Athens Journal of Social Sciences- Volume 12, Issue 4, October 2025 – Pages 283-300

Patterns of Migration Waves and Streams: Immigration to Israel, 1948–2016

*By Ilan Riss**

The expression "waves of migration" is frequently used in migration research, but the wave phenomena of migration remain insufficiently appreciated. This paper examines the wave features of migration systems by detecting types of migration waves and describing the distribution of the types of migration waves. Migration waves in the immigration to Israel from 1948 were classified by types according to their length, skewness, and steepness. Migration streams were also put in sets according to the types of waves within them. Types of waves and streams in migration systems can provide hints about the character of the sets of migration mechanisms and determinants acting in the migration systems. Because the detection of the structure of the set of migration waves is simpler than discovering migration determinants, this approach can alleviate the study of migration by throwing knowledge from already studied systems to unexplored ones by using the information on the shapes of their waves.

Keywords: *migration systems, migration waves, migration streams*

Introduction

Migration is extremely important in human lives. Its various aspects have been widely studied, but the wave structure, that is, the composition of the sets of migration streams and waves comprising them in the migration system, has not been discussed. At times, instead of the word "waves," other terms have been used, although the nature of the studied phenomenon was the waviness of migration streams. Migration streams from most European countries in the nineteenth century followed an inverted-"U" shape (Massey 1988, Hatton and Williamson 1998). In addition, rates of outmigration follow a trajectory that moves from low to high values and then to low again, generating a curve, which Martin and Taylor (1996) called the "migration hump." Migration waves have been investigated to determine changes in the rates of emigration and characteristics of migrants (Åkerman 1976). Additionally, determinants of migrations have been widely studied, demonstrating the variety of approaches (Bodvarsson and Van den Berg 2013, Hatton and Williamson 1998, Kley 2017, Mintchev et al. 2017, Cebula 2005, Kivisto and Faist 2010) but they have never been considered in connection with this aspect of migration streams. Ignoring the wave nature of migration streams can mislead researchers because these important characteristics of the migration process can be overlooked. This study aims to draw attention to the wave structure of migration systems, leaving the in-depth analysis of migration determinants of migration beyond the scope of this paper.

The wave approach proposed in this study considers the development of a migration flow within a system of demographic, social, economic, and natural processes in

*Retired Researcher, Israeli Central Bureau of Statistics, Israel.

https://doi.org/10.30958/ajss.12-4-4 doi=10.30958/ajss.12-4-4

migrant-sending and migrant-receiving regions and along migration routes. Migration waves are generated by negative feedback mechanisms in the migratory process and involve conditions at both the origin and destination, the carrying capacity of migratory channels, migrants' selectivity processes, and information exchange, among other factors. The migration wave appears as a reaction to the evolving migration drivers and expands until the region of arrival attains a point of saturation and/or until the pool of prospective outmigrants in the region of departure runs low. When this occurs, the migration flow fades out. During this process, different migration determinants are acting, and different types of migrants are becoming involved in the movement (Åkerman 1976). Consequently, migration waves are formed in different shapes, depending on the ever-changing situation in the migration system.

Background

The analysis of the patterns of migration waves and streams necessitates a brief explanation of some notions to introduce the approach presented in this paper. The first of the notions is the migration system. Numerous rather different definitions of this entity have been used because the system approach was first accepted in migration research decades ago (Bakewell 2014). The model of the migration system, which of a donor and a recipient subsystem interconnected by the migrant subsystem, has been argued to be the most suitable for studying migration as early as the beginning of the 1960s (Brown et al. 1963). De Haas (2009) described a migration system as a migration stream that begins and grows and then diminishes and eventually ends. Mabogunje (1970), in his frequently cited paper, defined a migration system as a set of places linked by flows of people, goods, services, and information. In another widely cited book on migration systems (Kritz et al. 1992), this analysis was extended to international migration. In other studies, international migration systems are viewed as comprising countries that exchange migrants and are regulated by feedback mechanisms linking the movement of people between countries, areas, and neighborhoods to the related flows of goods, capital, knowledge, and information (Bakewell et al. 2011). In a study of the characteristics and evolution of migration systems in time and space within the framework of the system approach, a migration system is defined as "identifiable flows of migration that link particular regions or countries to multiple destinations over time. This perspective views human mobility as part of global flows of goods, services, and information" (Borges 2009, p. 73).

This selection of studies on migration systems demonstrates the various definitions of migration systems adjusted to specific aims of different studies; thus, defining one additional purpose for the needs of this paper can be useful for a clearer presentation of the idea discussed herein. The definition of a regional migration system used in this paper is similar to Borges's (2009) definition. A regional migration system is a complex of migration streams related to a specific geographic region, flowing into, out of, or within it, and embedded within a wider socioeconomic system in its ecological environment and densely interacting with flows of information and matter. In this paper, the term "migration system" always refers to the regional migration system.

The migration stream consists of migrants moving from one place to another during a definitive period of time. Migration streams usually flow between two geographical regions for a considerable period. A short-lasting flow between two places can also be considered a type of stream in a migration system. A migration stream can include multiple substreams, each of which embraces specific groups of migrants or different types of migrants, such as people from disparate ethnic backgrounds and/or diverse occupational backgrounds, differently motivated migrants, and migrants from various places in the same region of origin or heading to different destinations.

Migration routes are paths of movement from places of origin to places of destination, such as the routes from the Soviet Union to Israel during the early 1990s, which included trips through, for example, Vienna, Budapest, and Warsaw. Migration channels relate to specific modes and itineraries by which the migrants migrate from the place of origin to the place of destination through specific routes, such as going by train from A to B and then by bus from B to C. The route of migration in this case is the way from A to C; the channel includes trains, buses, and railway stations when moving from A to B, from B to C, and so forth. Administrative and technical arrangements enabling the movement of people along specific routes are also parts of migration channels. Every route can include several channels. If it is possible to travel from A to B by train or by plane, there are two different migration channels along the same route. The migration stream can run through different routes between the same origin and destination, and its substreams that run along these routes can be split between the route or channels. Sometimes, statistics count migrants from only specific substreams, routes, or channels, presenting an incomplete, distorted picture of the migration stream.

Data

The paper studies wave patterns in the Jewish immigration to Israel from 1948 to 2016. This migration is the best documented subsystem of the Israeli migration system. Today, the published data are available for only one subset of the Israeli migration system, namely, Jewish immigration to Israel. Data on legal foreign workers are also available; however, they are temporary migrants and must be analyzed separately. Because these data are insufficient to characterize the system as a whole, the purpose of this paper is to analyze different types of migration waves in the Israeli migration system, although such an analysis is not comprehensive. The data used in this study is sourced from the Israeli Central Bureau of Statistics.

Israel is a country of immigration. From 1948 to 2016, the period considered in this paper, more than three million people immigrated to Israel, and this substantial number makes this analysis reliable. The streams differ by volume, from few hundred people from Norway to more than one million and quarter of immigrants from the USSR/former Soviet Union (FSU). A background information is needed for better understanding of the migration system of Israel. A valuable historical analysis of the immigration to Israel is given in the paper by Halamish (Halamish

2018). A relevant statistical classification of migration streams in Israel within its wider socioeconomic analysis is presented in the book by DellaPergola (2020).

The data on migrations are usually published in one-year intervals, which is one reason why the migration time series are still short. Obtaining the data for shorter periods is difficult and generally does not make sense because of seasonality within calendar years. In addition, the average duration of migration decision-making usually counts years (Amit and Riss 2013). Their implementation is also long; thus, the year intervals can be sufficient for most types of migration studies.

Data before 1970 were collected for one type of immigrants, namely, immigrants at the border, meaning those who declared their desire to obtain immigrant status when entering Israel. Potential immigrants and temporary and permanent residents were not included in the immigration statistics, although a considerable number of immigrants from Western countries belonged to these categories. A potential immigrant is defined in the Israeli statistics as a person entitled to immigration into Israel according to the Law of Return and who plans to stay in Israel to consider the option of settling in Israel (Dictionary of Terminology 2016). The Law of Return defines those persons who can receive Israeli citizenship through their ties to the Jewish people (The Law of Return 5710 1950). More complete data for immigration into Israel exist for the later period. The published data are less accurate for the 1970s than for the following years because the immigrants were presented not by actual year of immigration but by year of registration in the Israeli statistical system. These limitations do not prevent the use of this data for acquiring useful information on the distribution of migration waves.

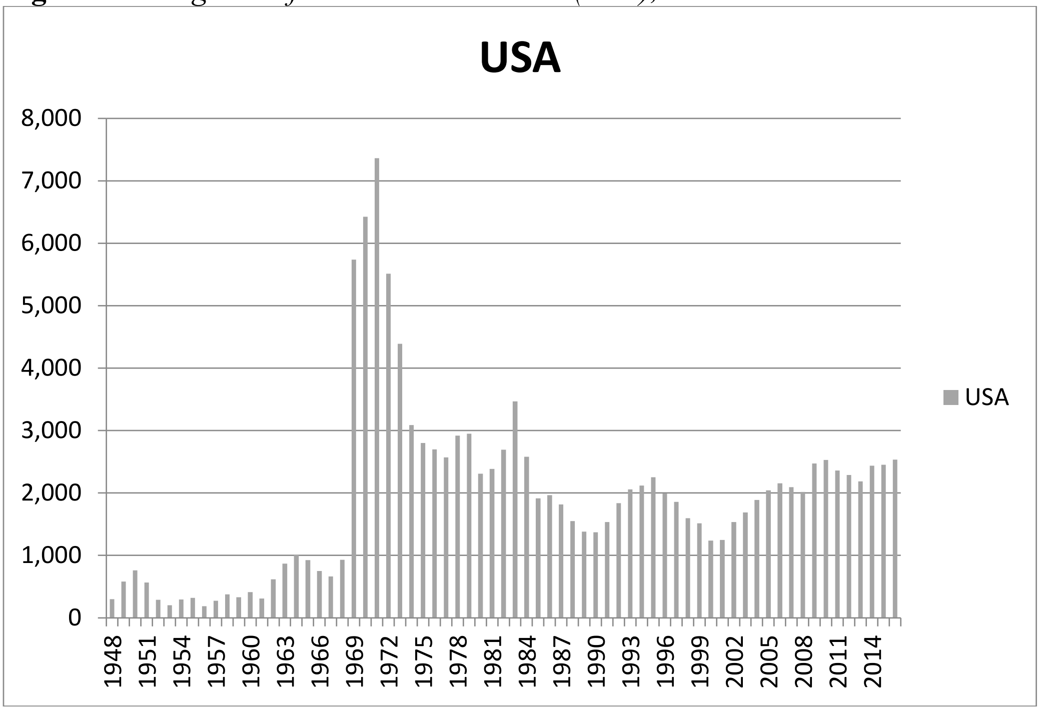
Data-restricted Research

Some general notes on the role of statistical data in social research are relevant in this section to explain the limitations of this study. An empirical study of migration waves is severely constrained by data availability. Usually, administrative data are collected for specific managerial purposes, and scientific research only reuses this data. Research based on dedicated surveys is restricted by the aims of the survey and by the size of the sample. Consequently, most migration research is data restricted, that is, the course of the research and the research questions are bounded and targeted by the available data and, accordingly, the migration theories derived from such statistics are also data restricted because researchers must study not what they want, but what they can. Paradigm-breaking research, such as that that introduces innovative ideas (Kuhn and Hacking 2012), is very problematic or often impossible because of restrictions put on the research by the available data. The collecting of administrative data should be driven not only by quotidian administrative needs but also by upcoming research targets; only then can the understanding of social processes move up to a higher stage.

Method

In this study, the shapes of migration waves were analyzed, and an apparatus to describe and classify them was proposed. First, characteristic numbers for migration waves describing their shapes were defined and computed. The characteristic wave number is built as a decimal number that mimics in its form the shape of the migration wave (Figure 1). This number was reduced to a binary number that provides a less detailed characterization of the wave but is more convenient for performing some important steps in the analysis of migration waves. Migration waves in the time series in the Israeli migration system were then classified by type according to their length, skewness, and steepness. Coefficients measuring these characteristics were defined and calculated. The next step was to count the incidences of migration waves of different lengths in the considered migration subsystem. Finally, cluster analysis was applied to groups with similar waves by shapes and streams by types of waves, and within them, in sets for their future consideration.

Figure 1. *Immigration from the United States (USA), 1948–2016*



Characteristics of the Shapes of Migration Waves

The wave decimal characteristic number (dectype) was calculated by using the following procedure. All computations were performed in an Excel VBA program written for this purpose. In this analysis, waves were taken as a set of values from trough to trough in the migration time series (Figure 1). The values of the troughs are presented in Table 1. The graph presents an example of an immigration stream, namely, that from the United States between 1948 and 2016. The first and last waves of the series are incomplete—the beginning of the first wave and the end of the last wave in the series are unknown and are not considered in the analysis. First, the beginning and end of the considered migration wave were detected as the troughs on the graph (Figure 1 and Table 1). Next, the maximal value was found for the considered wave. The maximal value was designated as A, which denotes 10 in the characteristic number to maintain one decimal position in the dectype for each year in the migration wave. Every other value in the characteristic number was defined as rounded for one decimal place result of division of every value in the wave into the maximal for the considered wave value. If the rounded value was larger than 9, the 9 was substituted instead to maintain only one maximum in the dectype. Obviously, the characteristic number could be built as a hexadecimal number, but it seems to be more laborious, and the effort was not deemed worthwhile at this stage of the study of migration waves.

Dectypes of the waves are shown in Table 1. Migration waves of different dectypes can be reduced to a smaller number of groups having equal bintypes. A migration wave's bintype was built as a sequence of ones and zeros, where one indicated that the number of the migrants was higher or equal to the previous value, and zero indicated that the number of migrants was less than or equal to the previous value. The accepted sequence of ones and zeros' is a binary characteristic number and is the wave's bintype (Table 1). Types of waves in the table refer to the waves enclosed between two successive troughs and are recorded in the line of the first of them. The binary characteristic number is always represented as a string of ones in its first part and a string of zeros in its second part. The proposed algorithm computes the dectype and bintype for every migration wave in the considered dataset (Table 1).

Table 1. *Characteristic Numbers of Migration Waves*

Year of Trough	Dectype	Bintype	Wave Length	Steepness of Growth	Steepness of Decay	Skewness
1956	9A6	110	3	0.45	0.3	0.5
1959	7A9	110	3	0.35	0.45	0.5
1961	A8	10	2	1	0.4	0
1967	69A977	111000	6	0.2	0.175	0
1977	189A764443	1111000000	10	0.025	0.042857143	-0.222222222
1980	9A8	110	3	0.45	0.4	0.5
1985	78A76	11100	5	0.233333333	0.2	0.25
1990	A9877	10000	5	1	0.14	-0.75
2000	7899A98775	1111100000	10	0.14	0.083333333	0
2008	67899A99	11111100	8	0.1	0.3	0.571428571
2013	9A999	11000	5	0.45	0.225	-0.25

Analyzing the determinants specific to every bintype is tedious; this analysis is even more tedious for the determinants specific to each dectype, although it can be helpful when migrations accumulate a very large amount of information. However, when numerous distinct types of migration waves represented by their dectypes are detected, their study can be simplified because they can be combined into a few groups by their shapes by using a cluster analysis procedure. The shape of a migration wave is characterized by its wavelength, steepness, and skewness; consequently, the wave shapes can be clustered by the values of these statistics. Migration streams can thus be clustered by the types of migration waves that comprise them. Dectypes and bintypes serve as a basis for the computation of the aforementioned characteristics of the waves. Wave steepness is generally understood as the ratio of the wave height to the wavelength. Here, the steepness is measured separately for the growth and decreases in migration waves.

Steepness of growth is measured as

$$(A\text{-}f)/N_F$$

The steepness of decline is measured as

$$(A\text{-}l)/N_L,$$

where A is the largest value in the dectype (10), f is the first number in the dectype, and *l* is the last one. N_F is the number of steps from the first number to A, and N_L is from A to the last one. Skewness is a measure of the symmetry in a wave; it is measured by the ratio of the number of digits before A less the number of digits after their sum. Its computation is simpler than that of the usual Pearson's coefficients of skewness, and the coefficient is sufficiently descriptive and precise for the purposes of this study. The examples of computed values for these statistics are also presented in Table 1. A cluster analysis based on these counted parameters of migration waves was performed using the "K-means cluster" procedure in SPSS 24. The cluster number serves as a generalized type of the migration wave.

Results and Discussion

Determinants of Shapes and Volumes of Migration Streams and Waves

The differences between various migration waves and various streams originate from different sets of migration determinants in migration systems, including the different durations of migration decision-making that also depend on the determinants acting in the system, especially the migrants' personal and cultural traits. Regrettably, because of the current availability of statistical data, wave-like processes in migrations are barely analyzable. Some data are available for reviewing the shapes of the waves, but the data for studying their wave determinants are scarce. Therefore, the following speculation is also a type of speculation about migration waves' determinants and aims to touch only the most salient of them. Some exemplary waves are schematically sketched together in this paper, along with their apparently decisive determinants. In this section, the distributions of migration waves and streams by types in Israel's migration system are presented.

Clusters of Migration Waves

The distribution of waves by dectype suggests that every wave is unique. A table of the distribution of the waves by their dectypes would be large, and its utility for this study would be small; thus, it is not shown in this paper. However, despite the vast variety of dectypes, even a quick glance at the migration waves on the graphs shows a noteworthy similarity between them. The purpose of this study is to detect and present this similarity. First, migration waves were grouped by length. The length of a migration wave was measured by the number of digits in its bintype. Table 2 shows some distinct wavelengths.

Table 2. *Distribution of Migration Waves by Length*

Wavelength	Frequency	Percent
2	162	27.6
3	144	24.6
4	94	16.0
5	62	10.6
6	53	9.0
7	26	4.4
8	20	3.4
9	3	.5
10	6	1.0
11	3	.5
Total	573	97.8

Lengths of migration waves in the considered part of the Israeli migration system are mostly short. The number of waves in each length group gradually diminishes from the length of two to eleven. The leap in length of ten is probably a random fluctuation, because the number of waves of these lengths is very small. However, migration waves are distinguished not only by length but also by shape, with the latter being more important. The cluster analysis performed in this study identified five types of waves according to shape. These clusters include waves of different lengths if their shapes were found to be similar, when the similarity is measured by previously defined coefficients characterizing the wave shapes. The inclusion of waves of similar shapes but of different lengths within the same cluster can indicate the functioning of similar determinants but with different strengths and paces of development. The distribution by wave clusters in the immigration subsystem of Israel’s migration system shows that different types of waves have different incidences. The distribution of the wave clusters by the bintypes comprising them provides a more descriptive presentation of the migration waves’ clusters (Table 3).

Table 3. *Distribution of Wave Clusters by Wave Bintypes*

Wave's Bintype	Number of Clusters					Total
	1	2	3	4	5	
10	0	0	0	0	162	162
100	0	0	71	0	0	71
1000	0	0	29	0	0	29
10000	0	0	16	0	0	16
100000	0	0	10	0	0	10
1000000	0	0	11	0	0	11
10000000	0	0	1	0	0	1
1000000000	0	0	1	0	0	1
10000000000	0	0	1	0	0	1
110	73	0	0	0	0	73
1100	0	0	0	38	0	38
11000	0	17	0	0	0	17
110000	0	18	0	0	0	18
1100000	0	5	0	0	0	5
11000000	0	6	0	0	0	6
1110	27	0	0	0	0	27
11100	0	0	0	25	0	25
111000	0	0	0	13	0	13
1110000	0	5	0	0	0	5
11100000	0	5	0	0	0	5
111000000	0	1	0	0	0	1
1110000000	0	2	0	0	0	2
11100000000	0	1	0	0	0	1
11110	4	0	0	0	0	4
111100	7	0	0	5	0	12
1111000	0	0	0	2	0	2
11110000	0	0	0	3	0	3
1111000000	0	1	0	0	0	1
1111100	2	0	0	0	0	2
11111000	0	0	0	3	0	3
1111100000	0	0	0	2	0	2
1111110	1	0	0	0	0	1
11111100	2	0	0	0	0	2
111111000	0	0	0	2	0	2
11111110000	0	0	0	1	0	1
Total	116	61	140	94	162	573

Description of the Clusters of Migration Waves

The clusters of migration waves by shape similarity are presented in the order of their magnitude: 5, 3, 1, 4, and 2 (Table 3). Cluster #5 includes only symmetrical and short waves of wave bintype 10. These waves result mainly from statistical inaccuracies and rarely from really small, mostly random fluctuations in the number of migrants over the years. It also explains why the fifth cluster is the biggest cluster, containing 162 waves. Random here means that fluctuations stem from the personal circumstances of the migrants and not from those related to the migration system as a whole. Naturally, waves of this type are more frequent in the streams with low volumes and intensities of migration that are generally triggered by personal motivations of migrants and not by determinants common to the majority of the migrants.

Cluster #3 includes waves whose shape is characterized by steep growth and gradual decline. This cluster includes 140 waves. An example is a case of the immigration from the FSU between 1999 and 2008. The wave was caused by Russia's default in 1998. However, this wave's impact was short-lived, and later, the long-term trend of the fading out of the emigration drives continued. This type of wave is probably created by short-term disturbances against the background of long-term determinants inducing the decline in migration.

Cluster #1 comprises 116 waves whose shape has gradual growth and a steep decline. Such a shape results from the gradual development of migration between two places where various determinants are the drivers, such as long-term differences between regions and the institutionalization of migration. This process is ended for strong reasons, external to the previously acting stream determinants, such as by administrative decisions on future immigration from a definitive country. Waves of immigration to Israel were influenced by Israel's immigration politics, including quotes, selections, and other measures of the regulation of the volumes and composition of migration streams to Israel (Friedlander and Goldscheider 1979).

One example is immigration from Ethiopia. The waves in 1984 and 1991 were prepared over multiple years when a growing number of immigrants were brought to Israel until the process culminated in the action of bringing many immigrants in one year. After this deed, the Israeli administration saw the mission as accomplished, and the wave was administratively halted. In 1984, it was a secret operation; however, moving many people from one country to another secretly was impossible, and the migration stream ceased. In 1991, the officers responsible for immigration thought that everyone eligible for immigration had already migrated to Israel (Bard 2005). However, each time, additional groups of immigrants who learned of the possibility of immigrating to Israel entered the collection centers in Ethiopia, and eventually, it was necessary to send them to Israel; thus, the process had to be continued, although the waves had considerably lower volumes.

Cluster #4 comprises 94 symmetric waves with gradual growth and a gradual decline. Such waves emerge when the migration process freely develops. Such waves were observed in the immigration from the United States between 1990 and 2000. This wave developed against a backdrop of a big wave from the countries of the former USSR. However, after a short period of confusion at the beginning of the mass immigration from the USSR in 1990–1991, the immigration from the USSR/FSU began to be strongly limited by the Israeli authorities. The US immigration, still small in number, could develop freely; thus, a type 4 wave formed. Only during the emergency in the FSU because of the severe economic crisis in 1998 did the number of US immigrants diminish; later, when the short upsurge of immigration from Russia changed because of its gradual diminishing, a new wave of immigration from the United States emerged.

Cluster #2 comprises 61 asymmetrical waves with relatively short gradual growth and a long slow decline. This cluster is similar to Cluster #3, but the waves develop somewhat more slowly. The determinants were insufficiently strong to cause large-scale outmigration in a short time, but the waves were strong, and considerable time was necessary for them to fade out, producing the specific shape of the migration wave. In addition, these waves of immigration can be modulated by the mechanisms of the migration channel. Immigration from the former USSR between 1993 and 1998 and from the US between 2009 and 2013 belong to a type 2 wave. The wave from the FSU can be related to the attempted coup in 1993 and the Chechen War in 1994, and the end of the wave to the default in Russia in 1998 triggered a new wave of emigration. The wave from the United States could be related to the 2008 economic crisis. These causes were insufficiently strong to cause large-scale outmigration but could have led some groups of the populations that previously considered the move to make the migration decision at that moment. These decisions were not made in a rush, but occurred in a brief period, producing the specific shape of the migration wave. In addition, these waves of immigration were modulated by the mechanisms of the migration channel, including administrative decisions made in Israel.

Some questions were from looking at the considered distribution of the wave types. Cluster #1 and Cluster #3 form a mirror couple. Why does is there no mirror couple for the second cluster, namely, asymmetrical long growth and a gradual decline? Is it specific to the considered dataset or are there causes that make such waves rare in general? Waves with a lower steepness of growth and decline (i.e., those of the second and fourth types) are rarer than other types, at least as studied in this paper in the subset of streams in the Israeli migration system. Such waves require more time to develop, which can make them occur less frequently because migration systems are generally vulnerable to changes in the acting set of migration determinants. Different sets of migration determinants probably have dissimilar longevity, which restricts the stability of the migration system. The differences in wave volumes and shapes can be traced to diverse wave-forming determinants. Long waves are related to long-term socioeconomic processes and based on long-lasting socioeconomic settings. Short waves are caused by short-term determinants, such as specific events in these countries that prompt some people to change their place of residence.

Clusters of Migration Streams

After distinguishing the types of migration waves, the patterns of occurrence of different waves in migration streams were checked using the clustering of migration streams from immigrants' countries of origin according to wave types. Streams in Israel's migration system differ in the numbers of waves and the types of waves within them.

Table 4. *Clusters of Streams of Migration from Countries of Last Residence*

Country of Residence	Wave Cluster Number					Number of Waves	Stream Cluster Number
Algeria	0	1	0	1	0	2	1
Iraq	1	0	3	0	0	4	1
Yemen-Aden	1	0	0	1	2	4	1
Iran	0	2	3	3	0	8	1
Libya	0	1	2	0	5	8	1
Egypt-Sudan	1	2	2	1	3	9	1
Syria-Lebanon	2	1	2	1	4	10	1
Afghanistan	2	0	3	2	4	11	1
Morocco	2	3	0	2	2	9	2
USSR_FSU	2	2	1	3	1	9	2
Argentina	3	4	1	2	1	11	2
USA	4	2	1	3	1	11	2
France	4	3	1	2	2	12	2
Brazil	3	2	1	5	3	14	2
Australia	2	1	5	4	4	16	3
Tunisia	1	2	4	2	2	11	3
United Kingdom	2	3	5	1	3	14	3
South Africa	3	3	4	2	1	13	3
Belgium	4	1	6	3	0	14	3
Uruguay	3	1	4	3	3	14	3
Czechoslovakia	3	0	5	4	3	15	3
Turkey	3	3	5	1	3	15	3
Ethiopia	5	2	3	2	2	14	3
Hungaria	5	2	3	3	2	15	3
Yugoslavia	4	2	3	4	3	16	3
Germany	4	1	3	4	3	15	3
Austria	5	0	4	2	7	18	4
Finland	3	3	3	1	8	18	4
Netherlands	6	0	5	1	7	19	4
Sweden	4	1	2	3	6	16	4
Mexico	4	2	3	2	6	17	4
Norway	4	1	3	3	6	17	4
Poland	1	2	5	1	6	15	4
Chile	2	3	4	2	5	16	4
Denmark	4	0	7	1	5	17	4
Switzerland	3	1	5	2	7	18	4
Romania	4	3	5	0	5	17	4
Bulgaria	2	0	7	3	6	18	4
Greece	2	1	7	2	9	21	4
Canada	3	0	3	5	6	17	5
India	1	0	5	5	6	17	5
Italia	4	0	2	2	10	18	6

Table 4 presents the numbers of waves in a country stream by wave types. The presence of different types of waves in the streams limits the number of waves; thus, the clusters are characterized by the average number of waves per cluster shown in the table. At this stage, the order of the waves in the migration stream was not considered when defining the clusters, although it can also be an important characteristic of the migration stream because the sequence of similar waves indicates the existence of similar long-term stream determinants. The same wave types can be observed in the migration streams of different volumes, which can hint at the acting of identical determinants in migration streams despite the differences in their volumes. Similar sets of determinants can act at different steps of development in their migration streams. Different stream clusters have different characteristics, and we summarized this next.

Cluster 1 includes streams with a low number of waves; these are the streams from those countries from which immigration ceased a long time ago, mostly because of the extinguishing of their Jewish populations because of emigration. These streams are characterized as short and discontinuous streams. Eight streams are in this cluster, and the average number of waves per stream in the cluster is 5.6.

Cluster #2 includes mainly waves of types 1, 2, and 4, and a few of type 5. Cluster #2 is the most notable for further analysis and includes Morocco, the USSR/ FSU, Argentina, the United States, France, and Brazil—countries with substantial Jewish populations that produce migration streams with considerable volumes, although with disparate intensities (i.e., ratios of the numbers of immigrants to the sizes of the sending Jewish populations). The Jewish populations in these countries live in very different political climates; they usually are not pressured to leave, except during social cataclysms, such as in the late 1950s and 1960s in Morocco after gaining independence from France and at the time of the Soviet Union's collapse in the 1990s. In the FSU, there have been no specific anti-Jewish events, but difficult socioeconomic conditions created outmigration pressure on all former Soviet people, and the Jewish people had an opportunity to leave for Israel. Immigration from all these countries is controlled by the Israeli authorities, and the volumes and shapes of the immigration waves are strongly influenced by them. Six streams are in this cluster, and there are on average 11 waves per stream in the cluster.

Cluster #3 includes many type 3 waves characterized by steep growth and gradual decline, which were mostly reactions to short-term wave determinants. The cluster consists mostly of the streams of immigration from Western countries, but Ethiopia also belongs to this cluster. Jewish emigration from Western countries reacts to relative changes in socioeconomic conditions there and in Israel that push some groups of Jews to relocate to Israel. This group of Jewish people has the freedom to react (or not) to these changes. The socioeconomic differences between Israel and Ethiopia are strong and steady. Israeli authorities regulated immigration from Ethiopia, which could shape the migration waves in the stream stronger than any other wave determinant. The waves include organized immigration operations that brought many immigrants to Israel during very short periods and brought other immigrants slowly on the basis of a thorough check of their right to enter Israel. These determinants include a strong push/pull component and gradual complementation of the emigration wave that create similar migration streams.

For Western countries, the major migration determinants were the interplay of socioeconomic settings and, probably, some wave-generating political events. For Ethiopia, the determinants mostly occurred in the administrative regulations in Israel, but they created similar streams of immigration. Thus, different systems of migration determinants may have a similar internal structure, generating similar shapes of migration streams, although these determinants may be of different socioeconomic characters and can be realized through different socioeconomic mechanisms. The commonality of all these streams is the existence of the continuous emigration pressure released from time to time because of some migration-generating events that initiate new migration waves. The number of streams in the cluster is 12, and the average number of waves per stream in the cluster is 14.3.

Cluster #4 contains many type 3 waves and five that are reactions to short-term determinants, in addition to random fluctuations or statistical flaws resulting in many waves in the streams. This finding can be explained by the small size of the Jewish populations in the countries of origin and by the absence of strong outmigration determinants. This cluster comprises 13 streams, and the average number of waves per stream is 17.5.

Cluster #5 comprises two countries and includes wave types 3, 4, and 5. Canada and India have similar, namely, rather calm, political conditions for the Jewish people who live there. The two countries differ in culture, economy, social structure, and the composition and origin of their Jewish populations. Nonetheless, the migration determinants in these streams are similar. The determinants of the Jewish emigration from these countries are short-term and determine the shortness of the waves. The small populations of the immigrants from these countries do not demand special reactions from Israeli authorities, and they were not administratively controlled. On average this cluster included 17 waves per stream.

Cluster #6 comprises one country, Italy, which has a small Jewish population that lives in a politically favorable climate. The cluster has 18 waves in the stream. Cluster #6 is similar to Cluster #5 but trembles even more because more than half of its waves are type 5 waves. As the streams in Cluster #5 and Cluster #6 are similar, they can be analyzed together.

Both migration streams and migration systems can be characterized by the number and shapes of waves that occur during a specific period, such as during the lifetime of the stream or during a timespan between two notable events in the system or a period under consideration. The trembling migration process is a sequence of many very short migration waves of type 5, including Cluster #5 and Cluster #6. Countries with a small population of Jewish immigrants show this stream pattern. Smooth migration processes, such as those in Cluster #2, comprise long migration waves. There are also mixed types of migration processes, as observed in Cluster #3 and Cluster #4; they are built from streams showing trembling, and the latter is somewhat more unsteady than former. This is evident from the clusters in which a definite size of the sending population is necessary to produce streams with long waves with high volumes. Streams from such origins are characterized by a relatively small number of waves of type 5 because they are smoothed by a sufficiently high volume of migration; errors and random fluctuations are less salient in them than in rivulets. General socioeconomic wave-forming determinants are stronger in such streams than personal stimuli are. In general, distinct types of migration streams have different sets of wave types that are set by determinants specific to migration streams of a certain type.

Conclusions and Further Research

In this pilot study of migration wave phenomena, the main types of migration waves in the subset of the Israeli migration system were identified and briefly discussed. This typology of migration waves can serve as an initial framework for the analysis of migration determinants. Different shapes of migration waves can be associated with specific migration determinants. Migration systems can have distinguishable distributions of migration wave types. The differences between them are expected to depend on the determinants of migration acting in the systems; in addition, the sets of waves in migration systems can suggest the sets of migration determinants that affect the migration system. A migration system's situation can be assessed by examining the types of discerned migration streams composing the system. The clustering of migration systems with different stream types, such as vibrating systems (many very short waves in the streams), quiet systems (smooth symmetric waves of moderate lengths), and troubled systems (many skewed waves of various lengths), can set the direction for the classification of migration systems. By contrast, volumes of migration waves, in general, are country specific because of their dependence on the population size; the shapes of migration waves appear to be rather universal because these shapes are mediated by the human decision-making processes that react to the environmental and socioeconomic settings of migrations.

The detection of the types of statistical distributions of waves and streams in migration systems can be useful. Specific statistical distributions are usually linked with definitive real processes. Binomial distribution is often used to estimate or determine the proportion of individuals with a particular attribute in a large population. The Poisson distribution is widely used in quality control, reliability, and queuing theory. The normal distribution is the most commonly used distribution to model univariate data from a population or an experiment. Gamma distribution occurs in situations where there are concerns about the waiting time for a definite number of independent events to occur. The Pareto distribution is used to simulate the data on personal incomes and city population sizes (Krishnamoorthy 2016). It is natural to expect the existence of specific statistical distribution for waves and streams in general for all migration systems, or perhaps different types of statistical distributions exist for different categories of migration systems. Knowing the underlying probability distributions of shapes of migration waves and migration streams in migration systems can improve the understanding of the migration processes and thus the governance of the migration system.

More sophisticated methods for defining the characteristic numbers of migration waves can be developed that will make it possible to describe the shape of migration waves more precisely. Every migration wave can be described by using a probability distribution. Every migration wave and every migration stream are processes with deterministic and stochastic components. Every dectype can be represented as a combination of Haar wavelets (Todd 1997). Undoubtedly, stronger mathematical methods can improve the results of the analysis of migration systems.

As the evaluation of the structure of the set of migration waves is seemingly simpler than defining the system of migration determinants, it can facilitate the study of migration systems. The mechanism we describe makes it possible to classify migration streams and waves and is intended to help in the analysis of migration determinants. Determinants of migrations can be better studied if migrations are considered wavy processes because in such a case, the determinants of growth and decline are necessarily studied. There are many social wave-like processes, and they likely have determinants analogous to those acting in migration. These wave-like phenomena in social processes should be the topics of further research.

References

Åkerman S (1976) Theories and Methods of Migration Research. In Harald Runblom, Hans Norman (eds.), *From Sweden to America*, 19–75. Uppsala: Acta Universitatis Upsaliensis, 1976.

Amit K, Riss I (2013) The Duration of Migration Decision-Making: Moving to Israel from North America. *Journal of Ethnic and Migration Studies* 39(1): 51–67.

Bakewell O (2014) Relaunching migration systems. (Oxford University Press) 2, no. 3 (November 2014): 300–318.

Bakewell O, de Haas H, Kubal A (2011) *Migration systems, pioneers and the role of agency.* Vol. Paper 48. IMI Working Papers Series.

Bard, Mitchell Geoffrey. *From Tragedy to Triumph: The Politics Behind the Rescue of Ethiopian Jewry.* Westport, CT: Praeger, 2005.

Bodvarsson Örn B, Van den Berg H (2013) The Determinants of International Migration: Theory. In Örn B. Bodvarsson, Hendrik Van den Berg (eds.), *The Economics of Immigration: Theory and Policy*, 27–57. New York: Springer Science+Business Media.

Borges MJ (2009) Regional Patterns of Migration: A Systems Approach. In Marcelo J. Borges (ed.), *Chains of Gold: Portuguese Migration to Argentina in Transatlantic Perspective*, 71–138. Leiden, Boston: Brill.

Brown JS, Schwarzweller HK, Mangalam JJ (1963) Kentucky Mountain Migration and the Stem Family: An American Variation on a Theme by Le Play. *Rural Sociology* 28: 48–69.

Cebula RJ (2005) Internal Migration Determinants: Recent Evidence. *International Advances in Economic Research* 11(3): 267–274 .

de Haas H (2009) *Migration System Formation and Decline: A theoretical inquiry into the self-perpetuating and self-undermining dynamics of migration processes.* Working Paper, 19. James Martin 21st Century School., International Migration Institute, University of Oxford.

DellaPergola S (2020) *Diaspora vs. Homeland: Developent, Unempployment and Ethnic Migration to Israel, 1991-2019.* Jerusalem: The Avraham Harman Institute of Contemporary Jewry, The Hebrew University of Jerusalem.

Dictionary of Terminology (2016, May 24) *Israeli Central Bureau of Statistics.* Available at: http://www.cbs.gov.il/reader/Milon/Milon_ByTerm_E.html?MyID=337&OnlyFinal=1.

Friedlander D, Goldscheider C (1979) *The Population of Israel.* New York, NY: Columbia University Press, 1979.

Halamish A (2018) Immigration Is Israel's History, So Far. *Israel Studies* 23(3): 106–113.

Hatton TJ, Williamson JG (1998) *The Age of Mass Migration: Causes and Economic Impact.* 1st Edition. Oxford University Press.

Kivisto P, Faist T (2010) *Beyond a border: the causes and consequences of contemporary immigration.* Los Angeles: Pine Forge Press, an Imprint of SAGE Publications, Inc.

Kley S (2017) Facilitators and constraints at each stage of the migration decision process. *Population Studies* 71(no. Sup1): 35–49.

Krishnamoorthy K (2016) *Handbook of statistical distributions with applications.* 2nd Edition. Boca Raton, FL: CRC Press, Taylor & Francis Group, LLC.

Kritz MM, Lean Lim L, Zlotnik H (1992) *International Migration Systems: A Global Approach.* Oxford: Clarendon Press.

Kuhn TS, Hacking I (2012)*The Structure of Scientific Revolutions.* 50th Anniversary Edition Fourth Edition. Chicago, IL.: University of Chicago Press, 2012.

Mabogunje AL (1970) Systems Approach to a Theory of Rural-Urban Migration. *Geographical Analysis* 2(1): 1–18.

Martin PL, Taylor JE (1996) The anatomy of a migration hump. In J. Edward Taylor (ed.), *Development strategy, employment, and migration: Insights from models*, 43–62. Paris: OECD, Development Centre.

Massey DS (1988) Economic development and international migration in comparative perspective. *Population and Development Review* 14(3): 383–413.

Mintchev V, Boshnakov V, Richter M, Ruspini P (2017) Determinants of Migration and Types of Migration and Mobility. In Marina Richter, Paolo Ruspini, Dotcho Mihailov, Vesselin Mintchev, Michael Nollert (eds.), *Migration and Transnationalism Between Switzerland and Bulgaria*, 25–60. New York: Springer, 2017.

The Law of Return 5710. (1950) *The Knesset.* Available at: https://knesset.gov.il/laws/special/eng/ return.htm.

Todd OR (1997) *Essential wavelets for statistical applications and data analysis.* Boston: Birkhauser.