An approximation to re-estimate the over-mortality occurred and not reported -missing persons- to face the possible claims: the Mexican case.

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Overview of this Webinar

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2. Missing persons official figures in Mexico
3. Some characteristics of the Mexican insurance market
4. Methodology: Controlled smoothing by segments
5. Application: re-estimating the over-mortality by sex
6. Conclusions
7. Basic references
1. Introduction

• In Mexico the problem of missing increases every year. In fact, official statistics suggest that this figure exceeds thousands in 2020.

• There are several implications for insured missing persons: their vital status is unknown; the affected beneficiaries can’t claim the respective insured sum because of the absence of the required death certificates.

• The exact number of missing with life insurance is unknown, however the Mexican Association of Insurance Companies (AMIS in Spanish) reports an increasing trend of homicides in the life insured population. A typical situation is to find missing as corpses in clandestine graves.
1. Introduction

- There is also an excess demand of forensic services, which causes severe delays in corpse identification and issue of death certificates.
- The objective of this paper is to re-estimate the over-mortality by sex assuming that insured missing people are death. To do that, smoothing by segments and other statistical tools are employed.
- The estimates are based on real data taken from the AMIS and the Mexican government ministry (SEGOB).
- The results suggest the necessity to constitute a new reserve to face the possible new claims from beneficiaries of the insured missing persons. According with the estimates, the main changes appear around the called accident hump.
In accordance with official reports taken from Mexican authorities, there are more than 73 thousand missing persons around the country (NBC NEWS, 2020).

The Mexican people missing is similar to the entire population of some American cities such as Turlock City, California, or Camden City, New Jersey among others.

In April 2018, the official registry stopped being updated, which means that there is no exact number of victims for the last 30 months (SEGOB, 2018).

In short, there is no information on the age and sex about new cases of missing persons. However, based on historical observations, forecasts were made for May through December 2018.

2. Official figures about missing persons in Mexico

<table>
<thead>
<tr>
<th>Rank</th>
<th>Geographic Area</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>484</td>
<td>Union City, California</td>
<td>74,107</td>
</tr>
<tr>
<td>485</td>
<td>Appleton city, Wisconsin</td>
<td>74,098</td>
</tr>
<tr>
<td>486</td>
<td>Turlock city, California</td>
<td>73,631</td>
</tr>
<tr>
<td>487</td>
<td>Camden city, New Jersey</td>
<td>73,562</td>
</tr>
<tr>
<td>488</td>
<td>Bismarck city, North Dakota</td>
<td>73,529</td>
</tr>
<tr>
<td>489</td>
<td>Evanston city, Illinois</td>
<td>73,473</td>
</tr>
<tr>
<td>490</td>
<td>Apple Valley town, California</td>
<td>73,453</td>
</tr>
<tr>
<td>491</td>
<td>Schaumburg village, Illinois</td>
<td>72,887</td>
</tr>
<tr>
<td>492</td>
<td>Woodbury city, Minnesota</td>
<td>72,828</td>
</tr>
</tbody>
</table>

Source: U.S. Census Bureau, Population Division
Before April 2018, there is an official database with information that can be taken into account to make some estimates (SEGOB, 2018).

For this paper, the age and sex are considered to describe the main characteristics of this population.

From 1968 to April 2018 the total missing people were 37,435. Just from 2016 to 2018, it has 31% of the cases, and from 2010 to 2018 the 90%.

The figure on the left suggests an increasing intensity from the so-called “war on drugs” started, in 2007, for almost all states in Mexico.
2. Missing persons official figures in Mexico

Missing: Men

Missing: Women
2. Missing persons official figures in Mexico

The top five affected states until April 2018 are: Tamaulipas (6131), State of Mexico (3918), Jalisco (3388), Sinaloa (3042) and Nuevo León (3042).

It could be appreciated that some border states are also affected (in addition to Tamaulipas and Nuevo León), such as Sonora and Chihuahua.

A particular sector identified is the set of foreign persons, coming mainly from US.

The main Mexican tourist destination of Quintana Roo (Cancun), was one of most affected states in 2017.
2. Missing persons official figures in Mexico

<table>
<thead>
<tr>
<th>State</th>
<th>Total</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yucatán</td>
<td>37.6 (19.2)</td>
<td>44.3 (18.3)</td>
<td>23.3 (11.8)</td>
</tr>
<tr>
<td>Tlaxcala</td>
<td>35.9 (22.2)</td>
<td>46.5 (22.8)</td>
<td>20.5 (7.7)</td>
</tr>
<tr>
<td>Mexico City</td>
<td>35.9 (22.4)</td>
<td>42.1 (22)</td>
<td>27.8 (20.4)</td>
</tr>
<tr>
<td>Jalisco</td>
<td>33.6 (12.8)</td>
<td>34.3 (12.6)</td>
<td>27.9 (13.3)</td>
</tr>
<tr>
<td>Michoacán</td>
<td>32.6 (14.7)</td>
<td>34.1 (14.5)</td>
<td>26.4 (14)</td>
</tr>
<tr>
<td>Guanajuato</td>
<td>32.6 (13.8)</td>
<td>33.7 (13.1)</td>
<td>26.7 (15.6)</td>
</tr>
<tr>
<td>Coahuila</td>
<td>32.5 (13.5)</td>
<td>33.4 (13.2)</td>
<td>28.2 (13.9)</td>
</tr>
<tr>
<td>Chihuahua</td>
<td>32.2 (15.2)</td>
<td>33.4 (15.1)</td>
<td>22.4 (13.1)</td>
</tr>
<tr>
<td>Durango</td>
<td>32.2 (13.1)</td>
<td>33.5 (12.7)</td>
<td>25 (12.7)</td>
</tr>
<tr>
<td>Querétaro</td>
<td>32.1 (15.4)</td>
<td>35 (14.4)</td>
<td>25.7 (15.7)</td>
</tr>
<tr>
<td>Zacatecas</td>
<td>31.8 (13.8)</td>
<td>32.7 (13.9)</td>
<td>26 (11.9)</td>
</tr>
<tr>
<td>Baja California Sur</td>
<td>31.7 (10.1)</td>
<td>32.4 (9.4)</td>
<td>25.5 (14.8)</td>
</tr>
<tr>
<td>Nuevo León</td>
<td>31.6 (14.5)</td>
<td>33.5 (14.4)</td>
<td>26.3 (13.5)</td>
</tr>
<tr>
<td>Sinaloa</td>
<td>31.6 (12.6)</td>
<td>32.6 (12.3)</td>
<td>25 (12.9)</td>
</tr>
<tr>
<td>Tamaulipas</td>
<td>31.3 (13)</td>
<td>32.6 (12.8)</td>
<td>26.5 (12.6)</td>
</tr>
</tbody>
</table>

For men, the state with the highest mean age is Tlaxcala (46.5) and for women, Coahuila (28.2).

States with the lowest mean age for men, excluding foreigners, is San Luis Potosí (28.8) and for women Tabasco (18.4).

The states with the highest standard deviation (Sd) are Tlaxcala (22.8) and Mexico City (20.4). While the states with the lowest mean age are Baja California Sur (9.4) and Tabasco (6.4).
## 2. Missing persons official figures in Mexico

<table>
<thead>
<tr>
<th>State</th>
<th>Total Mean (Sd)</th>
<th>Men Mean (Sd)</th>
<th>Women Mean (Sd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nayarit</td>
<td>31.1 (10.5)</td>
<td>31.9 (10.4)</td>
<td>23.3 (7.6)</td>
</tr>
<tr>
<td>Campeche</td>
<td>30.2 (20.5)</td>
<td>37.3 (21.6)</td>
<td>18.8 (12.1)</td>
</tr>
<tr>
<td>Sonora</td>
<td>30 (14.5)</td>
<td>32.9 (14.1)</td>
<td>23.2 (12.9)</td>
</tr>
<tr>
<td>Guerrero</td>
<td>30 (13.3)</td>
<td>31.4 (13)</td>
<td>24 (12.9)</td>
</tr>
<tr>
<td>Veracruz</td>
<td>29.4 (12.9)</td>
<td>31 (12.5)</td>
<td>24.1 (12.7)</td>
</tr>
<tr>
<td>San Luis Potosí</td>
<td>28.4 (9.8)</td>
<td>28.8 (9.8)</td>
<td>25.7 (10.3)</td>
</tr>
<tr>
<td>Colima</td>
<td>28.4 (13.3)</td>
<td>31.2 (12.9)</td>
<td>22.3 (12.2)</td>
</tr>
<tr>
<td>State of Mexico</td>
<td>28.4 (18)</td>
<td>34 (19.1)</td>
<td>21.8 (14.1)</td>
</tr>
<tr>
<td>Oaxaca</td>
<td>27.8 (14.9)</td>
<td>34 (15.2)</td>
<td>20.4 (10.8)</td>
</tr>
<tr>
<td>Puebla</td>
<td>27.3 (17.9)</td>
<td>33.2 (19.3)</td>
<td>21.6 (14.2)</td>
</tr>
<tr>
<td>Morelos</td>
<td>27 (16.8)</td>
<td>30.5 (19.3)</td>
<td>21.5 (9.9)</td>
</tr>
<tr>
<td>Baja California</td>
<td>26.7 (15.6)</td>
<td>31.4 (16.2)</td>
<td>20 (12)</td>
</tr>
<tr>
<td>Quintana Roo</td>
<td>26.6 (16)</td>
<td>32.7 (17)</td>
<td>20 (12)</td>
</tr>
<tr>
<td>Hidalgo</td>
<td>26.2 (14.4)</td>
<td>30 (16.1)</td>
<td>21.4 (10.2)</td>
</tr>
<tr>
<td>Tabasco</td>
<td>25.7 (14.7)</td>
<td>31.9 (16.9)</td>
<td>18.4 (6.4)</td>
</tr>
<tr>
<td>Aguascalientes</td>
<td>25.5 (15.5)</td>
<td>30.4 (17.1)</td>
<td>20.4 (11.8)</td>
</tr>
<tr>
<td>Chiapas</td>
<td>24.1 (15.3)</td>
<td>28.8 (16.8)</td>
<td>18.6 (11.1)</td>
</tr>
<tr>
<td>Foreign</td>
<td>21 (15.2)</td>
<td>25.2 (15.9)</td>
<td>14.8 (12.2)</td>
</tr>
</tbody>
</table>

At the national level, 75% are men and 25% are women, with an average age of 31, 33 and 24 for total, men and women respectively.

The age range goes from 0 to 106 years old. The first case registered in the data base is from 1968. One common aspect is that they are slim and average height.

The missing foreigners have been young people, given that 50% are under 27 years old.

The majority come from the US (63%) and men (72%). It is worth mentioning that more than half were thin complexion (56%), medium (23%) and robust (21%).
This is a typical structure of missing people and homicides in 2016. In this case, the homicides data are taken from the Statistical Ministry of Mexico (INEGI, 2020).

It is notorious the unbalance by sex. In fact, there is a high concentration of women missing between 10 and 15 years old.

For men the mode age for both, missing and homicides is around 30 years old. There is a high asymmetry for women missing. One possible explanation could be human traffic.

The most significant consequence for the growth in homicides is a reverse in the Mexican life expectancy (Aburto et al, 2016).
According to the National Financial Inclusion Survey (INEGI, 2018), among the main results are:

25% of Mexican population between 18 and 70 years old have some type of insurance. The proportion by sex is 28% (men) and 23% (women).

Taking into account the percentage of Mexicans with some type of insurance, 67% have Life, 39% Car and 25% Health in 2018.

Comparing the coverage with the previous one in 2015, there is just an increase in Car. However, there is an important opportunity to increase the number of policies in all cases.
3. Some characteristics of the Mexican insurance market

<table>
<thead>
<tr>
<th>Year</th>
<th>INEGI</th>
<th>AMIS</th>
<th>%AMIS/INEGI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Individual</td>
<td>Collective</td>
<td>Total</td>
</tr>
<tr>
<td>2013</td>
<td>11,774</td>
<td>1,713</td>
<td>7,708</td>
</tr>
<tr>
<td>2014</td>
<td>10,054</td>
<td>1,128</td>
<td>9,067</td>
</tr>
<tr>
<td>2015</td>
<td>9,941</td>
<td>986</td>
<td>10,817</td>
</tr>
<tr>
<td>2016</td>
<td>10,963</td>
<td>1,081</td>
<td>12,153</td>
</tr>
<tr>
<td>2017</td>
<td>15,042</td>
<td>1,110</td>
<td>11,400</td>
</tr>
<tr>
<td>2018</td>
<td>17,772</td>
<td>1,209</td>
<td>10,117</td>
</tr>
<tr>
<td>2019</td>
<td>17,198</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>92,744</td>
<td>7,227</td>
<td>61,262</td>
</tr>
</tbody>
</table>


In fact, if compared with official data taken from the INEGI (2013-2019), the yearly proportion seems disturbing.
The total number of claims by homicide is increasing over the last years for Individual Life Insurance (ILI). And its relative importance considering all causes, also shows a positive growth.

In regards to the Collective Life Insurance (CLI), deaths by homicide, although being high with respect to the INEGI’s statistics, show a slight decrease both in relative and absolute terms.
3. Some characteristics of the Mexican insurance market

<table>
<thead>
<tr>
<th></th>
<th>Individual</th>
<th></th>
<th></th>
<th></th>
<th>Collective</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2016</td>
<td>2017</td>
<td>2018</td>
<td></td>
<td>2016</td>
<td>2017</td>
<td>2018</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deaths</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Deaths</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sum insured</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Sum insured</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20,455</td>
<td>324,981,193</td>
<td>20,047</td>
<td>354,588,898</td>
<td>20,951</td>
<td>368,485,243</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>%</td>
<td>11.9</td>
<td>35.3</td>
<td>11.3</td>
<td>35.4</td>
<td>10.8</td>
<td>30.3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

It is very significant the total of sum insured claimed at the last years. The mounts are in US–dollars at 10/25/2020.

Comparing the proportion among ILI and CLI, both percentages of Deaths and Sum insured are decreasing among the types of insurances.
The person who disappears, after several days, could generate adverse consequences in his family. On the economic side, in many cases there are problems, for example, in paying rent or mortgage, food, services, school fees, clothing and/or footwear, and so on.

If the relatives do not have a certificate that guarantees the death, the insurance claim becomes difficult. According to the current clauses, they have up to five years from the insured’s death to make the claim (if and only if the event occurs when the policy was in force).
The beneficiaries must get a so-called Certificate of Presumption of Death (CPD), which takes between 1.5 and 6 years, after the declaration of absence. The waiting time is not the same in all states and depends on their respective laws (Torres, 2014).

Life insurance contemplates a period of up to five years to consider a claim as valid. Currently, there are legal loopholes regarding how life insurance of missing should be claimed.

Given that a typical situation is to find missing as corpses in clandestine graves and some of them have an ILI and/or ICLI. What would happen to the Mexican Insurance Companies (MIC) if a national law is approved to fast-track CPD’s expedition given the actual situation? How much mortality could the MIC expect? In which segment of your portfolio of insured clients? Do they need to re-estimate the over-mortality?...
4. Methodology: Controlled smoothing by segments

Actuaries working with mortality data, could apply smoothing to appreciate the underlying trend in the data.

Keeping fidelity to the observed values is desirable when graduating data for smoothing.

In this context, different variability patterns can be seen in log-mortality data, $\ln q_x$, corresponding to segments of the data range, with different variability patterns.

This situation appeared in the present work when graduating mortality rates of Sweden and Norway, with the same amount of smoothness in both cases.
Let’s consider the \( \ln q_x \) for both sexes in Sweden (left) and Norway (right) in 2019.

Trends with same percentage of smoothness: 75% at the top and 95% at the bottom, using the method of controlled smoothing proposed by Guerrero (2008).

<table>
<thead>
<tr>
<th></th>
<th>Sweden</th>
<th>Norway</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><img src="graph1.png" alt="" /></td>
<td><img src="graph2.png" alt="" /></td>
</tr>
<tr>
<td></td>
<td><img src="graph3.png" alt="" /></td>
<td><img src="graph4.png" alt="" /></td>
</tr>
</tbody>
</table>

**Methodology: Controlled smoothing by segments**
4. Methodology: Controlled smoothing by segments

• If we just need to estimate the underlying smooth trend (with no further explanation), we can divide the series into segments and control for the amount of smoothness in the trend, both globally and by segments.

• Controlling for the amount of smoothness in the trend allows us to establish valid comparisons between trends for different datasets.
4. Methodology: Controlled smoothing by segments

- We consider the two-segment case in detail and simply extend the results to the three-segment situations considered here.

- The function to be minimized (as with the Hodrick-Prescott filter) is

\[ \min \sum_{t=1}^{N_1} \frac{1}{\sigma_1^2} (Y_{1,t} - \tau_t)^2 + \sum_{t=N_1+1}^{N} \frac{1}{\sigma_2^2} (Y_{2,t} - \tau_t)^2 + \sum_{t=3}^{N} \frac{1}{\sigma_0^2} (\tau_t - 2\tau_{t-1} + \tau_{t-2})^2 \]

where \( \sigma_1^2 \) is the variance of the deviations from the first segment of the trend \( \{ \tau_1, \ldots, \tau_{N_1} \} \) and \( \sigma_2^2 \) is that for the second one.

\( \{ Y_{1,1}, \ldots, Y_{1,N_1} \} \) and \( \{ Y_{2,N_1+1}, \ldots, Y_{2,N} \} \) are the observations of the segmented series, with \( N_1 \) and \( N_2 = N - N_1 \) observations in each segment.
4. Methodology: Controlled smoothing by segments

- Due to the segmentation, the matrix of differences is now written as

\[
K = \begin{pmatrix} K_1 & 0 \\ k_1 & k_2 \\ 0 & K_2 \end{pmatrix}
\]

with
\[
k_1 = \begin{pmatrix} 1 & -2 \\ 0 & 1 \end{pmatrix}
\]

and
\[
k_2 = \begin{pmatrix} 1 & 0 \\ -2 & 1 \end{pmatrix}
\]

where the matrices \(K_1\) and \(K_2\), of size \((N_1-2)\times N_1\) and \((N_2-2)\times N_2\) respectively, are defined in similar fashion as \(K\).

- The system of equations is then written as

\[
\begin{pmatrix} Y_1 \\ Y_2 \\ 0 \end{pmatrix} = \begin{pmatrix} I_{N_1} & 0 \\ 0 & I_{N_2} \\ K \end{pmatrix} \begin{pmatrix} \tau_1 \\ \tau_2 \end{pmatrix} + \begin{pmatrix} \eta_1 \\ \eta_2 \end{pmatrix}
\]

with
\[
\text{Var} \begin{pmatrix} \eta_1 \\ \eta_2 \end{pmatrix} = \sigma_0^2 \begin{pmatrix} \sigma^2_i / \sigma_0^2 & I_{N_i} & 0 & 0 \\ 0 & \sigma^2_i / \sigma_0^2 & I_{N_2} & 0 \\ 0 & 0 & I_{N-2} \end{pmatrix}
\]

where the ratio \(\lambda_i = \sigma_i^2 / \sigma_0^2\) for \(i = 1, 2\), are assumed known.
4. Methodology: Controlled smoothing by segments

- Generalized Least Squares yields the Best Linear Unbiased Estimator (BLUE) of \( \tau = (\tau_1', \tau_2')^\ast \), that is,

\[
\begin{pmatrix}
\hat{\tau}_1 \\
\hat{\tau}_2
\end{pmatrix} = \left( I_{N_1} + \lambda_1 (K_1' K_1 + k_1' k_1) \right) \begin{pmatrix} \lambda_1 k_1' k_2 \\
\lambda_2 k_2' k_1
\end{pmatrix}^{-1} \begin{pmatrix} Y_1 \\
Y_2
\end{pmatrix}
\]

- With variance-covariance matrix is given by

\[
\Gamma = \text{Var} \left( \begin{pmatrix}
\hat{\tau}_1 \\
\hat{\tau}_2
\end{pmatrix} \right) = \begin{pmatrix}
\sigma_1^{-2} I_{N_1} & 0 \\
0 & \sigma_2^{-2} I_{N_2}
\end{pmatrix} + \sigma_0^{-2} \begin{pmatrix}
K_1' K_1 + k_1' k_1 & k_1' k_2 \\
K_2' K_2 + k_2' k_2 & k_2' k_1
\end{pmatrix}^{-1}
\]
4. Methodology: Controlled smoothing by segments

- The inverse of the variance-covariance matrix $\Gamma$ is a precision matrix and can be written (for some weights $0 \leq c_i \leq 1$, $i = 1, \ldots, 4$) as a sum of precision matrices, i.e.

\[
\Gamma^{-1} = \begin{pmatrix}
\sigma_1^2 I_{N_1} & 0 \\
0 & \sigma_2^2 I_{N_2}
\end{pmatrix} + \sigma_0^{-2} \begin{pmatrix}
K_1' K_1 + c_1 k_1' k_1 & c_2 k_1' k_2 \\
c_3 k_2' k_1 & c_4 k_2' k_2
\end{pmatrix} + \sigma_0^{-2} \begin{pmatrix}
(1-c_1) k_1' k_1 & (1-c_2) k_1' k_2 \\
(1-c_3) k_2' k_1 & (1-c_4) k_2' k_2
\end{pmatrix}
\]

- $B_0$ is linked to the unobserved-component model, while $B_1$ and $B_2$ are linked to the smooth trend representation of each segment.

- We choose $c_i = N_1 / N$ for $i = 1, \ldots, 4$, in order for the matrices $B_1$ and $B_2$ to be symmetric and positive semidefinite.
4. Methodology: Controlled smoothing by segments

- We propose to measure the precision share attributable to smoothness in each segment of the data range by means of

\[
\text{tr}[B_1(B_0 + B_1 + B_2)^{-1}]/N = \text{tr}[\sigma_0^2 \begin{pmatrix} K'_1 K_1 + k'_1 k_1 & \frac{N_1}{N} k'_1 k_2 \\ \frac{N_1}{N} k'_2 k_1 & 0 \end{pmatrix} (B_0 + B_1 + B_2)^{-1}]/N
\]

and

\[
\text{tr}[B_2(B_0 + B_1 + B_2)^{-1}]/N = \text{tr}[\sigma_0^2 \begin{pmatrix} 0 & \frac{N_2}{N} k'_1 k_2 \\ \frac{N_2}{N} k'_2 k_1 & K'_2 K_2 + k'_2 k_2 \end{pmatrix} (B_0 + B_1 + B_2)^{-1}]/N
\]

- They quantify relative precision and have the following properties:
  
  (i) take on values between zero and one; (ii) sum up to unity; (iii) are invariant under linear transformations of the variables involved; (iv) behave linearly.
4. Methodology: Controlled smoothing by segments

- From each measure of precision share we deduce an index that can be expressed as a percentage of smoothness attributable to each segment, such that, for \( i = 1, 2 \)

\[
S_i (\lambda_1, \lambda_2; N) \rightarrow N_i/N \quad \text{as} \quad \lambda_i \rightarrow \infty
\]

- For segmenting the data we suggest either

  1) Fixing a reasonable value on \textit{a priori} grounds, from subject matter considerations

  or

  2) Using a data-based procedure that optimizes some statistical criterion, \textit{e.g.} minimizing the standard error of the trend estimate.
4. Methodology: Controlled smoothing by segments

• The first two datasets refer to total Mortality rates for Sweden and Norway in year 2019.

• The data are expressed as \( \log(q_x) \) where \( q_x \) is the mortality rate for age \( x \).

• Our results show that smoothing is needed even for data pertaining to these countries (that produce good vital statistics).

• The need of smoothing data with lower quality becomes evident.
4. Methodology: Controlled smoothing by segments

Inqx’s for Sweden (left) and Norway (right) in 2019. Trends and ±2 standard error bands with 75% global smoothness and three segments, with respective smoothness 80%, 75% and 72.67% (cut-off points at ages 20 and 65).

Trends are now comparable by segments and variability is more clearly appreciated (larger in the Norway data).
4. Methodology: Controlled smoothing by segments

Lnqx’s for Norway in 2019. Segmented trend with 75% global smoothness and three segments: solid line; ±2 standard error bands: dotted lines; 75% smoothed trend without segmentation: dashed-dotted line; cross-validation trend with three segments: dashed line; observed data: circles. The cross-validation trend shows discontinuities near the joints.
Quarterly remittances from the US to Mexico. Trends with 80% global smoothness and ±2 standard error bands, without segmentation and with two segments.

Cut-off point located in 2002:03 (a year after the 9/11 terrorist attack), with 70% smoothness for the first segment and 87.75% for the second one.

The increase in variability is taken into account by segmenting the data.
4. Methodology: Controlled smoothing by segments

It was not clear to us the timing and reason for a change in variability, so we chose the cut-off point that minimizes the standard error of the estimated trend ($N_1 = 31$, is the 3rd quarter of 2002).

Estimated standard error of the trend estimate for the remittances data.

Other possibility is to fix the cut off point using exogenous information. In case of the Mexican mortality, the ages 15 and 30 are used.
5. Application: re-estimating the over-mortality by sex

The data are taken from AMIS (2016-2018) and SEGOB (2018) for the years 2016-2018. Likewise, the rest of 2018 was projected through using exponential smoothing. The structure by age and sex for missing people was estimated according to those from SEGOB (2018). The over-mortality rates are calculated as follows

\[ m_x = \frac{D_x + K M_x}{P_x} \]

where \( D_x \) is the number of deaths at age \( x \) in the year \( t \) and \( P_x \) is the population aged \( x \) that is at risk of death in the year \( t \), \( K \) is the percentage of missing with any Life Insurance (13.5%) taking into account 73 thousand missing and \( M_x \) is the missing population aged \( x \) that is assumed as death. Based on these rates, death probabilities \( q_x \) are obtained for all ages \( x \) (Kintner 2004), as follows

\[ q_x = \frac{2 m_x}{2 + m_x} \]

All the estimates were made in R statistical software version 4.0.2.
5. Application: re-estimating the over-mortality by sex

Scenarios for 2016, 2017 and 2018 by sex and for both Life insurance (ILI, CLI) are provided; missing persons with minimum demographic information: 37 thousand; total missing persons recognized by the government: 73 thousand.

As reference, the currently Life tables for Life Insurance made by the Mexican Regulator (CNSF) are presented in every estimate. The assumptions are:

- The death’s missing occurs the same year that they disappear.
- The homicides’ missing are uniformly distributed across the country.
- The probability to die for homicide is the same for all population with or without Life Insurance.

All the estimates use the following Smoothing Index: $S\% = 75\%$, $S1\% = 70\%$, $S2\% = 75\%$ and $S3\% = 77\%$ and the smoothing parameters: $\lambda_1 = 3.9$, $\lambda_2 = 5$ and $\lambda_3 = 9.2$ respectively.
5. Application: re-estimating the over-mortality by sex

Comparing mortality curves: Women

- CLIW2016+\%MP
- CLIW2016
- CLIW-CNSF
5. Application: re-estimating the over-mortality by sex

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Comparing mortality curves: Women

- ILIW2018+%MP
- ILIW2018
- IWIW-CNSF
5. Application: re-estimating the over-mortality by sex

Comparing mortality curves: Men
5. Application: re-estimating the over-mortality by sex

Comparing mortality curves: Men

- CLIM2017+\%MP
- CLIM2017
- CLIM-CNSF
5. Application: re-estimating the over-mortality by sex

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5. Application: re-estimating the over-mortality by sex

Comparing mortality curves: Men
6. Conclusions

• The assumption of that insured missing are death, could help us estimate scenarios about the real mortality in the Mexican insured population.

• The main consequences are observed around an before of the accident hump for both, men and women. The over-mortality of the CNSF could be a deterrent to greater penetration of Life Insurance in the Mexican market.

• This technique may be used to estimate the interaction among missing and the over mortality by COVID-19. The last one is a real challenge.
6. Conclusions

• It should be used basically as an exploratory tool, that may lead to rethink the needed to re-estimate the mortality rates, and then primes and reserves.

• The suggested methodology provides a great deal of flexibility to estimate trends with different amounts of smoothness for data segments defined by the analyst.

• This technique may be used to estimate trends where the quality of information has a noticeable distinction for different segments of the data range.
7. Basic references


Thank you!
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