

# The Role of Indices in Financing Government Debt; and the Introduction of the HMAX Index

The Government Debt Management Agency Pte. Ltd. (ÁKK) introduced a new index on January 1, 2020. This HMAX Index targets longer maturity government bonds. The question might arise how this move makes sense when the MAX Index, published for over two decades now, contains the long end of the government bond market as well. Furthermore, one can question why ÁKK deviates the weighting scheme of the new index. Actually, what role does a bond index – or an index in general – even play? In the following, we inspect the issues above, showing how the creation of indices representing different government bond market segments together with investors tracking those indices can make debt financing more secure and robust.

## Debt indices

By definition, an index is essentially a statistical measure. It is typically a price or an amount that is calculated using a representative set of background data. Indices are generally known for their benchmark roles, embodying money market standards against which the performance of a security can be measured. In this role, any index provides an opportunity to measure the performance of a given market segment. Furthermore, it is also some sort of a neutral measure; outperforming the index on the market embodied by it means that an investment yielded better than the market, whereas underperforming the index means that an investment yielded poorer than the market.

Nowadays, indices are used to measure the performance (the achievable yield) of several financial instrument groups. Most widely known are stock, bond, real estate, commodity and volatility indices. There are fundamental differences between index types. Most stock market indices (eg.: BUX, S&P 500) reward success, giving the largest weights to stocks with the largest market capitalization.

Bond indices, on the other hand, usually use a weighting scheme based on amount outstanding, which is a good indicator of market success only in the rarest of cases.

Additionally, the price changes of different bonds – especially government bonds – have a significantly higher correlation than stocks, as price changes of government bonds are fundamentally driven by yield curve shifts. Furthermore, the market capitalization of the bond market is an order of magnitude higher than that of the stock market. In addition, as bonds are generally not traded on the open market, investors have limited information available, making the measurement of bond market indicators significantly more complex.

Bonds have an essential role in the functioning of the global financial system, connecting investors and borrowers. In practice, the investor lends money to the issuer by buying a bond that pays back the lent amount plus periodical interest. Tracking bond indices makes it possible for bond market investors to measure their investment activity precisely.

There are two fundamental ways for investors to manage their portfolios. One such possibility is active management, a constant search for opportunities to outperform an index. The other possibility is passive management, trying to construct a portfolio that tracks the chosen market segment, thus reaching a nearly identical performance as the index describing the given market.

## Goals, expectations

In the late 1990s, the EFFAS/European Bond Commission decided it was time to review and fine-tune the ground rules of index construction<sup>1</sup>. Consequently, the following goals are highlighted as a recommendation for bond indices:

- to act as a benchmark for portfolio management;
- to act as an indicator for market performance and development;
- to act as the basis on which market options and futures may be derived;
- to act as a comparator for different markets.

Additionally, the commission proposed the following suggestions regarding the ground rules of bond indices:

- the indices should reflect the experience of the average holder in the sector;
- the calculations should be reproducible by another party;
- as far as possible objective, not subjective criteria, should be used in selecting and processing the data;
- the criteria used for selecting the securities and the source of the data used should be published;
- the formulae used should be published;
- the performance of an index should reflect the percentage change of the market over the relevant time period, i.e. it should be independent of the base date;
- the calculations should only be based on data relating to the constituents;
- the calculations must reflect changes in the structure of the market in a timely manner (e.g. new issues);

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<sup>1</sup> 1994: Patrick J. Brown: Constructing and Calculating Bond Indices – A Guide to the EFFAS Standardized Rules (A second, updated edition was published in 2002).

- the calculations should be applicable to a wide range of bond markets and sectors of markets;
- it should be possible to calculate specific indices using the same methodology which can be compared with the published indices;
- the indices should reflect the performance of a portfolio which contains the same specific percentage of each of the securities in the index;
- the indices must be valid over a reasonably long time horizon.

During the formation of the Hungarian government bond market, ÁKK felt it necessary to create an appropriate bond market index. Thus, the MAX Index was created in 1997, revised in 1999 in adherence to the aforementioned principles, with a goal of serving as a reliable market benchmark to institutional and private investors alike.

## Investor sphere

We can distinguish between multiple investor spheres based on whether or not they track an index, they use active or passive portfolio management, and whether they are interested in domestic or international investments.

The main trackers of government bond indices are usually domestic pension funds and life insurance companies. The investor base of these two sectors is strongly risk-averse. Therefore, the domestic bond market makes an ideal target for their investments.

Foreign investors generally track a global index. Sovereign bonds of a given country constitute only a minor share of such an index due to diversification. One of the most popular indices with Hungarian government bonds as constituents is the JP. Morgan Government Bond Index-Emerging Markets (GBI-EM). 6 indices belong to the GBI-EM index family. There are three subgroups (GBI-EM, GBI-EM Global, GBI-EM Broad) with different geographic investment areas and requirements. Furthermore, there is a diversified (Div) index in every subgroup.

For example, the market capitalization, or the total value of constituent government bonds in the index basket, of the GBI-EM index is \$469.56 billion<sup>2</sup>. The share of the Hungarian market in this index is 8.68%, with a total value of \$40.75 billion. The minimum entry requirement is approximately an amount outstanding of \$1 billion for a given fixed interest rate government bond.

Another popular emerging market index is the Bloomberg Barclays EM Local Currency Government + China Index. This index has a different entry requirement per country, for example approximately \$650 million for Hungarian bonds.

## Methodology

The first and most important aspect is that any bond index imitates the behavior and nature of a bond portfolio. To achieve that, an arithmetic base must be used during the calculation of the index, with a constantly changing average time-to-maturity. Thus, if an investor constructs a portfolio with weights analogous to the index, the performance of the portfolio has to be consistent with the performance of the index. It has to be mentioned, however, that transaction costs are not accounted for in the index, thus, some difference between the performances can be expected.

The so-called chain-link method is suggested to handle changes in the index. It is essential, that changes in the index composition due to new issuances or buybacks changing the amount outstanding of a bond do not cause jumps in the index value given no price changes. The essence

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<sup>2</sup> As of October 31, 2019.

of the chain-link method is that today's index value is defined as the previous day's index value multiplied by the aggregate percentage change of current constituents between the previous and the current day.

A one-month frequency is suggested for following changes in the index basket. The index itself should be calculated with a daily frequency, however.

The book by Patrick J. Brown examines several additional essential methodological aspects and proposes suggestions for handling different issues (e.g.: holidays, new issuances, suspended bonds, bonds in default, bond selection criteria, etc.), which will not be discussed here in detail.

## Index types

In the beginning, bond indices with a universally accepted methodology were created to compare different government bond markets. It can be said, that the government bond market is the most homogenous and bonds are the most traded among all financial instruments. Users of given indices have different goals. Whereas a domestic investor might intend to cover an entire sector, international investors may only be interested in holding the bonds with the highest liquidity in a given sector.

Multiple bond index types can be distinguished based on investor viewpoints. An "all-bond" index contains every available and comparable bond on a given market. Thus, investors tracking it can measure their performance against the market. Thus, should an investor overweight a given government bond in their portfolio, its performance can be clearly compared to the performance of the market. Such indices are tracked primarily by domestic investors, as they are the ones who also hold bonds available in the market that have a lower liquidity.

The goal of so-called "tracker-bond" indices is collecting and tracking government bonds with a pre-set criterion. The most often used criteria include market value, secondary market liquidity or credit rating. During the construction of such an index, government bonds are ranked based on a criterion, and the highest-ranked bonds are included into the index until a significant part of the market is covered. "Tracker-bond" indices are excellent for both domestic and international investors, as such an index tracks the market quite accurately, while bonds with special characteristics can be simply excluded.

Tracking "bellwether-bond" indices that, primarily contain bonds with the highest liquidity, is also suitable for international investors. Liquidity is an essential aspect for international investors as the ability to exit their investments at the most opportune moment is a priority for them.

## Maturity considerations

When choosing an index, its maturity profile is of great importance. An index with a significantly shorter or longer maturity profile than an investment portfolio provides little useful information for an investor. A long maturity profile is especially useful for pension funds. Thus, segmenting the market by maturity can be useful for investors aiming at different maturity profiles.

Multiple maturity indicators are available based on maturity expectations. Time-to-maturity, average time-to-maturity, operative time-to-maturity and duration are viable alternatives. Most indices segment using average time-to-maturity because of its simplicity.

## Formula

“Total return” indices like the MAX Index in the Hungarian government bond market assume that prevailing interest payments are reinvested into the index constituents according to the current index weights. Total return index  $I$  is calculated as follows:

$$I_0 = 100,$$

$$I_t = I_{t-1} * \frac{\sum_{i \in D_{t-1}} (P_{t,i} + A_{t,i} + G_{t,i}) * w_{t-1,i}}{\sum_{i \in D_{t-1}} (P_{t-1,i} + A_{t-1,i}) * w_{t-1,i}},$$

where  $D_t$  denotes the index basket at time  $t$ ,  $P_{t,i}$  is the clean price of bond  $i$  at time  $t$ ,  $A_{t,i}$  is the interest accrued of bond  $i$  at time  $t$ ,  $G_{t,i}$  is the interest paid of bond  $i$  at time  $t$ , and  $w_{t,i}$  is the weight of bond  $i$  at time  $t$  in the index basket, based on its amount outstanding.

## Hungarian government bond indices

ÁKK publishes several government bond indices, aiming at different maturity profiles. Accordingly, investors with different maturity preferences can measure their performance against different market benchmarks.

- *RMAX Index*: The index basket of the RMAX Index is equivalent to a passively managed, well-diversified government security portfolio in the targeted maturity range. The constituents of the index basket are Hungarian Forint denominated, fixed interest rate Hungarian Government Bonds and Discount Treasury Bills issued domestically, with a remaining time-to-maturity of at least 105 days and shorter than 365 days.
- *MAX Index*: The index basket of the MAX Index is equivalent to a passively managed, well-diversified government bond portfolio in the targeted maturity range. The constituents of the index basket are Hungarian Forint denominated, fixed interest rate government bonds issued domestically, with a remaining time-to-maturity of at least 365 days.
- *HMAX Index*: The index basket of the HMAX Index is equivalent to a passively managed, well-diversified government bond portfolio in the targeted maturity range. The constituents of the index basket are Hungarian Forint denominated, fixed interest rate government bonds issued domestically, with a remaining time-to-maturity of at least 1095 days.
- *ZMAX Index*: The index basket of the ZMAX Index is equivalent to a passively managed, well-diversified government security portfolio in the targeted maturity range. The constituents of the index basket are Hungarian Forint denominated, fixed interest rate Hungarian Government Bonds and Discount Treasury Bills issued domestically, with a remaining time-to-maturity of at least 14 days and shorter than 182 days.
- *MAX Composite Index*: The index basket of the CMAX Index is equivalent to a passively managed, well-diversified government security portfolio in the targeted maturity range. The constituents of the index basket are Hungarian Forint denominated, fixed interest rate Hungarian Government Bonds and Discount Treasury Bills issued domestically, with a remaining time-to-maturity of at least 105 days.

Further information on government bond indices published by ÁKK can be found at: <https://akk.hu/en/page/government-securities-issuance-and-trading#government-bond-indices-description>.

## Effects of index tracking

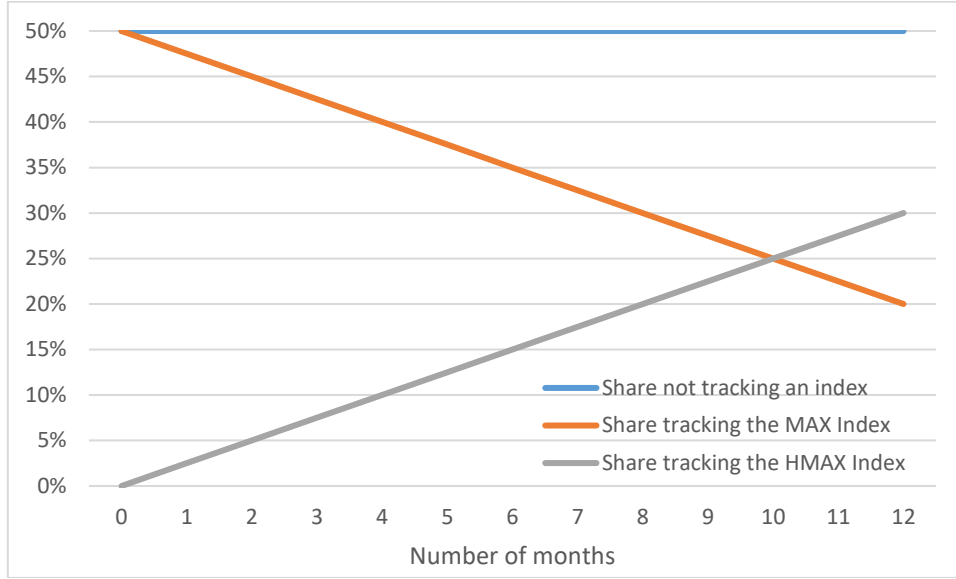
According to the expectations of the issuer, there will be investors considering tracking the HMAX Index more useful in case of certain investments, the HMAX Index better fitting their activity. Therefore, they are expected to rearrange their investments. In the following, the effects of the introduction of the HMAX Index are demonstrated through a hypothetical example of investors starting to track the HMAX Index instead of the MAX Index. This is called an index accommodation process. Let us suppose, that in the baseline state, the government bond market and the MAX index has four constituent bonds at time  $t = 0$  in the following manner:

| Name     | Remaining time-to-maturity | Amount outstanding | MAX Index weight |
|----------|----------------------------|--------------------|------------------|
| Bond „A” | 2 év                       | 200 HUF            | 20%              |
| Bond „B” | 4 év                       | 400 HUF            | 40%              |
| Bond „C” | 7 év                       | 300 HUF            | 30%              |
| Bond „D” | 15 év                      | 100 HUF            | 10%              |

1. Table: Main specifics of bonds in the example

Every instrument with a remaining time-to-maturity longer than 1 year enters the MAX Index with a weight determined by its amount outstanding. Rebalancing occurs once every month. Thus, in our case, the MAX index covers the entire government bond market (all four bonds). The total amount outstanding of the government bond market is 1,000 HUF. Let us assume that half of it (500 HUF) tracks the MAX Index. Let us also assume that no new government bond series will be issued in the next 12 months ( $t = 1, 2, \dots, 12$ ) and there are no changes in the amount outstanding of the government bond market. According to these assumptions, the market will be in a steady state for the next 12 months, as there are no instruments with a remaining time-to-maturity falling under 1 year, and investors tracking the MAX index will not make any transactions changing the composition of the index.

However, the baseline state is altered by the introduction of the HMAX Index at time  $t = 0$ . The HMAX Index contains bonds with a remaining time-to-maturity of over 3 years, therefore bond A is not part of this index. Furthermore, bonds with a remaining time-to-maturity of shorter than 5 years receive a maturity-based weight of 0.8, the 5-10 year maturity bucket gets a maturity-based weight of 1, whereas bonds with a remaining time-to-maturity of over 10 years receive a maturity-based weight of 1.2 in the HMAX Index. Thus, in the next 12 months, the maturity-based weight of bond B will be 0.8, bond C gets 1 and finally, bond D receives a 1.2 multiplier in the new index. Furthermore, we assume that a part of the investors (30% of them) will gradually use the new index as a benchmark instead of the MAX Index. The transition process is linear and takes 12 months:



1. Figure: Distribution of investors on the market based on index tracking behavior

We still assume that the total amount outstanding of the government bond market remains unchanged. However, in this case, the composition of the market can undergo serious alterations. We assume that investors not tracking an index will hold on to their portfolios and that there is unlimited primary market liquidity for supply and demand generated by index tracking actors. Index tracking actors rebalance their portfolios at every time  $t$  based on index weights at time  $t - 1$ . The indices are rebalanced at every time  $t$  based on the changed amounts outstanding. This dynamic with the aforementioned assumptions can be described using the following equations:

$$S_t^i = \widehat{W}_t S_{t-1}^i + \bar{S} (W_t^{MAX} w_{t-1}^{i,MAX} + W_t^{HMAX} w_{t-1}^{i,HMAX}),$$

$$w_t^{i,MAX} = \frac{S_t^i}{\bar{S}},$$

$$w_t^{i,HMAX} = \frac{S_t^i v_t^i}{\sum_i S_t^i v_t^i},$$

where  $S_t^i$  is the amount outstanding of bond  $i$  at time  $t$ ,  $\bar{S}$  is the amount outstanding of the government bond market,  $\widehat{W}_t$  is the share not following an index at time  $t$ ,  $W_t^X$  is the share following index  $X$  at time  $t$ ,  $w_t^{i,X}$  is the weight of bond  $i$  in index  $X$  at time  $t$ ,  $v_t^i$  is the maturity-based weight of bond  $i$  at time  $t$  in the HMAX index (0-3: 0; 3-5: 0.8; 5-10: 1; 10+: 1.2).

Substituting into the equations, we can calculate the amounts outstanding for every bond as well as the index weights for every time  $t$ :

| $t$ | Bond amounts outstanding |        |        |        | MAX Index weights |       |       |       | HMAX Index weights |       |       |       |
|-----|--------------------------|--------|--------|--------|-------------------|-------|-------|-------|--------------------|-------|-------|-------|
|     | $A$                      | $B$    | $C$    | $D$    | $A$               | $B$   | $C$   | $D$   | $A$                | $B$   | $C$   | $D$   |
| 0   | 200.00                   | 400.00 | 300.00 | 100.00 | 20.00             | 40.00 | 30.00 | 10.00 | 0.00               | 43.24 | 40.54 | 16.22 |
| 1   | 195.00                   | 400.81 | 302.64 | 101.55 | 19.50             | 40.08 | 30.26 | 10.16 | 0.00               | 43.03 | 40.61 | 16.35 |
| 2   | 187.75                   | 401.88 | 306.49 | 103.88 | 18.78             | 40.19 | 30.65 | 10.39 | 0.00               | 42.72 | 40.72 | 16.56 |
| 3   | 179.79                   | 402.84 | 310.80 | 106.57 | 17.98             | 40.28 | 31.08 | 10.66 | 0.00               | 42.35 | 40.84 | 16.81 |
| 4   | 171.92                   | 403.49 | 315.16 | 109.43 | 17.19             | 40.35 | 31.52 | 10.94 | 0.00               | 41.96 | 40.97 | 17.07 |
| 5   | 164.47                   | 403.76 | 319.40 | 112.38 | 16.45             | 40.38 | 31.94 | 11.24 | 0.00               | 41.56 | 41.09 | 17.35 |
| 6   | 157.56                   | 403.65 | 323.43 | 115.36 | 15.76             | 40.37 | 32.34 | 11.54 | 0.00               | 41.15 | 41.21 | 17.64 |
| 7   | 151.21                   | 403.20 | 327.24 | 118.36 | 15.12             | 40.32 | 32.72 | 11.84 | 0.00               | 40.74 | 41.33 | 17.94 |



|    |        |        |        |        |       |       |       |       |      |       |       |       |
|----|--------|--------|--------|--------|-------|-------|-------|-------|------|-------|-------|-------|
| 8  | 145.36 | 402.43 | 330.82 | 121.38 | 14.54 | 40.24 | 33.08 | 12.14 | 0.00 | 40.32 | 41.43 | 18.24 |
| 9  | 139.97 | 401.39 | 334.20 | 124.43 | 14.00 | 40.14 | 33.42 | 12.44 | 0.00 | 39.91 | 41.54 | 18.56 |
| 10 | 134.99 | 400.12 | 337.39 | 127.50 | 13.50 | 40.01 | 33.74 | 12.75 | 0.00 | 39.49 | 41.63 | 18.88 |
| 11 | 130.37 | 398.64 | 340.39 | 130.60 | 13.04 | 39.86 | 34.04 | 13.06 | 0.00 | 39.08 | 41.71 | 19.21 |
| 12 | 126.07 | 396.97 | 343.22 | 133.74 | 12.61 | 39.70 | 34.32 | 13.37 | 0.00 | 38.67 | 41.79 | 19.54 |

2. Table: Bonds and index weights

With the introduction of the HMAX Index, the greatest reduction in weight can be observed for bond *A* that is not a constituent of the HMAX Index. In case of bond *B*, the moderate initial growth in amount outstanding turns into a drop as the weight of the HMAX Index grows. Most of the demand arising from redemptions of bond *A* is transferred into the two longer maturity bonds. We can see, that the introduction of the new index increased the demand for bond *D* by over 33%. The same effect for bond *C* is much more moderate, just over 14%. Obviously, demand for the short maturity bond *A* drops sharply. Due to the index accommodation process, its amount outstanding changes significantly by the end of the examined period.

| <i>t</i> | <i>A</i> | <i>B</i> | <i>C</i> | <i>D</i> |
|----------|----------|----------|----------|----------|
| 12       | -73.93   | -3.03    | 43.22    | 33.74    |

3. Table: Differences in amounts outstanding for given bonds at the end of the time period

The maturity-based weighting scheme of the HMAX Index means, that its weights gradually shift towards longer maturity instruments, month-by-month, facilitating the fulfillment of ÁKK's goal of increasing the average time-to-maturity of the government bond market.

## Expectations of the issuer

The intention of the debt manager becomes understandable by examining the effects of such bond portfolio rebalancing. There are several actors on the market allocating their resources into investments with different maturity profiles based on their services offered. Formerly, among the indices available on the market, only the MAX Index provided a low-risk investment opportunity with a relatively high maturity profile, adequately representing the government bond market. However, at the time of the introduction of the MAX Index, the longest maturity of a fixed interest rate bond was 5 years. Now, with the introduction of the 20-year bond in January 2020, this profile, once rightfully regarded as long-maturity, no longer supports adequately the lengthening of the average time-to-maturity. A new index with a longer maturity profile than the MAX Index, however, can drive several index tracking investors to track an index better aligned to their services offered, altering their portfolios accordingly.

A bond portfolio rebalancing toward longer maturities is desirable for the debt manager, as the average time-to-maturity of the entire debt portfolio can be increased, making debt financing more secure. Deviating the weighting scheme of the index with maturity-based weights is a more effective way of supporting the same goal, as the portfolio rebalancing is concentrated more strongly on longer maturities. If there is adequate investment potential, demand can be generated for issuing a new product on the long end, grounding its initial success, and creating a market for it in the long run. Once a product becomes liquid domestically, it attracts international investors as well by reaching the amount outstanding requirement to enter several large global indices.

It is also worth mentioning, that a liquid product with a longer maturity enables the debt manager to gain more information about further points of the yield curve.

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