

Methodology: Constructing Bilateral Remittance Matrices

Background paper accompanying "[The Geography of Remittances: An Updated Global Bilateral Remittances Matrix](#)" by Sam Huckstep and Michael Clemens

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Summary

This methodology note describes the construction of estimated bilateral remittance matrices for two years: a 2021 re-run of the World Bank (KNOMAD's) matrix, and a 2024 update using the same allocation logic.

We create a directional matrix, in which each cell estimates remittances received by a country of origin (remittance-receiving) economy from migrants living in a country of destination (remittance source) economy. The matrix allocates each recipient economy's aggregate remittance inflows across possible source economies using migrant-stock and income-based weights.

This matrix should not be interpreted as observed bilateral transaction data. It is a modelled allocation of official aggregate inflows, in which by construction each allocated recipient row sums to the remittance inflow total for that year as provided by the World Bank's dataset of remittances received.

The 2021 version is a current-vintage methodological re-run; it may therefore differ from the published KNOMAD 2021 matrix to the extent that data sources for relevant years have been updated in the intervening period. It applies the current (2024) UN DESA International Migrant Stock release to the 2020 reference-year migrant-stock table, preferring Eurostat host-row data where available and usable, and supplementing origins that the current release omits in the same way as for 2024 (see 'Supplementing origins omitted from UN DESA data'). Differences from the published KNOMAD 2021 matrix may therefore reflect changes in input vintages, source coverage, and implementation rules, not only substantive differences in remittance patterns. A variant that instead uses the UN DESA 2020 release directly, as KNOMAD did, is closer to the published matrix and is reported as a validation check under 'Assumptions and limitations'.

Data inputs

We use four main types of input data.

Input	Use in the construction
World Bank personal remittances received, current US\$	Binding recipient-row control. Each recipient's allocated bilateral inflows sum to this value.
World Bank GNI per capita, PPP, current international \$	Income proxy used in the corridor allocation score.
UN DESA International Migrant Stock origin-destination data	Default source of global migrant-stock data.
Eurostat country-of-birth data	Preferred host-row source for eligible EU/EFTA economies where coverage is adequate.
UN DESA International Migrant Stock 2020 release	Used to share out migrants whom the 2024 release groups as 'Others' across the countries of origin it omits.
National migrant-stock data for the United States, United Kingdom, and Germany	Used in place of the 2020 release to share out omitted countries of origin for these three countries of destination.
World Bank personal remittances paid, current US\$	Outflow diagnostic. (These values are not used to force column totals, and we have not systematically validated the matrix against observed bilateral transaction data.)

The same core method is applied to both target years.

Parameter	2021 re-run	2024 update
Target remittance year	2021	2024
Remittance inflow control	World Bank personal remittances received, 2021	World Bank personal remittances received, 2024
Income input	World Bank GNI per capita, PPP, current international \$, 2021	World Bank GNI per capita, PPP, current international \$, 2024
Global migrant-stock	UN DESA 2020 reference-year origin-destination table from the 2024 release, with omitted origins supplemented from the 2020 release and national data	UN DESA 2024 reference-year origin-destination table, with omitted origins supplemented from the 2020 release and national data
National data (only where origins are omitted)	US: American Community Survey 2020–2024 5-year; UK: Census 2021; Germany: Ausländerzentralregister, 31 December 2021	US: American Community Survey 2020–2024 5-year; UK: Census 2021; Germany: Ausländerzentralregister, 31 December 2024
Eurostat host-row override	Eurostat 2021 where usable; otherwise 2020; otherwise UN DESA	Eurostat 2024 where usable; otherwise 2023, 2022, 2021, or 2020; otherwise UN DESA

Notation

Symbol	Definition
i	Home or recipient economy
j	Host or source economy
T	Target year
R_i	Official remittance inflows received by economy i in year T
M_{ij}	Migrant stock from origin i living in host j
Y_i	GNI per capita of recipient economy i
Y_j	GNI per capita of source economy j
r_{ij}	Relative remittance score for corridor j to i
S_{ij}	Corridor allocation score
w_{ij}	Recipient-row allocation weight
B_{ij}	Estimated bilateral remittances received by i from j

Method

1. Defining the economy universe

We first map all source datasets to a common World Bank-centred economy concordance. We use World Bank economy codes and names as the main join and display standard wherever possible. We retain original labels and codes from UN DESA, Eurostat, and validation files for auditability.

We exclude world, regional, subregional, income-group, and other aggregate geographies, and include economies and territories in the final allocation only where they have both a usable remittance inflow control and usable migrant-stock data after harmonization.

We set self-corridors to zero only where the recipient and source are the same canonical economy, and retain distinct canonical territories as ordinary international corridors.

2. Attaching remittance and income controls

For each target year, we attach World Bank data on personal remittances received as the binding recipient-row control.

The World Bank's data on personal remittances received is obtained from balance-of-payments aggregated data collected by national authorities (almost always the central bank) compiled under the IMF's sixth Balance of Payments Manual and reported to the IMF, with estimates by World Bank staff filling gaps. This data source has advantages and disadvantages.

On the one hand, it is better than data compiled from remitters, cash apps, or even banks, because it is intended to include a major form of informal remittances: namely informal transfers, such as cash carried across borders as repatriated savings. This in principle gives it wider coverage. On the other hand, the use of central bank data may place some informal transfers –for example, hawala transfers settled through trade over-invoicing— in different parts of the national accounts, thus missing them in balance-of-payments aggregates; equally, some illicit finance laundered through unrequited transfers may mistakenly end up reported as remittances (Clemens and McKenzie, 2014).

We then attach GNI per capita, PPP, current international dollars for both the recipient and source economies. Where a target-year income value is missing, we use the most recent value from up to two years before the target year and flag it as lagged. We do not use post-target income values. Where no value exists within that window, we treat recipient and source economies differently. For a recipient economy, we use the most recent earlier value and flag it as stale; in practice this applies to South Sudan (2015) and Yemen (2013). For a source economy, we score the corridor at the recipient-income floor described below, so that it receives no income bonus. This mainly affects Venezuela and small territories such as Guam, New Caledonia, and Monaco, and follows the treatment implied by KNOMAD's published 2021 flows, in which corridors from these economies are scored at almost exactly the recipient's income. Recipient economies with no admissible income value in any year (New Caledonia and French Polynesia) remain unallocated, as in KNOMAD's matrix.

We use the current-PPP GNI per capita series consistently across economies.

3. Building the migrant-stock matrix

We build the migrant-stock matrix by host or source economy. For each source economy, we select one origin distribution and one host-row total, then map the distribution to the canonical geography.

We use UN DESA as the global default. However, UN DESA is an imperfect data source; its 2024 stock update fully reassessed only sixty countries' figures. For eligible EU/EFTA countries of destination, we therefore use Eurostat country-of-birth data where coverage is adequate; this covers the EU27-countries plus Iceland, Liechtenstein, Norway, and Switzerland.

For accepted Eurostat rows, the selected host-row total is the Eurostat total foreign-born stock. For UN DESA rows, the selected host-row total is the corresponding UN DESA total. This means the final migrant-stock matrix is intentionally heterogeneous: accepted Eurostat rows use Eurostat distributions and totals, while other rows use UN DESA.

4. Supplementing origins omitted from UN DESA data

The 2024 UN DESA release publishes far fewer named countries of origin for several major countries of destination than the 2020 release used by KNOMAD, including for the 2020 reference year. The number of named origins falls from 150 to 59 for the United States, from 205 to 35 for the United Kingdom, from 138 to 27 for Germany, and from 204 to 53 for France. The remaining migrants are grouped as ‘Others’: across all countries of destination, this category rises from 12.7 million to 22.6 million migrants for the 2020 reference year.

Without correction, corridors from omitted origins receive no migrant stock and therefore no remittances, while named origins are scaled up to the host-row total. This can produce implausible allocations. For example, the 2024 release records no Bermudians in the United States, United Kingdom, or Canada, so Bermuda’s remittances would be attributed mainly to Australia and Chile, rather than to the United States and United Kingdom as in KNOMAD’s 2021 matrix.

We therefore keep every named cell in the 2024 release unchanged, and allocate each country of destination’s residual (its UN DESA total less the sum of its named origins) across the origins that the release omits for that country. Each omitted origin is weighted by a prior stock: its stock in the 2020 release, multiplied by the growth of the country of destination’s total migrant stock between the two releases. No omitted origin receives more than its prior, so that a residual made up mostly of migrants of genuinely unknown origin is not loaded onto a few small omitted origins; any residual that remains is then allocated proportionally across all origins, as before.

For the three countries of destination where the loss of detail matters most—the United States, United Kingdom, and Germany—we replace the 2020-release prior with national data, rescaled to UN DESA levels using the ratio of UN DESA to national stocks across the origins that both sources name. For the United States we use the American Community Survey 2020–2024 five-year estimates of place of birth for the foreign-born population. For the United Kingdom we use Census 2021 country of birth for England and Wales (which contains 190 countries of birth), supplemented by Northern Ireland’s Census 2021 for origins that the England and Wales table also lists (Scotland’s census table is too aggregated to be used). For Germany we use the Central Register of Foreigners at 31 December of 2021 and 2024. The German register counts citizenship rather than country of birth, and so is used only for omitted origins; notably, it provides the Kosovo–Germany corridor, as Kosovo is not recorded separately in UN DESA data. Origins that the national tables themselves group together (for example, Bermuda and Tonga in the American Community Survey) fall back to the 2020-release prior.

We apply the same procedure to both target years, using the 2020 and 2024 reference-year columns of the 2024 release respectively, so that changes between 2021 and 2024 are not driven by UN DESA revisions between releases.

5. Applying a Eurostat residual rule

For each candidate Eurostat host row, we calculate named-origin coverage as:

$$\text{named – origin coverage} = \frac{\text{mapped named foreign – born origins}}{\text{total foreign – born stock}}$$

Reporting-country/native-born records, unknown origins, residual foreign-born categories, EU/non-EU aggregates, candidate-country aggregates, world totals, regions, and subregions are excluded from the named-origin numerator.

Rows with named-origin coverage of at least 95 percent are used without a residual-warning flag. Rows with coverage from 80 percent to below 95 percent are used but flagged. Rows below 80 percent are rejected, and the source-precedence rule moves to the next eligible year or to UN DESA.

For accepted Eurostat rows, mapped named-origin cells are scaled to the Eurostat total foreign-born stock. The scaling factor and residual share are recorded. This proportionally allocates residual mass to mapped named origins; it is not used where coverage falls below the acceptance threshold.

Blank Eurostat cells are treated as unpublished rather than as zero. Before scaling, unpublished origins in accepted rows are supplemented from the UN DESA 2020 release in the same way as omitted UN DESA origins (see above). In practice this matters mainly for Spain, for which Eurostat publishes only 52 named countries of birth.

6. Calculating corridor scores

For each corridor from source economy j to recipient economy i , we calculate a relative remittance score following the allocation approach taken by Ratha and Shaw (2007), as used by KNOMAD.

If the source economy is poorer than the recipient economy:

$$r_{ij} = Y_i$$

If the source economy is at least as rich as the recipient economy:

$$r_{ij} = Y_i + (Y_j - Y_i)^{0.75}$$

We follow Ratha and Shaw (2007) in setting the exponent at 0.75: for an explanation of the use of an exponent set at 0.75 see section 6.1. The score should be read only as a relative allocation score; it is not a monetary estimate and does not have a direct standalone interpretation.

We then combine the relative remittance score with the migrant stock:

$$S_{ij} = M_{ij} \cdot r_{ij}$$

For each recipient economy, we normalize corridor scores across all eligible source economies:

$$w_{ij} = \frac{S_{ij}}{\sum_{k \in J_i} S_{ik}}$$

Estimated bilateral remittances are then:

$$B_{ij} = w_{ij} \cdot R_i$$

This ensures that, for each allocated recipient economy, bilateral inflows sum exactly to the official remittance inflow control R_i .

6.1. Setting the exponent

Following Ratha and Shaw (2007), we set the exponent at 0.75 to maintain comparability to previous iterations of the matrix. This is not, however, the only option, nor the only option considered by Ratha and Shaw. In this subsection, we explain why this is chosen as a defensible simplification. A future improvement to the matrix could make use of new studies to fix a range of exponents on a country-by-country basis.

We know each recipient economy's total receipts R_i and the migrant stocks M_{ij} (migrants from home i living in host j), but not how much of R_i came from each host. The task is to split a known total, not to measure a new one. Suppose we pick a per-migrant amount r_{ij} ; a host's share is $r_{ij} M_{ij}$ normalised, applied to the known total. Estimating bilateral flows then reduces to one choice, what to use for r_{ij} :

$$w_{ij} = \frac{r_{ij} M_{ij}}{\sum_j r_{ij} M_{ij}}, \text{ bilateral}_{ij} = w_{ij} R_i$$

6.2. Upper bound option: treat every migrant alike

The first option provides an upper bound as applied to South-South remittances. In this case we would treat r_{ij} as a constant, so the weight is just the stock share. This would ignore income and thus over-weight poor populous hosts.

$$w_{ij} = \frac{M_{ij}}{\sum_j M_{ij}}$$

6.3. Lower bound option: scale by host income

The second option provides a lower bound to South-South flows. In this case we make r_{ij} equal host per-capita income Y_j . Now richer hosts would count for more, but remittances would be assumed to be strictly proportional to income, thus crediting a migrant in a host country poorer than the country of origin with almost nothing.

$$w_{ij} = \frac{M_{ij} Y_j}{\sum_j M_{ij} Y_j}$$

6.4. Ratha and Shaw (2007)'s approach

The approach used by Ratha and Shaw (2007) assumes migrants earn more than the non-migration counterfactual, but also assumes that there are limits to the remittances they are willing to send.

The first element is an earnings floor: even when working in a poorer country of destination workers are credited with at least home income Y_i , the income the migrant's absence costs the household, which keeps corridors between lower-income countries from collapsing to zero. The rationale applied here assumes that migrants make choices to avoid excessive opportunity cost. In leaving, the migrant chooses against the counterfactual earnings in the place of origin, which is on the order of Y_i , and the household thus loses that income. We assume that the household is seeking to optimise earnings, and thus that remittances will equal what would have been earned in the non-migration counterfactual. Accordingly, we use income levels as a proxy.

The second element is that of a diminishing bonus: when the host is richer, we add the income gain (Y_j minus Y_i) raised to a power below 1, so it rises but with diminishing returns, because the marginal propensity to remit falls as the migrant earns more. A migrant earning twice the income gain, for example, does not send home twice as much extra, because they consume more where they live whereas the family's needs back home are roughly fixed by living costs there. Pushed toward 1 the bonus mimics approach 2; flattened it mimics approach 1; 0.75 is an interpolation.

$$r_{ij} = \begin{cases} Y_i & \text{if } Y_j < Y_i \\ Y_i + (Y_j - Y_i)^{0.75} & \text{if } Y_j \geq Y_i \end{cases}$$

Ratha and Shaw derived the exponent by comparing raw model totals with observed receipts. In this update we subsequently fix recipient totals through row rescaling, so the exponent affects the allocation across source countries rather than each recipient's total. Let the model's raw row total S_i . We could fit the exponent country by country so that S_i equals the recorded receipts R_i :

$$S_i = \sum_j r_{ij} M_{ij}$$

However, Ratha and Shaw note that the fitted exponent proved broadly stable (0.74 for Bangladesh and China; 0.78 for India; 0.77 for the Philippines; 0.67 for Vietnam), so for all countries fixed it at 0.75, the average of the top twenty countries. Given that we are aiming to update the data in KNOMAD's model, rather than overhaul the model itself, we follow this approach. Future work could update the exponent, which is likely now to be less accurate than in 2007.

6.5. Pinning bilateral flows to country-receipt totals

If we simply fix the exponent at 0.75, S_i no longer equals R_i : r_{ij} cannot adjust because Y , M and the exponent are all fixed. Instead we multiply every corridor in a recipient's row by one scaling constant $c \equiv \frac{R_i}{S_i}$, the same for all hosts, equal to the recorded total over the model's raw total. Each corridor thus becomes that constant multiplied by its raw product. Summing the row makes the raw total cancel so that the row equals R_i exactly regardless of the exponent size:

$$\begin{aligned} \text{bilateral}_{ij} &= c_i r_{ij} M_{ij} \\ \sum_j \text{bilateral}_{ij} &= c_i S_i = \frac{R_i}{S_i} S_i = R_i \end{aligned}$$

The rescaling parameter c_i is R_i divided by the sum already sitting in the recipe's weight ($c_i r_{ij} M_{ij} = w_{ij} R_i$). It serves to convert the score units into recorded dollars. The total of remittances received by a country in total is thus fixed by R_i , while the exponent determines how this fixed total is allocated across source countries.

This method offers a pragmatic interpolation between an income-blind upper bound and an income-proportional lower bound. It sets a floor following assumptions regarding the avoidance of opportunity cost, while including an income-based diminishing-returns bonus, with a common curvature parameter of 0.75.

7. Applying exclusions and blocked corridors

Before normalization, we exclude or zero corridors that should not enter the allocation denominator.

Reported migrant-stock zeroes are treated as zeroes. Missing, suppressed, residual, or aggregate records are not converted into positive bilateral stocks unless they can be mapped to a named canonical economy, or are supplemented as described in 'Supplementing origins omitted from UN DESA data'.

Corridors with migrant stock but no admissible income score (after the fallbacks described in 'Attaching remittance and income controls') are recorded as unscored rather than zero. They are excluded from the recipient-row denominator.

Following KNOMAD's methodology, the following bilateral corridors are bidirectionally set to zero before normalization: India-Pakistan, Lebanon-Israel, and Azerbaijan-Armenia. Given transfer bans introduced between Russia and Ukraine following Russia's invasion in 2022, we also block the Russia – Ukraine corridor for 2024 only. No other corridors are zeroed.

These corridors are blocked at zero before recipient rows are normalised. Because each recipient's total inflow remains fixed, the excluded allocation is redistributed proportionally across its remaining eligible corridors. Results for affected countries therefore describe the distribution under the blocking assumption, not an estimate of the distribution that would prevail without it.

Assumptions and limitations

- The matrix estimates bilateral remittance exposure using migrant stocks and income-based allocation weights. It does not observe bilateral remittance transactions. Corridor-level values should therefore be interpreted as model-based estimates.
- The 2021 re-run is not a strict replication of the published KNOMAD 2021 matrix. It is a current-vintage reconstruction using the specified migrant-stock, supplementation, and Eurostat override rules, chosen so that 2021 and 2024 are built from the same UN DESA release. As a check, a variant that instead uses the UN DESA 2020 release directly for 2021, as KNOMAD did, reproduces 59 percent of KNOMAD's corridors worth more than US\$10 million to within 10 percent (value-weighted absolute difference: 14 percent). The adopted specification reproduces 36 percent (23 percent), largely because UN DESA revised its 2020 estimates between releases.
- The supplementation of omitted origins assumes that their relative size within each country of destination has changed little since the 2020 release, or is captured by the national data used. The UK census data date from 2021, the American Community Survey estimates pool 2020–2024 and are used for both target years, and the German data count citizenship rather than country of birth. Supplemented corridors are identified in the published matrix ('Stock data release' column).
- The fallbacks used where income data are missing are pragmatic. Scoring corridors from economies without income data at the recipient-income floor may understate flows from high-income territories, and stale income values for South Sudan and Yemen may not reflect current conditions.
- Because accepted Eurostat rows use Eurostat foreign-born totals and UN DESA rows use UN DESA totals, the migrant-stock matrix is not a single-source global stock matrix. This is intentional and auditable, but it should be considered when comparing results with KNOMAD 2021 or with single-source stock totals.
- Some economies may appear in Eurostat country-of-birth data but lack compatible UN DESA origin-destination stock coverage. These economies are retained only where usable corridor data exist and are flagged as partial-stock-coverage cases. Their bilateral distributions should be interpreted separately from fully covered economies.
- The remittance control variable, personal remittances received, includes both personal transfers and compensation of employees. This is broader than the migrant-stock concept and may create measurement tension for corridors involving short-term, seasonal, or cross-border workers.
- Column-sum discrepancies against outward-remittance controls are expected. They are reported as diagnostics rather than resolved through a second balancing procedure.
- Because the Ratha-Shaw score increases with source-economy income, small high-income jurisdictions and financial centres may receive high per-migrant scores even when migrant stocks are modest. This is a consequence of the allocation rule and these scores should be interpreted with caution.
- The core income specification uses current PPP GNI per capita to maximise coverage in the target-year build. This is suitable for cross-sectional allocation scoring, but it should not be interpreted as a constant-price measure of income growth over time.
- The 0.75 exponent used following Ratha and Shaw has not been re-estimated using contemporary corridor data. Corridor rankings and concentration measures are therefore conditional on this parameter.

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