this approach lacked the analytical precision based on preliminary results of sample conduit countries and perceived to be bias and were difficult to defend in a replicable statistical production setting.

By narrowing the model set to Flow-Based, PageRank, and Stochastic methods, methodological diversity is retained while ensuring each approach is empirically grounded, conceptually aligned with *BPM7* principles, and operationally feasible.

4 Results

This section presents the empirical findings of the study, organized into two interconnected components. The first examines the reverse investment probabilities of conduit destinations within the global DI network using three modeling approaches: Flow-Based Propagation, PageRank Diffusion, and Stochastic Simulation. This analysis, grounded in the probabilistic methodologies developed in Section 4, aims to identify the likely UIEs behind investments channeled through prominent conduit jurisdictions. The second section applies the global modeling framework to the case of Sri Lanka, operationalizing the hybrid methodology that combines firm-level data, AI-assisted ownership tracing, and model-based inference. This case study demonstrates the full cycle of UIE transformation and validates the feasibility of implementing *BPM7* aligned DI statistics in a data constrained environment.

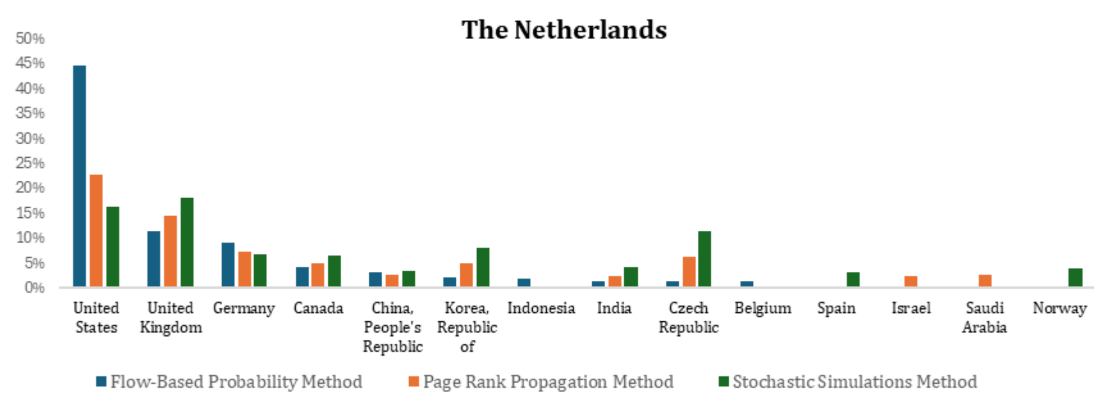
4.1 Reverse Inverse Probabilities of Conduit Destinations Using Different Modeling Approaches in the Global Context

A key innovation in operationalization of DI statistics by UIE lies in estimating *reverse investment probabilities*—the likelihood that DI recorded as originating from conduit jurisdictions (such as the Netherlands or Hong Kong) can be traced back to the true UIE. These probabilities are particularly important where direct ownership paths are unavailable or distorted by financial engineering and tax optimization strategies. The models underpinning this approach—the Flow-Based Propagation Method, the PageRank Algorithm, and Stochastic Simulations—each simulate alternative routes of ownership tracing using the global DI network. The Flow-Based model redistributes using bilateral investment matrices; the PageRank method captures recursive influence structures; and the stochastic simulation draws on randomized ownership path sampling to estimate probabilistic origins.

To illustrate the behavior and comparative outcomes of the three models, six conduit jurisdictions are examined in detail: the Netherlands, Hong Kong, Seychelles, Ireland, Singapore, and the Marshall Islands. These economies were selected to reflect a cross-section of conduit economies, including major global financial hubs, recognized tax havens, and newly identified pass-through jurisdictions, each playing a distinct role in the global DI network. They serve as illustrative examples where conduit-based reporting significantly obscures the identification of the UIE.

The Netherlands emerges as a dominant European financial conduit (see Figure 4). All three models identify the United States as the principal ultimate investor, with the Flow-Based model attributing nearly half of the Netherland’s inward DI to United States origin. The prominence of the United Kingdom and Germany reflects the Netherlands' role as a gateway to and within the European Union. All three models have the top six countries the same, with the Flow Based model suggesting United States having a larger share compared to the other two models.

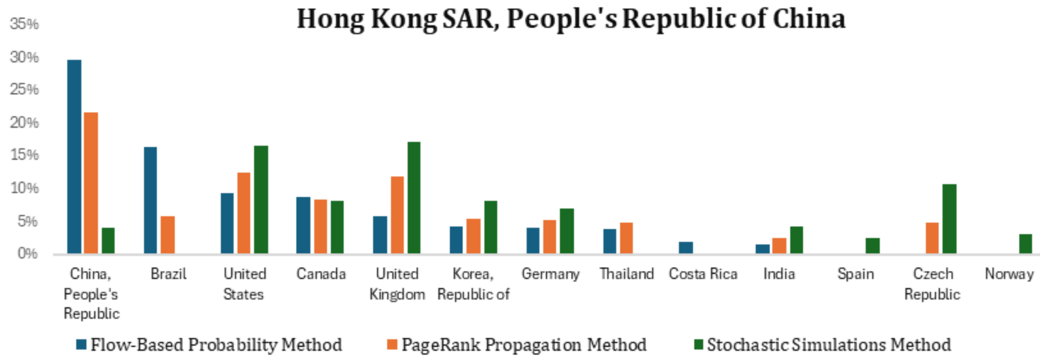
Figure 4 – Reverse Investment Probabilities of the Netherlands Based on the Three Models



Source: Model outcome

Hong Kong SAR of the People’s Republic of China serves as a hybrid financial center (see Figure 5), acting both as a global hub and a conduit for Asian investments. The models indicate that the primary ultimate investors are China, Brazil, and the United States. China's dominance reflects historical and geopolitical integration, while Brazil's prominence—especially under the stochastic simulation—highlights Hong Kong's role in South-South investment patterns and offshore trade finance. The PageRank model, which places greater emphasis on indirect linkages, highlights Canada and the United Kingdom, likely reflecting complex multinational enterprise ownership chains involving cross-listed firms.

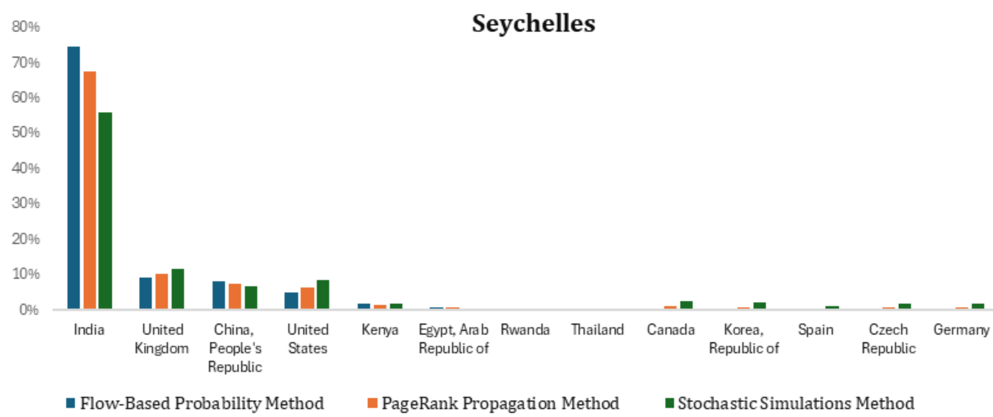
Figure 5 –Reverse Investment Probabilities of Hong Kong SAR, the People’s Republic of China on the Three Models



Source: Model outcome

In the case of Seychelles (see Figure 6), reverse investment probabilities are heavily skewed toward India, particularly under the Flow-Based model (nearly 70 percent), followed by the United Kingdom and China. This pattern reflects the well-documented use of Seychelles based vehicles by Indian investors for tax structuring and anonymity. The convergence of all three models in identifying South, East and Southeast Asia as the primary sources validates the robustness of these findings.

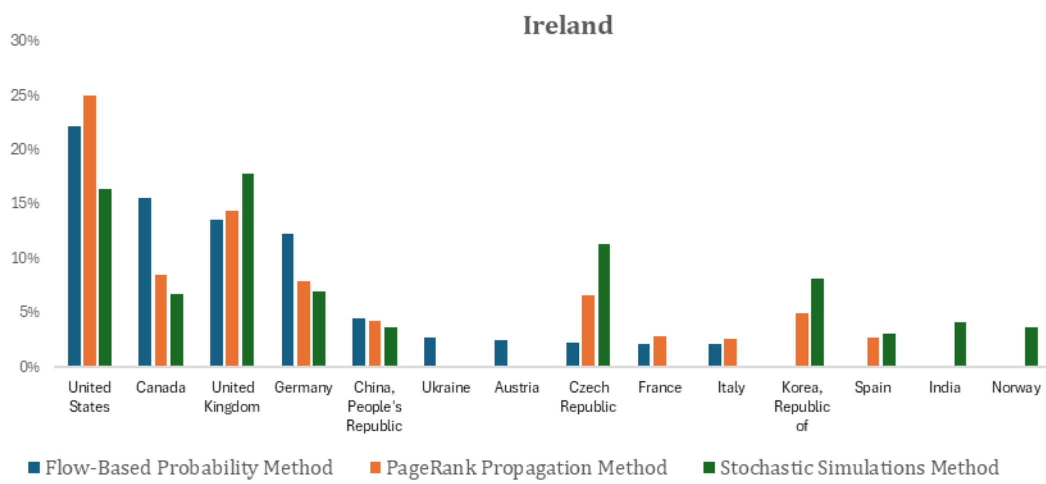
Figure 6 –Reverse Investment Probabilities of Seychelles on the Three Models



Source: Model outcome

Ireland displays a familiar profile (see Figure 7): the United States emerging as the dominant ultimate investor across all three models, due to longstanding DI inflows from United States multinationals in tech and pharmaceuticals. Germany, the United Kingdom, and Canada follow, underscoring Ireland's role as both an entry point to the European Union and a hub for intra-European investment redistribution.

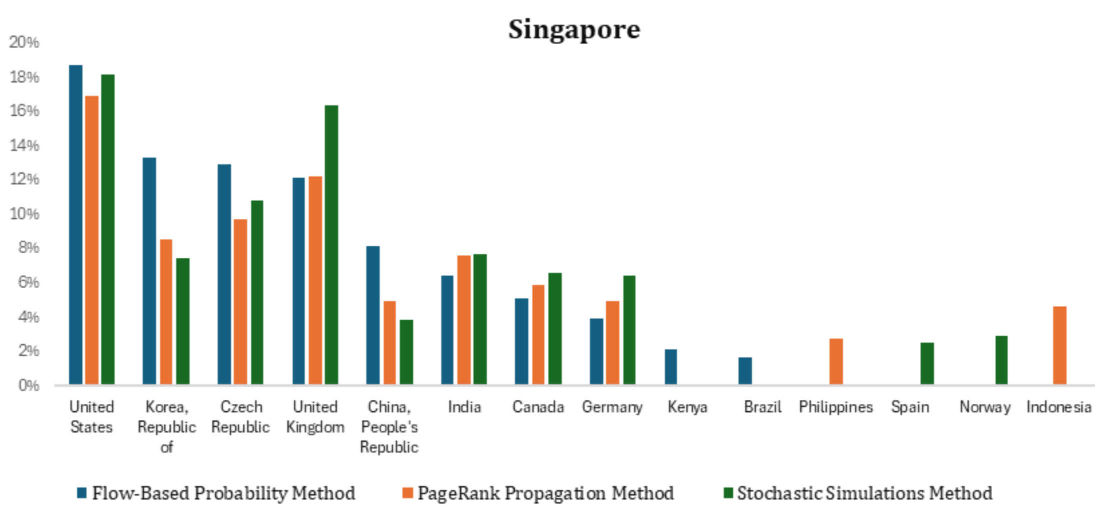
Figure 7–Reverse Investment Probabilities of Ireland Based on the Three Models



Source: Model outcome

Singapore, often described as Asia's financial switchboard, exhibits a broadly diversified UIE profile (see Figure 8). The United States, Korea, and the Czech Republic consistently rank highly across models, with India, Germany, and China also featuring prominently. This reflects Singapore's central role in regional value chains and Asian capital intermediation. Notably, the PageRank model reveals more regional linkages, reinforcing Singapore's embeddedness regionally as well as globally.

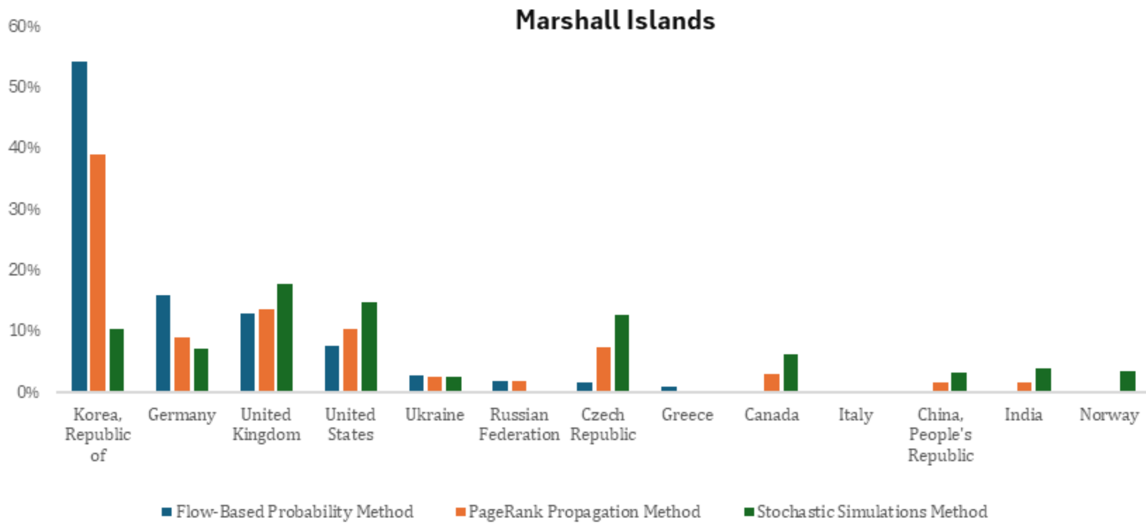
Figure 8 –Reverse Investment Probabilities of Singapore Based on the Three Models



Source: Model outcome

The Marshall Islands represents a prototypical flag-of-convenience and secrecy jurisdiction, showing a strong bias toward East Asia (see Figure 9). The Republic of Korea accounts for the highest reverse probabilities, followed by the United States and Japan. These patterns are consistent with the Marshall Islands' role in global shipping and offshore trade financing structures.

Figure 9 –Reverse Investment Probabilities of Marshall Islands Based on the Three Models



Source: Model outcome

Other conduit jurisdictions are presented as an Appendix (refer Appendix II). While not detailed here, their patterns confirm the presence of statistically significant linkages with both major OECD economies and emerging market investors, often structured through regionally specific financial architectures.

Examples include:

- The Bahamas, strongly linked to the United States and the United Kingdom, reflecting longstanding Atlantic financial corridors.
- Luxembourg, with balanced linkages across the United States., United Kindgdom, Germany, and Spain, highlighting its role as an intra-European holding platform.
- Switzerland, diversified but with strong ties to wealthy economies such as Belgium and Canada.
- Cyprus, connected to Russia, Czech Republic, and Germany, serving as a corporate platform for Eastern European investors.
- The Cayman Islands, with global reach and significant ties to China, the United States, and Korea, widely used by hedge funds and private equity firms.
- The British Virgin Islands, exhibiting significant exposure to Chinese ultimate investors, consistent with documented offshore structuring.
- Bermuda, linked to United States, Canada, and the United Kingdom via insurance and reinsurance flows.
- Malta and the Isle of Man, demonstrating intra-European Union investment dispersion.
- Panama and Liechtenstein, maintaining strong connections to traditional European financial centers.
- Jersey and Guernsey, smaller but consistently attributed to the United Kingdom, and Western Europe.

These patterns, detail in Appendix II, reaffirm the importance of model-based estimation for correcting misleading DI signals arising from pass-through economies.

4.2 Application of the Global Model to the Context of Sri Lanka: A Hybrid Approach

Building on the global reallocation framework, this subsection applies the model to the Sri Lankan context as part of a comprehensive hybrid approach. By integrating direct survey data, AI-assisted ownership tracing, and probabilistic modeling, the analysis reallocates inward DI stock from conduit economies to their likely ultimate investor economies in line with *BPM7* recommendations.

4.2.1 Starting Point – Sri Lanka's DI Stock Position Based on IIE

The baseline of the UIE transformation process begins with Sri Lanka's firm-level DI stock positions classified by IIE. Table 4 summarizes the top 20 source countries for DI stock in Sri Lanka for the years 2023 and 2024, as compiled by the CBSL based on IIE.

Table 4 – Sri Lanka DI Stock Position by IIE (USD millions)

Country	2023	2024
Singapore	1,863	2,426
India	2,258	2,416
China	2,226	2,248
Netherlands	1,206	1,505
Hong Kong	1,174	1,177
Mauritius	590	847
United Kingdom	792	805
Malaysia	711	744
Japan	496	506
Canada	358	504
UAE	437	474
United States	347	414
Italy	368	370
Switzerland	308	336
Australia	225	232
British V. I.	173	195
Sweden	171	184
Seychelles	127	128
Germany	117	124
Luxemburg	93	96
Others	793	815
Total	**14,833**	**16,545**
Total inward DI stock attributed to conduit destinations	5,620	6,810
Percentage share of plausible conduit destinations	38%	41%
Total inward DI stock attributed to conduit destinations	**5,620**	**6,810**
of which,		
1) Tax Heavens and SPE reporters	2,274	2,871

2) Large financial intermediaries that play a major role as financial conduits (excluding United Kingdom)	3,346	3,939

Source: CDIS, CBSL

A key insight from the IIE breakdown is the significant role played of jurisdictions classified as known or plausible conduit economies. Based on this classification of conduit economies as developed in Section 4.3, conduit economies—including Singapore, Netherlands, Hong Kong, Mauritius, Luxembourg, and the British Virgin Islands—account for USD 6.8 billion, or 41 percent of Sri Lanka's total inward DI stock in 2024. Of this amount, USD 2.9 billion is attributable to tax havens that are also SPE-reporting jurisdictions. An additional USD 3.9 billion originates from large financial intermediaries functioning as conduits, such as Netherlands, Singapore, and Switzerland, excluding the United Kingdom. Although the United Kingdom is among the top 10 investors, it is excluded from the conduit category and treated as an absorbing economy, due to its substantial real-sector corporate presence and the likelihood of genuine investor control.

This tabulation forms the empirical baseline for the hybrid reallocation framework. The overarching goal is to fully eliminate conduit positions, defined as capital flows that transit through intermediate jurisdictions without underlying control or economic substance, and to reassign them to their UIE.

To operationalize this, the study adopts a tiered resolution strategy (detailed in Section 4.4). First, direct responses from redesigned DI surveys are used to identify ultimate investors, focusing on firms contributing significantly to the stock. Second, for firms lacking direct survey data, AI-assisted web searching infers ownership chains from public and administrative data sources. Third, unresolved cases undergo probabilistic reallocation using flow propagation, PageRank diffusion, and stochastic simulation. This sequence ensures that all plausible conduit positions are either empirically resolved or systematically reallocated, aligned with the *BPM7* recommendation to enhance policy relevance and statistical accuracy.

4.2.2 UIE Transformation Process: Stock Attribution by Methodological Stages

The combined UIE results are shown first for clarity. While model-based reallocations (Stage 3) represent a key methodological contribution, their impact on total reallocation is relatively small. Given the technical nature of the models, presenting results upfront contextualizes subsequent sections. Survey-based and AI-assisted stages together account for over 95 percent of the total reallocated DI stock, as summarized in Table 5.

Table 5 –Summary of Reallocated DI Stock by Resolution Stage and Attribution Method

	Methodology	No. of Distinct Direct Investors	Representative DI stock position (USD mn)	Percentage Share
Stage 1	Survey based responses	91	7,526	45.5
Stage 2	AI assisted web searching	1,291	8,233	49.8
Stage 3	Probabilistic Model - Conduit Countries	239	608	3.7

Assumed	Unknown UPC from non-conduits assumed Immediate Investor Country as the Ultimate Parent Country	17	178	1.1
Total		**1,638**	**16,545**	**100.0**

Source: direct surveys, web-based searches and estimation models

The final compilation of inward DI stock by UIE for Sri Lanka covers a total of 1,638 distinct direct investors and a cumulative inward DI stock of USD 16.5 billion.

Out of this total, 95.3 percent of the DI stock (USD 15.76 billion) was resolved through the first two empirically grounded stages:

- Stage 1 – Survey-based responses: 91 high-value firms provided direct identification of their ultimate controlling parent, covering USD 7.5 billion (45.5 percent).
- Stage 2 – AI-assisted investigation: 1,291 firms were resolved using advanced entity-matching and ownership tracing tools, drawing on both public corporate databases and administrative sources. This accounted for USD 8.2 billion (49.8 percent).

The remaining investors were addressed as follows:

- Stage 3 – Probabilistic Model-Based Reallocation: For 239 investors domiciled in known or plausible conduit jurisdictions—where direct survey and AI-based tracing failed—ownership chains were inferred using probabilistic model-based methods. The inferred UIEs account for USD 608 million (3.7 percent).
- Assumed – IIE as Proxy for UIE: In 17 cases where no information was retrievable, and where the immediate investor was domiciled in a non-conduit country, the IIE was retained as the UIE. This cautious assumption applied to USD 178 million, or 1.1 percent, and is clearly recorded in the firm-level DI database to support transparency and future revision. This treatment is also reflected in the metadata.

Together, these four categories ensure full coverage of Sri Lanka's inward DI stock in 2024. Importantly, all capital (100 percent) linked to conduit jurisdictions was either empirically resolved or systematically reallocated, fulfilling *BPM7*'s objective to reflect genuine economic linkages.

4.2.3 Direct Surveys

Table 6 presents the reallocation of inward DI stock from the originally reported IIEs to UIEs, based on survey responses from 91 major direct investors. Despite the modest response rate of approximately 48 percent, the magnitude of coverage was substantial. This is attributable to the survey's deliberate focus on the largest investors: the top 200 firms were prioritized, with particular emphasis on major DIEs accounting for the bulk of the DI stock.

Table 6 – Comparison of Immediate vs. Ultimate Investor Economies Based on Survey Results (USD millions)

	Based on Immediate Investor	Reallocation based on Survey Results as Ultimate Investor Economy
United Kingdom	566	1,721
Japan	142	1,334
India	571	702
United States	225	639
Singapore	1,831	511
Malaysia	537	490
Sri Lanka	0	416
Italy	293	307
Hong Kong	51	281
China	383	281
Switzerland	199	199
Sweden	78	190
Australia	156	156
UAE	482	128
Denmark	0	87
Netherlands	995	57
Mauritius	792	0
Seychelles	122	0
British V. I	20	0
Luxemburg	14	0
Others	69	27
Total	**7,526**	**7,526**

Source: Direct surveys

Results show significant realignments: DI positions of absorbers like the United Kingdom, Japan, and the United States increased markedly (e.g., United Kingdom's share rose from USD 566 million to USD 1.7 billion). Conversely, conduit economies such as Mauritius, Luxembourg, and Seychelles were fully reallocated, indicating no firms identified them as ultimate investors. The Netherlands and Switzerland retained some DI, reflecting their dual role as conduits and genuine investor locations.

Importantly, the survey also identified Sri Lanka, the host economy itself, as an UIE, with USD 416 million in round-tripping DI. This aligns with guidance in *BPM7*, which recognizes round-tripping as a legitimate feature of DI statistics when domestic investors channel funds abroad only to reinvest them back home via foreign affiliates. The emergence of Sri Lanka as a UIE underscores the importance of firm-level verification in accurately capturing the economic substance of cross-border investment flows. These findings validate the tiered framework applied in this study. The ability to directly observe ultimate investor economies reinforces both the importance of survey-based data collection and the cautious application of model-based reallocations for unresolved cases. The results support the broader *BPM7* principle: conduit-dominated DI positions should not obscure genuine economic linkages.

4.2.4 AI Assisted Web Search Results

Table 7 shows the reallocation of DI stock from IIEs to UIEs based on AI-assisted ownership identification for 1,291 firms (USD 8.2 billion).

Table 7 – Comparison of IIEs vs. UIEs Based on AI assisted Web Searches (USD millions)

	Based on IIE	Reallocation based on AI assisted web searches on UIE
China	1,853	2,202
India	1,844	1,888
Hong Kong	1,015	797
France	35	485
Japan	348	416
Malaysia	129	269
United States	190	267
Singapore	285	266
Sweden	106	192
UAE	233	183
UK	239	177
Germany	107	153
Italy	63	145
Thailand	21	140
Switzerland	109	99
Sri Lanka	0	93
Australia	76	70
Canada	504	59
Netherlands	511	22
Bahamas	13	0
British V. I	85	0
Cyprus	13	0
Luxemburg	81	0
Mauritius	46	0
Others	330	312
Total	**8,233**	**8,233**

Source: CBSL DI database, AI assisted search results

The AI assisted web search results-based reallocation resulted in near-complete elimination of conduit economies as ultimate investor destinations. Jurisdictions such as Mauritius, Luxembourg, British Virgin Islands, Cyprus, and Bahamas—all classified in our typology as 100 percent conduit jurisdictions—were effectively stripped of ultimate investor status in this phase.

This confirms their structural role as pass-through entities in global DI networks. At the same time, the AI-based web search results reaffirmed the central role of genuine absorber economies. Substantial increases were observed for countries such as China, India, France, and Germany, with France's attribution rising from USD 35 million (IIE) to USD 485 million (UIE). Other absorber economies such as Japan, Italy, and Sweden similarly recorded significant upward adjustments. These findings illustrate the methodological strength and operational scalability of the AI-assisted approach. The near-complete displacement of conduit economies through algorithmic searches underscores the validity of combining structured AI tools in transforming DI statistics toward true economic ownership.

4.2.5 Results of Model-Based Reallocation

As shown in Table 8, the remaining unresolved portion was thus subjected to reallocation through probabilistic modeling.

Table 8 - Breakdown of Conduit-Origin DI by Method of UIE Attribution (USD millions)

	DI position as of end 2024	UIE Identified through Survey and AI Search	DI Stock Requiring Model-Based Reallocation
Singapore	1,863	1,546	317
The Netherlands	1,206	1,206	0
Hong Kong, Republic of China	1,164	1,053	111
Mauritius	590	580	10
British Virgin Islands	422	332	90
Switzerland	308	280	28
Seychelles	127	127	0
Luxembourg	93	92	1
Gibraltar	35	0	35
Cyprus	13	13	0
The Bahamas	11	11	0
Cayman Islands	11	6	5
Malta	10	0	10
Isle of Man	9	9	0
Ireland	1	0	1
Bermuda	1	1	0
Panama	1	1	0
Jersey	0	0	0
Guernsey	0	0	0
Barbados	0	0	0
Principality of Liechtenstein,	0	0	0
Curacao, Netherlands	0	0	0
Sint Maarten, Netherlands	0	0	0
Republic of the Marshall Islands	0	0	0
TOTAL	**5,865**	**5,257**	**608**

Source: CBSL DI database, model estimates

These findings demonstrate the robustness and complementarity of the hybrid approach, in line with *BPM7* principles.

4.2.6 Results of Flow Based Estimation Model

The flow-based estimation method reallocates DI from unresolved conduit-originating investments using a propagation formula that simulates the likely movement of capital through intermediary economies before reaching its ultimate destination. As shown in Table 9, this model reallocated the remaining USD 608 million across a wide range of plausible investor countries.

Table 9 - Estimated Ultimate Investor Economies from Conduit Jurisdictions Using Flow-Based Reallocation Method

UIE	DI Position (USD mn)	Percentage
China, People's Republic of	83	14%
United States	77	13%
United Kingdom	56	9%
Korea, Republic of	44	7%
Czech Republic	37	6%
Spain	35	6%
Brazil	33	5%
Canada	30	5%
India	28	5%
Germany	26	4%
Pakistan	17	3%
Thailand	14	2%
Kenya	13	2%
Austria	10	2%
Morocco	10	2%
Others	96	16%
Total unknowns via conduit destinations	**608**	**100%**

Source: Flow Based Model Outcome

The largest estimated ultimate investors were China (USD 83 million), the United States (USD 77 million), and the United Kingdom (USD 56 million), together accounting for more than one-third of the total modeled value. These results closely align with the empirical findings from earlier survey and AI-based stages, where these economies were identified as dominant absorbers of DI.

The model also allocates shares to Korea, India, and Canada, which were prominently identified in the previous stages. Importantly, no conduit economies appear among the final destinations, consistent with the *BPM7* principle of removing pass-through distortions. However, the appearance of countries such as Czech Republic, Brazil, Morocco, Austria, and Kenya—none of which featured significantly in the survey or AI-based phases—suggests that the model's recursive logic may introduce plausible but less empirically grounded reallocations in marginal cases. Nonetheless, the overall allocation pattern remains broadly consistent with the hybrid reallocation framework and reinforces the model's utility as a structured fallback.

4.2.7 Results of Page Rank Estimation Model

As shown in Table 10, the model redistributed the remaining USD 608 million in unidentified DI stock across a diverse set of UIE.

Table 10 - Estimated Ultimate Investor Economies from Conduit Jurisdictions Using Page Rank Reallocation Method

UIE	DI Position (USD mn)	Percentage
United States	83	14%
United Kingdom	71	12%
China, People's Republic of	56	9%
Czech Republic	42	7%
Korea, Republic of	39	6%
Spain	38	6%
Canada	35	6%
Germany	32	5%
India	31	5%
Brazil	21	3%
Pakistan	14	2%
Indonesia	12	2%
Thailand	12	2%
Ukraine	10	2%
Kenya	9	2%
Others	101	17%
Total unknowns via conduit destinations	**608**	**100%**

Source: Page Rank Based Model Outcome

The largest estimated recipients are the United States (USD 83 million, 14 percent), the United Kingdom (USD 71 million, 12 percent), and China (USD 56 million, 9 percent), all of which were dominant absorbers in the survey-based and AI-assisted stages. These results closely resemble those of the flow-based propagation model, showing broadly similar country rankings and distribution patterns. Other top destinations include the Czech Republic, Korea, and Spain, which again align with the flow model outputs but remain less empirically grounded in earlier identification efforts. Importantly, the PageRank algorithm, like the flow method, successfully excludes conduit jurisdictions from the list of ultimate investors, upholding the *BPM7* objective of removing pass-through bias. Some peripheral economies—such as Ukraine, Kenya, and Indonesia— appear with modest shares, likely reflecting the model's sensitivity to dispersed network linkages rather than direct control.

4.2.8 Results of Stochastic Simulation Estimation Model

As shown in Table 11, the stochastic simulation model distributes the residual USD 608 million across a broadly similar set of countries as the flow and PageRank methods.

Table 11 - Estimated Ultimate Investor Economies from Conduit Jurisdictions Using Stochastic Simulation Reallocation Method (USD millions)

UIE	DI Position (USD mn)	Percentage
United States	99	14%
United Kingdom	99	12%
Czech Republic	61	9%
Korea, Republic of	45	7%
Spain	43	6%
Canada	41	6%
Germany	40	6%
India	35	5%
China, People's Republic of	22	5%
Norway	19	3%
Ukraine	13	2%
Russian Federation	9	2%
Kenya	9	2%
Austria	6	2%
Pakistan	5	2%
Others	60	17%
Total unknowns via conduit destinations	**608**	**100%**

Source: Stochastic Simulation Based Model Outcome

The United States (USD 99 million, 14 percent) and United Kingdom (USD 99 million, 12 percent) remain the top destinations, followed by Czech Republic, Korea, and Spain, each of which received between 9 percent and 6 percent of the total. These outcomes closely align with those of the previous two models, reinforcing the robustness of the modeling framework and bolstering confidence in the DI stock reallocation. However, the stochastic method exhibits slightly greater dispersion in the tail, with countries such as Norway, Russia, and Austria appearing with modest shares, despite minimal presence in earlier empirical stages. This is an expected feature of stochastic simulations, where random pathways can introduce variation at lower probability levels, even as cumulative distributions remain consistent.

4.3 Model Selection

Among the three probabilistic models applied to reallocate the unresolved USD 608 million in DI stock from conduit jurisdictions, the Flow Propagation Method was selected as the final model. The flow-based model aligns closely with empirical results from survey and AI-assisted stages, particularly in attributing significant shares to China (USD 83 million) and India (USD 28 million)—both major absorbers identified earlier in the reallocation process. It excludes conduit economies entirely and concentrates attribution among known absorber countries, avoiding excessive dispersion into marginal destinations. In contrast, while PageRank and stochastic models showed overall consistency, they introduced greater diffusion toward less substantiated economies such as Ukraine, Norway, and Kenya.

The interpretability of the flow method further support its selection. Its logic is grounded in observable investment structures and is easier to explain in policy and statistical settings compared to abstract probabilistic simulations. Importantly, its results reflect regional economic realities and enhance the coherence of the reallocation in the South Asian context. For these reasons, the flow model offers the best balance of empirical fit, methodological rigor, and practical credibility, and is used as the final step in reallocating conduit-origin DI positions.

4.4 Ending Position – DI position by Ultimate Investment Economy

The final reallocation of Sri Lanka's inward DI stock reveals substantial shifts in the investor landscape once conduit economies are removed and ultimate ownership is properly identified. As shown in Table 12, the total inward DI position of USD 16.5 billion remains unchanged in aggregate, but its distribution by country differs markedly from the immediate investor framework.

Notably, Singapore, Mauritius, Luxembourg, Seychelles, and the British Virgin Islands—which collectively represented over USD 3.5 billion in immediate investor positions—are entirely or almost entirely removed as UIE, confirming their role as pure conduits. Their positions are predominantly redistributed to India (USD 2.6 billion), China (USD 2.6 billion), the United Kingdom (USD 2.0 billion), Japan (USD 1.8 billion), and the United States (USD 983 million)—countries with established real-sector linkages and global investment footprints (see Figure 10). The transformation also reveals several new UEI not visible in the IIE view, including Sri Lanka itself, reflecting round tripping flows totaling USD 509 million, as recognized in *BPM7*. Smaller but notable increases are also seen for France, Sweden, Germany, and Korea suggesting a more nuanced and geographically dispersed pattern of investment control once indirect ownership is considered.

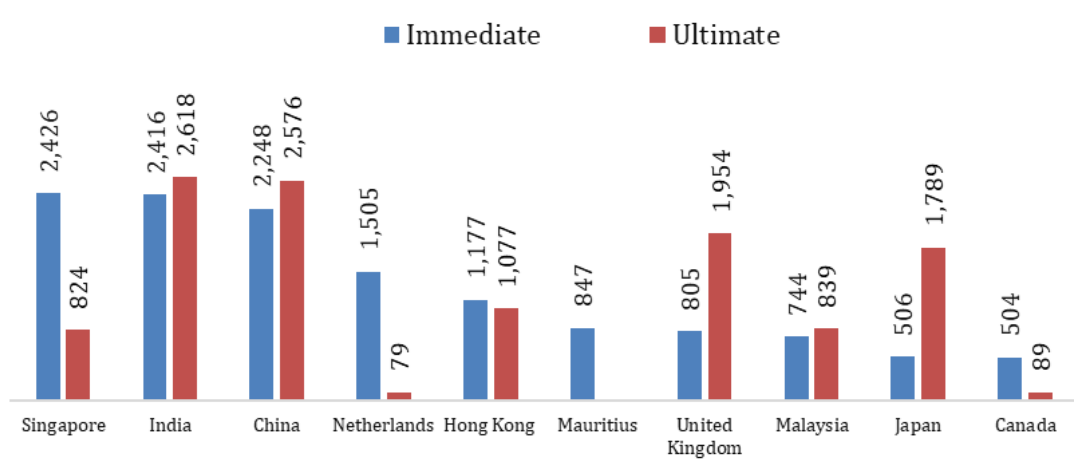
Table 12 - Comparison of Sri Lanka's Inward DI Stock by Immediate vs. Ultimate Investor Economy, 2024 (USD millions)

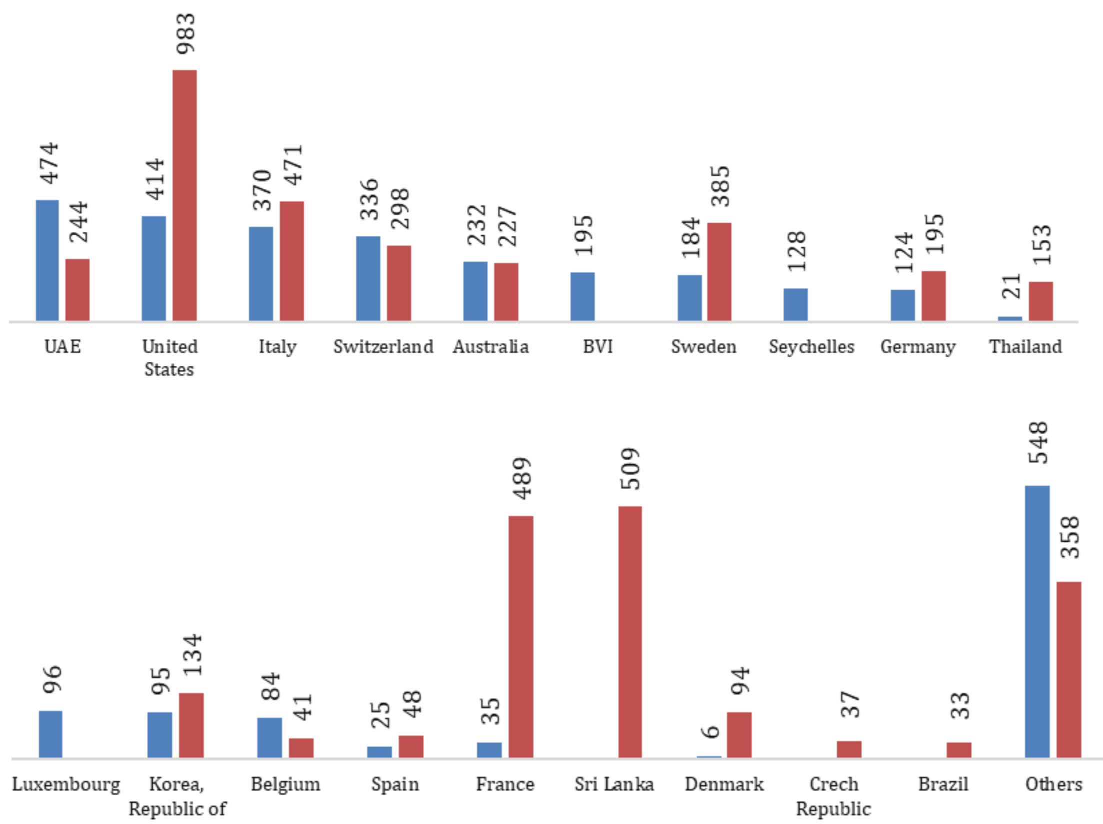
Country	Immediate	Ultimate
Singapore	2,426	824
India	2,416	2,618
China, People's Republic of	2,248	2,576
Netherlands, The	1,505	79
Hong Kong, People's Republic of China	1,177	1,077
Mauritius	847	-
United Kingdom	805	1,954
Malaysia	744	839

Japan	506	1,789
Canada	504	89
United Arab Emirates	474	244
United States	414	983
Italy	370	471
Switzerland	336	298
Australia	232	227
British Virgin Islands	195	-
Sweden	184	385
Seychelles	128	-
Germany	124	195
Thailand	21	153
Luxembourg	96	-
Korea, Republic of	95	134
Belgium	84	41
Spain	25	48
France	35	489
Sri Lanka	-	509
Denmark	6	94
Czech Republic	-	37
Brazil	-	33
Others	548	358
Total	**16,545**	**16,545**

Source: CDIS, Study Outcomes

Figure 10 - Reallocation of Sri Lanka's Inward DI Stock from Immediate to Ultimate Investor Economies, 2024 (USD millions)





Source: CDIS, Study Outcomes

The reallocation underscores the importance of hybrid estimation, combining surveys, AI-assisted investigation, and model-based inference to eliminate distortions caused by pass-through jurisdictions. The resulting UIE-based statistics provide a more accurate and policy-relevant representation of DI statistics, restoring economic substance to cross-border positions and ensuring alignment with *BPM7* statistical standards. In sum, the reallocation process not only removes artificial concentration in financial hubs but also reveals the true geographical structure of investment control—a crucial step for both national policymaking and global statistical comparability.

This exercise demonstrates that meaningful DI statistics cannot rely solely on immediate investor reporting, especially in economies where conduit jurisdictions prominently feature in reported stocks. The application of the *BPM7*-aligned reallocation framework to Sri Lanka's DI data shows that, with a carefully structured hybrid approach—combining direct reporting, intelligent data tools, and probabilistic modeling—it is possible to reconstitute a plausible map of ultimate investor linkages. The results not only correct artificial inflations from pass-through economies but also shed light on underreported relationships with real economic partners. The identification of round-tripping flows, the emergence of key Asian and transatlantic investor economies, and the diversified structure of residual allocations demonstrate the practical feasibility of this framework even in data-constrained environments.

5. Conclusion

This paper advances the operationalization of *BPM7*'s recommendations by developing and applying a hybrid framework to produce DI statistics by UIE. Through the structured integration of firm-level surveys, AI-assisted ownership identification, and probabilistic reallocation models, the study demonstrates that the limitations of IIE-based statistics—particularly those distorted by conduit jurisdictions—can be effectively overcome. The global model estimates reveal how traditional financial centers obscure the true origin of investment flows, while the country-level application for Sri Lanka confirms that a complete UIE transformation is feasible even in resource-constrained environments. Notably, over 95 percent of Sri Lanka's inward DI stock was resolved through direct and AI-assisted methods, with the remaining 3–5 percent addressed through statistically robust model-based reallocation.

Beyond its empirical contributions, a key strength of this framework is its replicability. The modular, stepwise design can be readily adapted to other countries with firm-level DI databases, even when ownership chains are only partially observed. By combining empirical intelligence and network-based inference, the methodology offers a practical and scalable solution for enhancing the accuracy and policy relevance of DI statistics. Furthermore, it serves as a technical assistance tool, supporting capacity-building and statistical modernization in countries preparing to adopt *BPM7*. As interest in UIE statistics grows among national compilers, the framework developed here provides a concrete blueprint for implementation—both in national statistical programs and in IMF-capacity development in this area.

6. Way Forward

Looking ahead, several promising directions can strengthen and expand the operationalization of UIE-based DI statistics. First, the AI-driven tools demonstrated in this study can be further developed to include automated industry classification (e.g., ISIC coding) and identification of multinational group structures, thereby improving alignment with *BPM7* guidance and enabling more nuanced sectoral analyses. Second, incorporating economic modeling techniques, particularly gravity models, can complement the existing probabilistic framework by offering additional insight into the determinants and dynamics of reverse investment probabilities, especially in relation to conduit economies. Third, the construction of the manual R matrix can be refined using dynamic thresholds, regional benchmarking, and time-sensitive adjustments to better capture evolving investment relationships. Fourth, comparative studies with economies that already report UIE data through SPE-based methodologies could provide important validation and identify areas of methodological convergence or divergence. Finally, the structured and modular nature of the hybrid approach makes it well-suited for replication in resource-constrained settings, mostly in developing countries, particularly within the context of IMF's capacity development activities.

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Appendix I

GPT Instructions Prompt for Web Searching and Retrieving

This GPT helps users find information on Sri Lankan companies, specifically focusing on foreign ownership, ISIC, and key contact details. When a user provides the name of a Sri Lankan company, the GPT will: Search the web to determine if the company has any foreign investors and identify their country of origin. Identify the industry classification based on ISIC Revision 4, providing the correct four-digit ISIC code and description. Find information on the nature of the business. Locate the company's registered address. Retrieve any publicly available Sri Lankan telephone number and email address. Identify the names and designations of key executives, including the Chief Executive Officer, Managing Director, Chief Investment Officer, or Finance Manager. The GPT will always present its findings in the following fixed format:

1. Company Name:
2. UIN Number:
3. ISIC Revision 4 number:
4. ISIC Revision 4 Description:
5. The nature of business:
6. Any foreign investors involved?:
7. Name of the foreign investor, if there is a foreign investment:
8. Country of origin of the foreign Investment:

For every answer, an Excel worksheet will be generated with the provided information, and a download link will be given to the user. If specific data is unavailable on the web, the GPT will leave that field blank rather than generating speculative information. The UIN number will only be retrieved from the uploaded Excel file and will not be searched online. The user will not be given access to download the uploaded Excel file.

Sample results of the use of GPT to Retrieve Ownership Details from Web Searching of a publicly listed Sri Lankan company.

User Input:

Dialog Axiata PLC

Part of GPT Response:

Here is the compiled information for **Dialog Axiata PLC**:

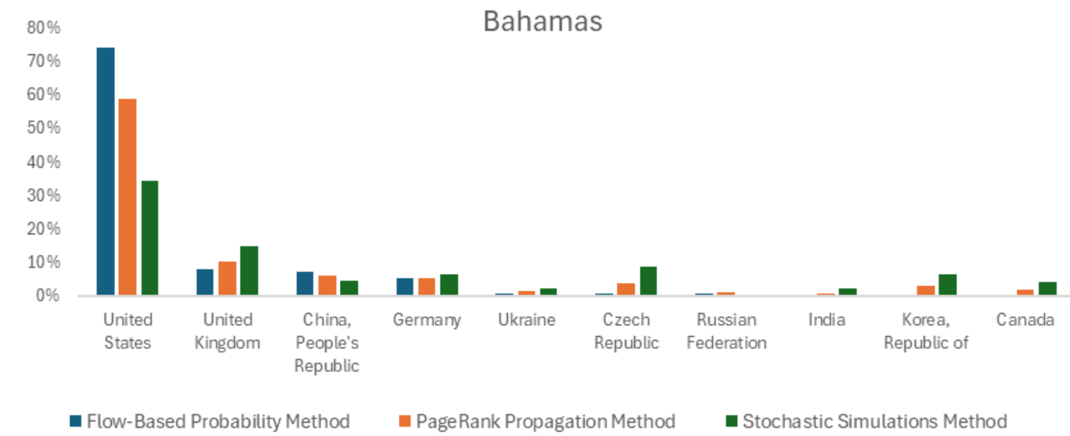
1. **Company Name:** Dialog Axiata PLC
2. **UIN Number:** *(To be retrieved from uploaded file)*
3. **ISIC Revision 4 number:** 6110
4. **ISIC Revision 4 Description:** Wired telecommunications activities
5. **Nature of Business:** Provision of mobile and fixed telecommunications services, including broadband internet, satellite TV, and digital services in Sri Lanka.
6. **Any foreign investors involved?:** Yes
7. **Name of the foreign investor, if there is a foreign investment:** Axiata Group Berhad (73.75% ownership), Bharti Airtel (10.36% ownership)
8. **Country of origin of the foreign Investment:** Malaysia (Axiata Group Berhad), India (Bharti Airtel)

Checking with administrative data of publicly available audited financial statements in the Colombo Stock Exchange:

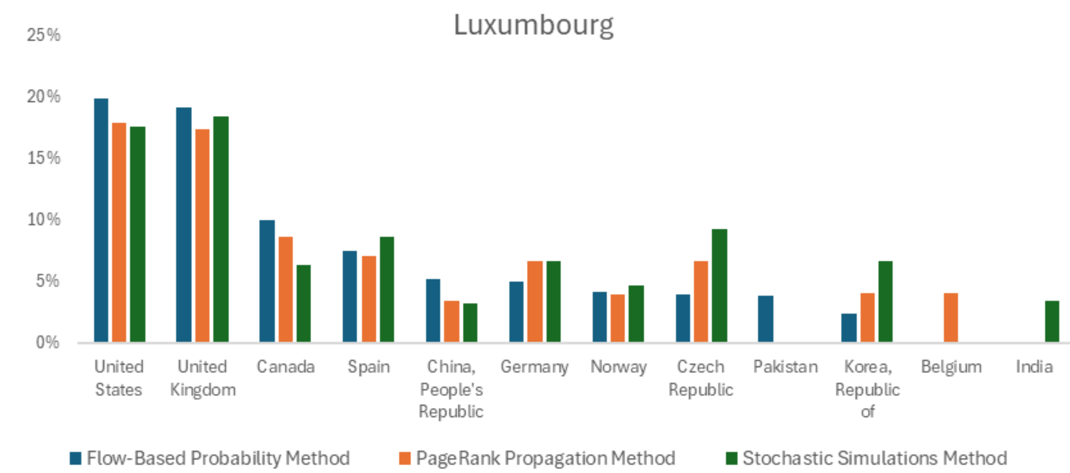
10 Twenty largest shareholders of the Company

	Name of Shareholders	No. of shares	% Holding
1	Axiata Investments (Labuan) Limited	6,785,252,765	73.75
2	Bharti Airtel Limited	952,694,689	10.36
3	Employees' Provident Fund	237,424,082	2.58
4	Citibank Hong Kong S/A Hostplus Pooled Superannuation Trust	182,574,513	1.98

APPENDIX II - Reverse Investment Probabilities of Other Conduit Destinations Based on the Three Models



Source: Model outcome



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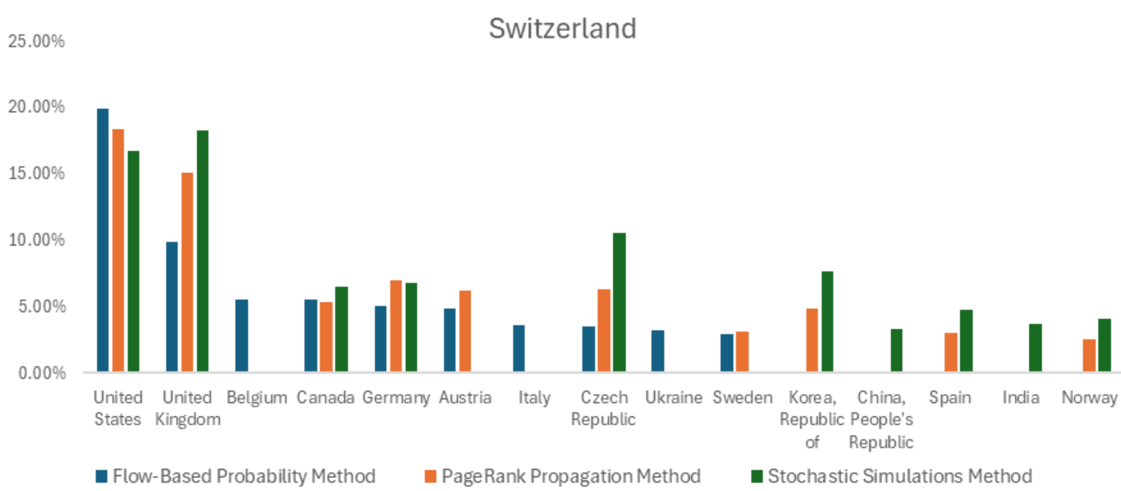

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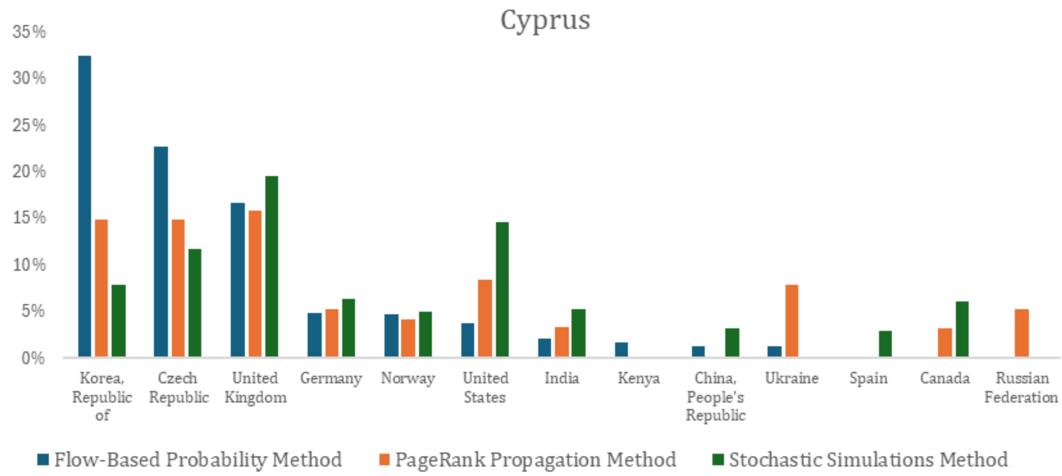

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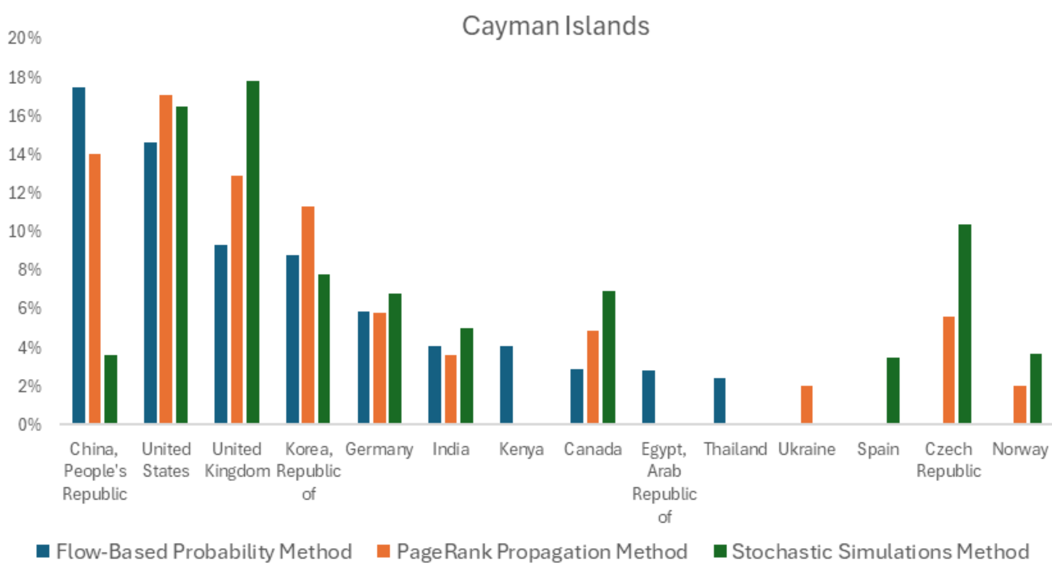

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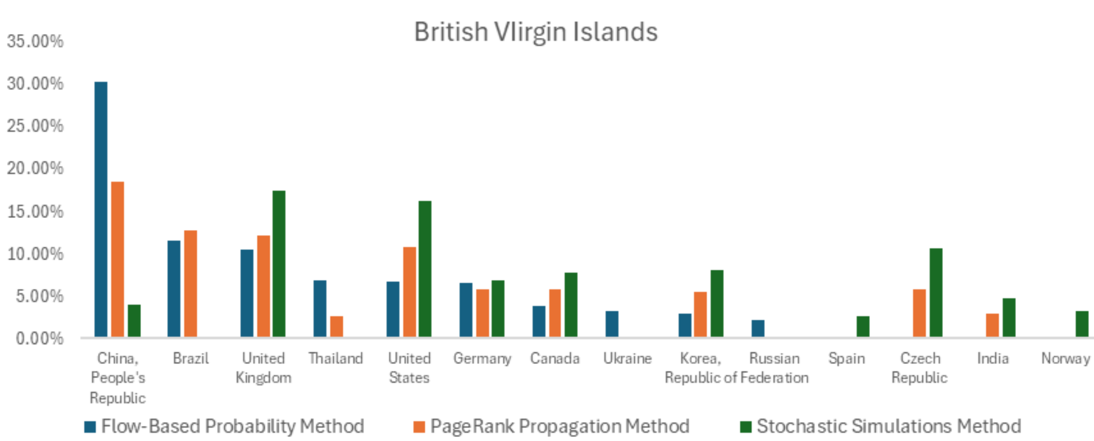
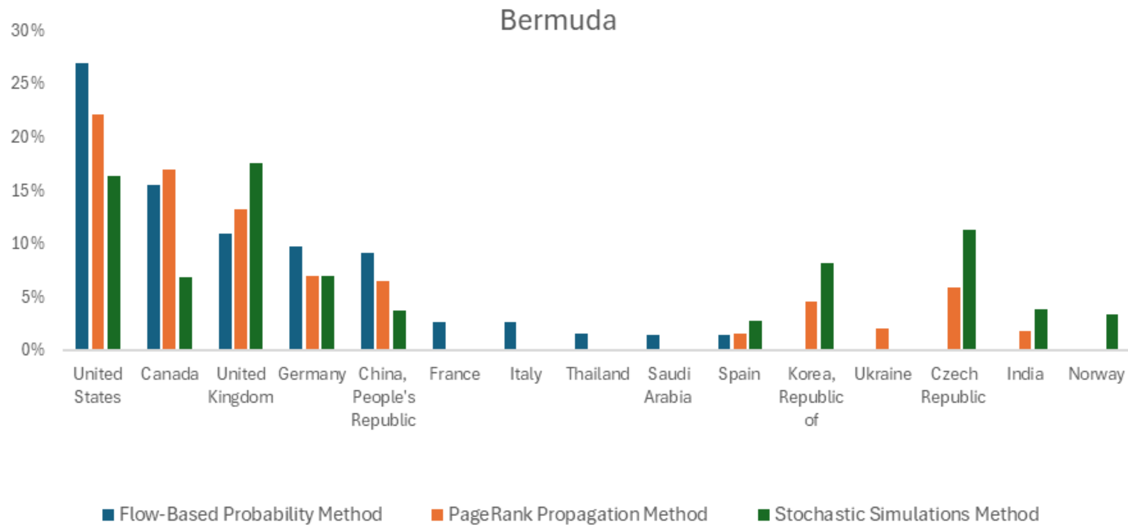


Source: Model outcome



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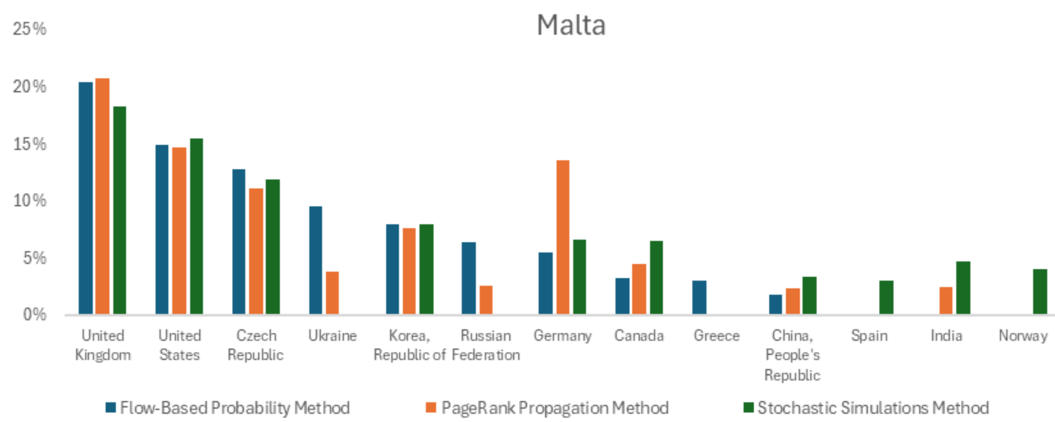

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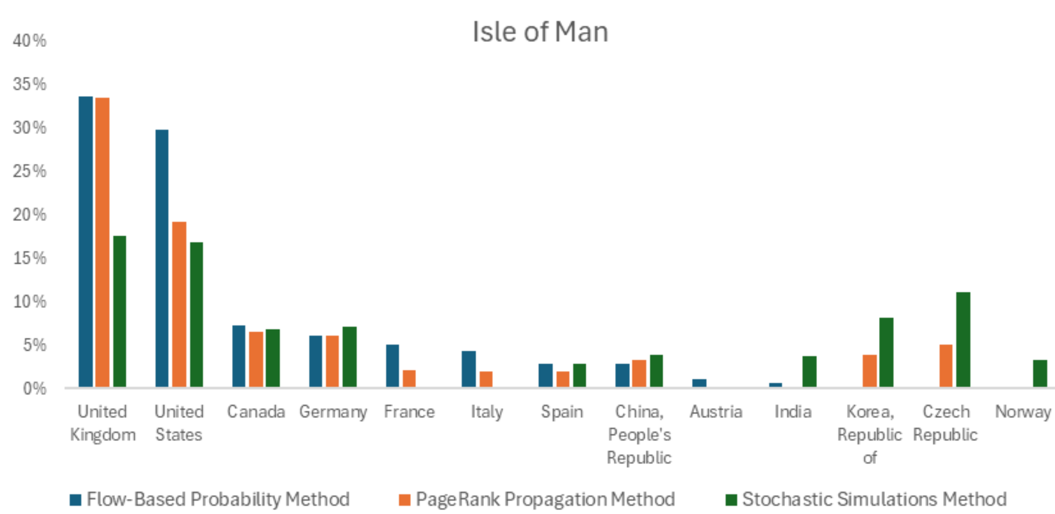
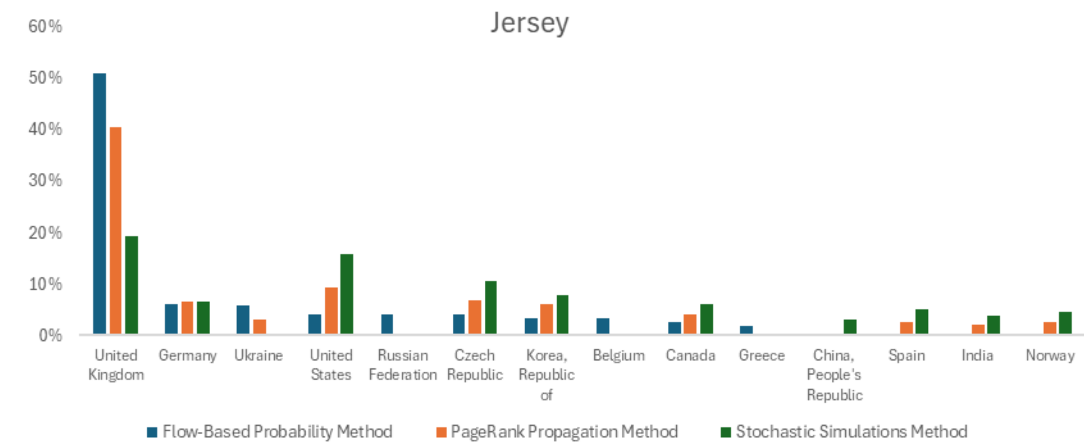
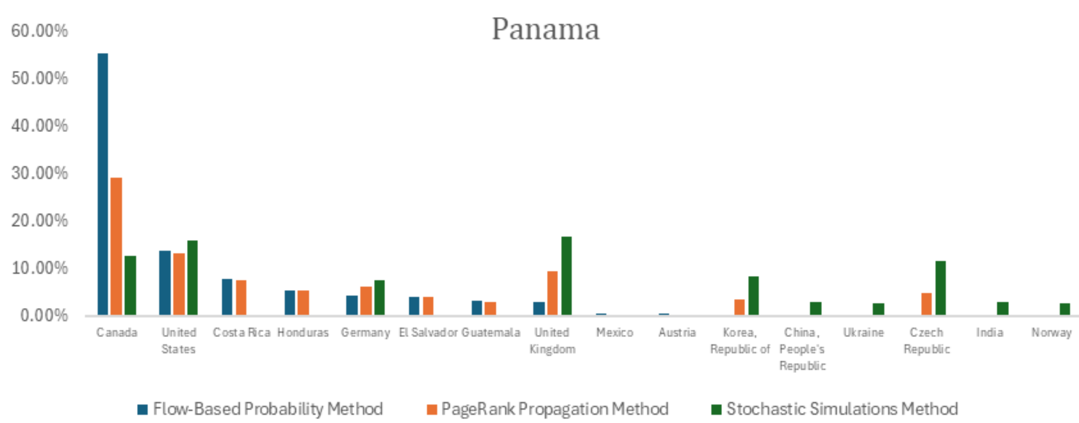


Source: Model outcome



Source: Model outcome



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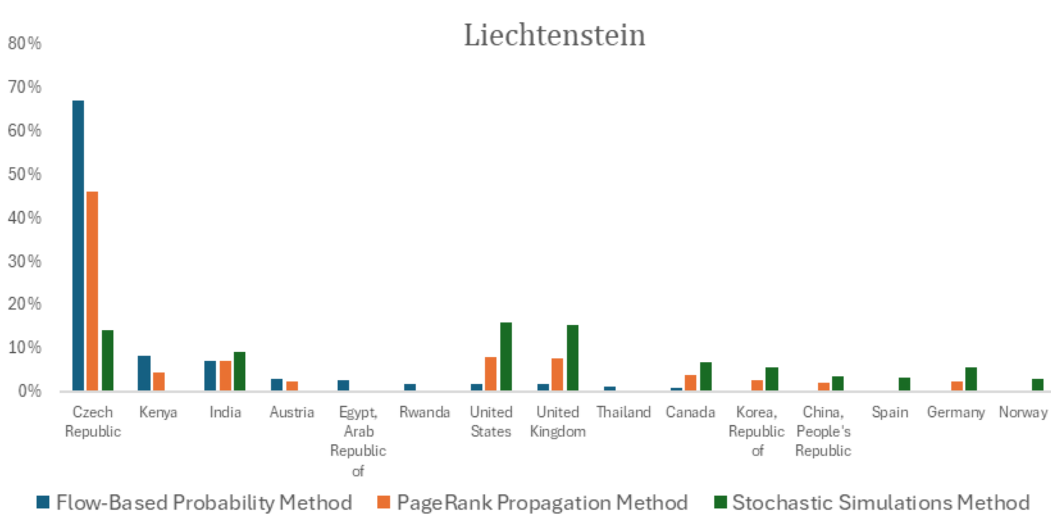

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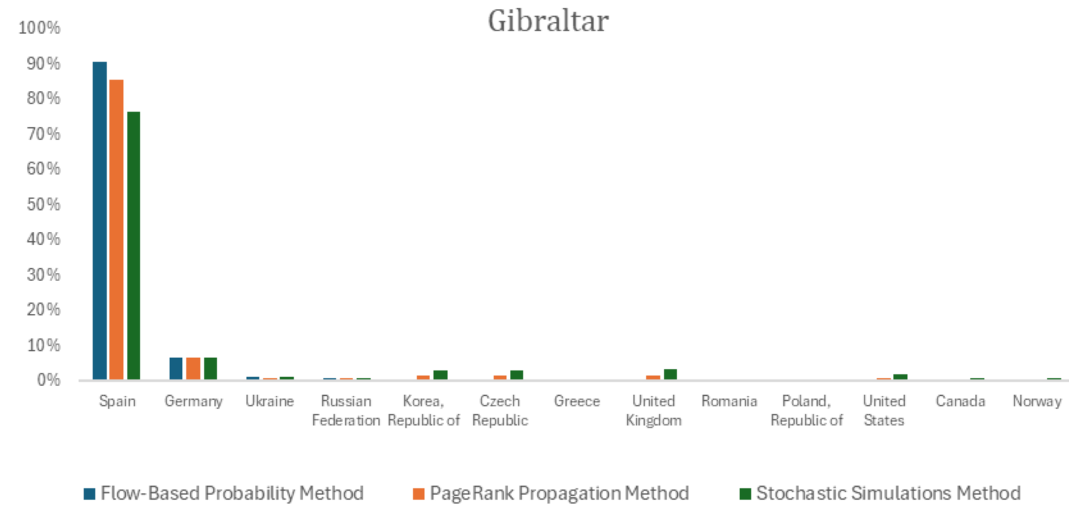

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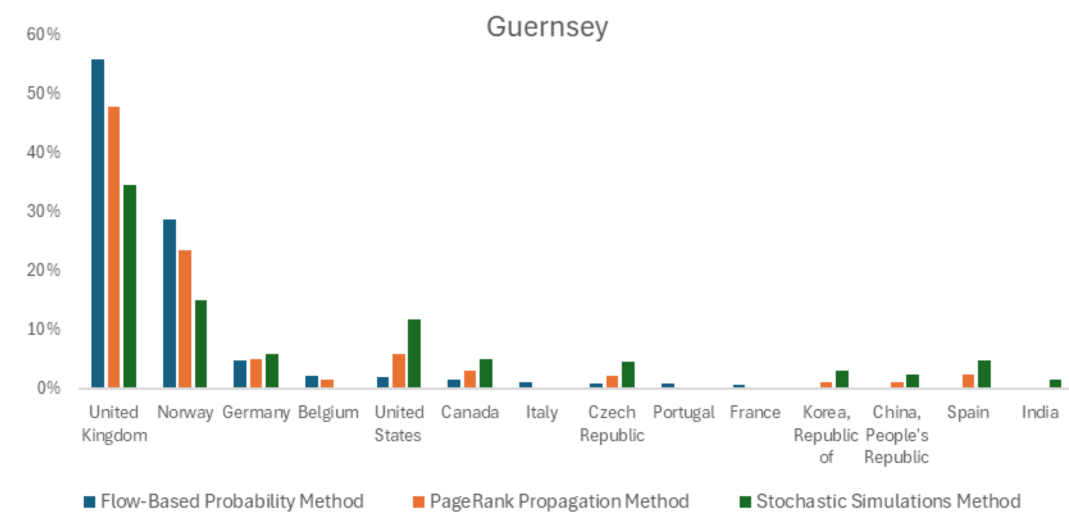

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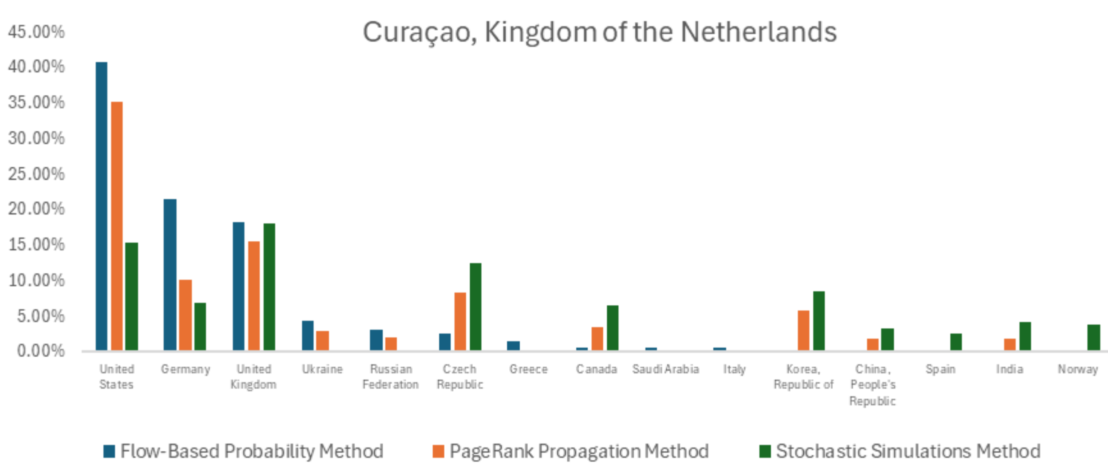

Source: Model outcome