An international comparison of Mexico's over-the-top video services market using hierarchical clustering algorithm[*]

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Abstract

There exists a strong worldwide debate regarding over-the-top (OTT) services regulation. Its advocates argument that OTT companies do no invest in the network nor subject themselves to safety requirements; they do not have to pay for spectrum licenses and usually fiscal questions are attended in the countries with lower tax rates. Thus, it is considered that the fact that OTT companies are not subject to similar obligations and regulations than traditional operators promotes an unequal competition between OTT companies and traditional operators. On the other side, the growth of OTT services has allowed the development of an economy that every day bases more on the Internet. This phenomenon implies multiple benefits, however, also imposes new challenges. One of them refers to the consideration of a regulation that could be applied, in this case, to the new services. Futhermore, net neutrality principles' defenders, hold that any type of charge imposed by internet service providers (ISP) to OTT companies in order to priorize its traffic would suppose a barrier to nascent and potentially disruptive companies that otherwise might not develop. In any case, before considering any type of regulation it is important to know if a particular OTT service market is doing well. For that respect the aim of this research consists on analyze the development of Mexico's over-the-top (OTT) video market from an international perspective. For that purpose we implement a hierarchical clustering algorithm considering agglomeration methods such as *centroid, complete* and *ward*. The fundamental

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objetive lies in identify if Mexico's OTT video market is comparable to promising markets instead of those who are stagnated. The study focuses particularly on OTT video total revenues and active devices (fixed, mobile and portable) for a sample data of 19 countries. The main advantage of hierarchical clustering analysis is that it allows to elucidate the existence of countries subgroups which share substantially similar characteristics in their OTT video market.

Keywords: Hierarchical Cluster Algorithm, Data Mining, Over-the-Top, Telecomm Regulation.

JEL Classification: C38 L96

1   Introduction

The worldwide introduction of OTT's services relying on the network of the internet service provider (ISP) has affected the revenues of traditional telecom operators. Their success has generated a growing flow of traffic over broadband network imposing pressure on traditional telecoms into a need of investment in the network. Zuhdi et al. [13] argue that the access network is affected by the consumption of bandwidth that is done by OTT's applications and contents. Additionally, in pay-TV segment a notorious effect has been the decline in the number of subscribers, effect which is known as *cord-cutting*.

At Latin America regional level OTT companies such as Amazon, Facebook and Google have had an unquestionable economic success in recent years. In this regard, OTT video regional revenues have more than doubled in two years, increasing from US$1,050 millions in 2012 to US$2,606 millions in 2014[1]. Even though these achievements are still behind in comparison with main economies such as those in Western Europe, OTT video regional revenues are forecasted to reach US$4,755 millions by year 2019. Furthermore, the number of active OTT video devices is a good indicator for the future trends in the progress of OTT video's applications. In 2014 the number of active devices, fixed and mobile, in Latin America region reached more than 13 and 80 millions, respectively (see Fig. 1). Mexico's figures reached 8 millions in the case of

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[1] OVUM: OTT Video Forecast: 2015_19 OTT Video Forecast: 2015_19. https://www.ovumkc.com/

active mobile devices and 1.7 millions for active fixed devices in year 2014 (see Fig. 1). Regarding digital

subscriptions or subscriptions on-demand (SVOD), such as Netflix or Amazon Instant Prime Video services,

in Latin America region, they have increased from 1.4 million in 2012 to 3.4 millions in 2014 (see Fig. 2). It

is expected that it will reach 6 millions by 2019[2]. As Figure 2 shows, in Mexico the subscribers have more

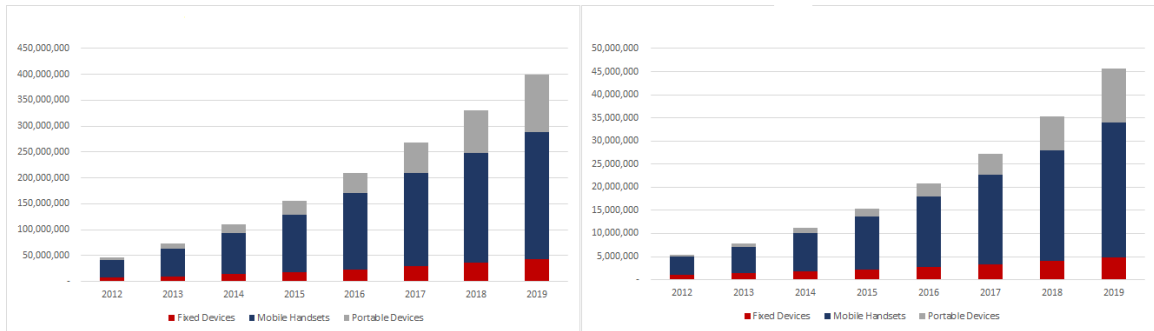than doubled from .591 million in 2012 to 1.2 million in 2014.

Fig. 1 Total OTT video devices split by type. a) Left graph, Latin America and Caribbean; b) Right graph,
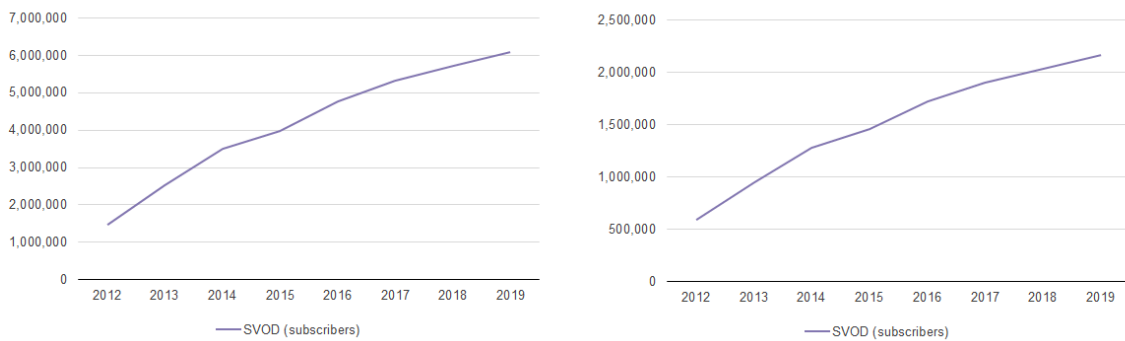Mexico (Source: OVUM. https://www.ovumkc.com/)

Fig. 2 Subscription on-demand. a) Left graph, Latin America and Caribbean; b) Right graph, Mexico (from
OVUM. https://www.ovumkc.com/)

Despite previous considerations in favour of OTT video services some analysts such as Friedrich et al. [5]

consider than traditional telecom operators have a room for manoeuvre. Specifically, Friedrich considers that

they would be able to formulate and implement different competitive strategies aimed at the conservation of

their revenues and subscribers. Whereas some others consist on the preservation of the infraestructure

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[2] OVUM: OTT Video Forecast: 2015_19 OTT Video Forecast: 2015_19. https://www.ovumkc.com/

business through the development of advanced connectivity services. Other options require the development of new applications and services. This approach involves a shift of paradigm beneficial for customers towards a *quality-of-experience* (QoE) instead of *quality-of-service* (QoS) [12]. The main difference being that QoE prioritizes the relation between the consumer and the applications which differs of QoS's vision that links the network with the applications. Ganuza et al. [6] analyze the bundling of services (fixed and mobile telephony, internet and TV) and the development of propietary OTT products by traditional operators in Latin America. The objective is to prevent *cord-cutting* effect in the region and to compete with OTT services. They argue that in the short and medium run the traditional operators shall not be threatened by OTT services because of the lack of high speed access networks in Latin America. A similar conclusion is found by Baccarne et al. [1] in an analysis for OTT TV services in Flemish market. The authors argue that competition between the two dominant television distributors and the adoption of triple play bundles has dispelled a *cord-cutting* scenario. Notwithstanding these claims, OTT telecommunication services has been historically considered a factor in the decline of established traditional telecommunications services [4]. For instance, during the second half of the 1990's decade the email OTT service considerable affected the volume of global postal letters.

Some other services that are, or could be displaced of the market by OTT's disruptive innovation are:

- Netflix, Hulu and similar platforms are an alternative for a considerable number of consumers, to the detriment of the open TV (FTA) and pay TV.

- Facetime and Skype could be a better option that long-distance calls.

- Youtube shows videos and music which is also offered by broadcast channels.

- Itunes displaces CD sellers.

- Chat services as Whatsap replaced SMS.

On the other hand, Detecon Consulting[3] establishes that telecommunications industry will generate worlwide 1.3 trillion Euros by year 2017, of which OTTs will generate 402 billions Euros. The compounded annual growth rate (CAGR) of worldwide OTT services for 2012 to 2017 period would reach 17.3%; while CAGR for traditional telecommunications services would be 2.6% for the same period. It is expected that cloud services will be the most important service segment, almost representing 1/3 of total service market by year 2017. Furthermore, there is now considerable optimism for Pay OTT video services in Mexican market. The Competitive Intelligence Unit[4] measures its impact over restricted TV market and it concludes that Pay OTT video services will add up to 44% of paid content market in Mexico by year 2020.

Even though OTT's services have impacted traditional operators' resources, which in certain occasions prevent the investment in broadband infrastructure, they have positively contributed to the explosion of contents and innovation. The fact that OTT operators are free of legal requirements such as a license fee in order to enter to the market has allowed them to left its stamp in the development of innovative projects such as start-ups or individual content providers.

There exists a debate with respect to the application of a regulation to OTT companies that will impose a minimum standard of quality to its services. In that respect, it should be analyzed if that regulation could be applicable to all type of OTT services.

In this article we will focus on the assessment of Mexico's OTT video market by conducting a cluster analysis for a set of 19 developed and developing countries, by applying a hierarchical algorithm. The objective is to identify if Mexican OTT video market could be compared to successful international markets by considering OTT video revenues and OTT video active devices for years 2012 to 2015.

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[3]https://www.itu.int/en/ITU-D/Regional-Presence/AsiaPacific/Documents/Events/2014/ITU-ASEAN%20Forum%20-%20Indonesia%20-%20Dec%202014/ITU%20Conference%20Jakarta%20-%20Day%202%20-%20Dr.%20Werner%20Knoben%20-%20Detecon.pdf

[4] http://www.the-ciu.net/nwsltr/386_1Distro.html

The hierarchical clustering algorithm is also known as similarity grouping and it considers different agglomeration methods such as *centroid, complete* and *ward*. The convenience of cluster analysis as a descriptive tool is its consideration of a multivariate framework, i.e. a set of measured variables [10], useful to classify a sample of objects, or subjects, into groups whose members share similar characteristics.

The paper is organized as follows. The following section presents the methodology for hierarchical clustering. Then, section 3 describes the sample data and the variables used in our analysis. In section 4 we present the results. Section 5 is about some regulations considerations for OTT services and in section 6 are the conclusions.

2 Methodology

In this article we analyze Mexico's OTT video market and for that respect we implement a data analysis based in a hierarchical clustering algorithm. In the stylistic vein of Exploratory Data Analysis (EDA) the main purpose is to present a comparison of the resemblances and differences between Mexico's OTT video service market and a set of countries' markets from a multidimensional point of view. In this way we shall obtain a more precise perspective for Mexico's OTT video market. In the next subsection this data analysis tool is explained in detail.

2.1 Hierarchical clustering

Hierarchical clustering method examines the similarities between individuals with respect to all variables and it organizes them into groups whose members are comparable in some way [7]. The analysis is based in agglomerative methods such as *centroid, complete* and *ward*, in which each item starts in its own separate cluster. The agglomerative methods are used to determine which cluster should be joined at each stage. Then, the algorithm is repeated iteratively in order to merge pairs of groups until all data is merged in a single cluster. The result is a Dendrogram plot which is a summarization tool for the interpretation of the algorithm

and data. Furthermore, the analysis requires to specify a distance measure between observations. Since all our variables are continuous we use the Euclidean distance between the variables:

$$d_{ij} = \sqrt{(x_{i1} - x_{j1})^2 + \cdots + (x_{ip} - x_{jp})^2}$$

As it was aforementioned the agglomeration methods used in this article are *centroid, complete* and *ward*, which are detailed below (A, B and C refer to different groups of points):

- *Complete* linkage or farthest neighbor method. In this case the distance between the two new clusters is the greatest of the distances between groups before merging.

$$d(C, AB) = max(d(C, A), d(C, B))$$

- *Centroid* method. In this case the distance between two groups is equal to the Euclidean distance from the mean of the observations belonging to each group.

$$d(C, AB)^2 = \frac{n_a}{n_a + n_b} d(C, A)^2 + \frac{n_b}{n_a + n_b} d(C, B)^2 - \frac{n_a n_b}{(n_a + n_b)^2} d(A, B)^2$$

- *Ward* method. All possible pairs of clusters are combined and the sum of the squared distances within each cluster is calculated. This is then summed over all clusters and minimized. The combination that gives the lowest sum of squares is chosen.

3   Data

In this paper we use a dataset of 19 countries for a four-year period, 2012 to 2015. The source of data is OVUM Knowledge Center[5], a telecom and media consulting. The variables considered for our multivariate

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[5] https://www.ovumkc.com/

cluster analysis approach are OTT video total revenues by type of content segment (movies, TV and other) and total active devices (fixed, portable and mobile) (see Table 1). Due to data restrictions the countries considered are: Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, Mexico, Nigeria, Russia, Saudi Arabia, South Africa, South Korea, Spain, Turkey, United Kingdom and USA. The units for OTT video revenues are in millions US Dlls, while total active devices are in millions. In Table 2 we can observe the moments of our sample.

Table 1. Variables*

Variable	Description
x_1	Total (EST, TVOD, SVOD) OTT Video Revenues by movies segment, 2012
x_2	Total (EST, TVOD, SVOD) OTT Video Revenues by movies segment, 2013
x_3	Total (EST, TVOD, SVOD) OTT Video Revenues by movies segment, 2014
x_4	Total (EST, TVOD, SVOD) OTT Video Revenues by movies segment, 2015
x_5	Total (EST, TVOD, SVOD) OTT Video Revenues by TV segment, 2012
x_6	Total (EST, TVOD, SVOD) OTT Video Revenues by TV segment, 2013
x_7	Total (EST, TVOD, SVOD) OTT Video Revenues by TV segment, 2014
x_8	Total (EST, TVOD, SVOD) OTT Video Revenues by TV segment, 2015
x_9	Total (EST, TVOD, SVOD) OTT Video Revenues by other segment, 2012
x_{10}	Total (EST, TVOD, SVOD) OTT Video Revenues by other segment, 2013
x_{11}	Total (EST, TVOD, SVOD) OTT Video Revenues by other segment, 2014
x_{12}	Total (EST, TVOD, SVOD) OTT Video Revenues by other segment, 2015
x_{13}	Total active devices (fixed, portable, mobile), 2012
x_{14}	Total active devices (fixed, portable, mobile), 2013
x_{15}	Total active devices (fixed, portable, mobile), 2014
x_{16}	Total active devices (fixed, portable, mobile), 2015

* Source: OVUM: OTT Video Forecast: 2015_19 OTT Video Forecast: 2015_19. https://www.ovumkc.com/.

Table 2. Moments of the sample

	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}	x_{11}	x_{12}	x_{13}	x_{14}	x_{15}	x_{16}
$\bar{x}$	173.4	235.2	274.8	323.1	133.2	220.2	290.9	354.5	11	15.2	17.6	19.5	32.5	45	60	77.2
σ	558.4	740.2	819.4	937.5	461.1	748.7	950.6	1124.9	35.6	45.8	47.9	49.1	52.4	70.8	90	110.9
skew	3.9	3.8	3.8	3.8	3.9	3.9	3.9	3.9	3.9	3.9	3.8	3.7	2.6	2.6	2.5	2.5
kurt	16.5	16.4	16.2	16.1	16.7	16.7	16.6	16.5	16.7	16.6	16.2	15.9	8.6	8.7	8.5	8.3

Fig 3 shows a three dimensions (3D) scatter plot in which total active devices in year 2015 is plotted against OTT video total revenues by movies segment and TV segment, in year 2015. The scatter plot seems to suggest that an increase in total active devices tends to increment revenues in both OTT video segments. It seems logical since more access to digital technologies, that is more screens in our lifes [2], allows people to fit their own schedule in order to watch OTT video content, which increases OTT revenues.
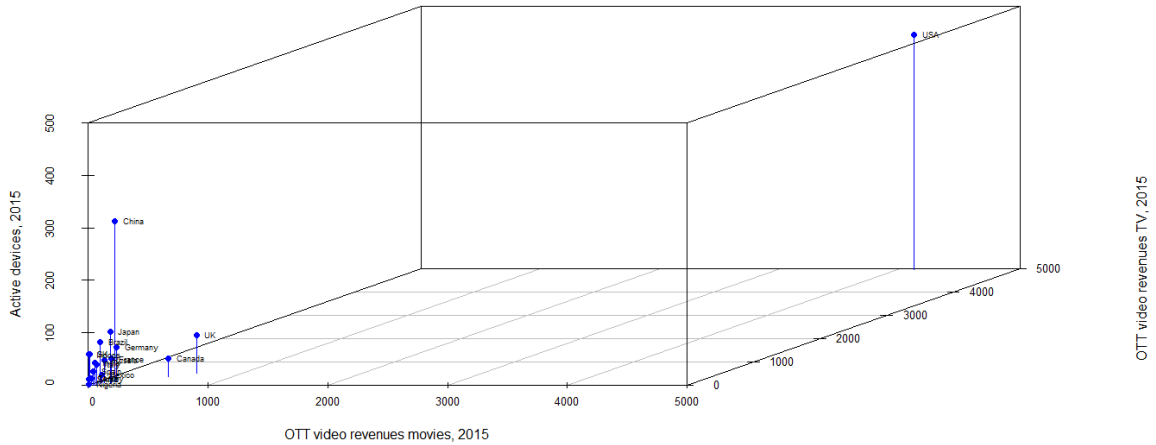
Fig. 3 Three dimensions scatter plot. Total OTT digital video revenues by content segment (movies and TV) and active devices in year 2015

4   Results

In a first step we preprocess our dataset. For that purpose we scale the data by applying *scale()* function in *R* program[6]. The process subtracts from each vector its mean and then divide it by its standard deviation. Then, in order to decide the number of clusters for our analysis we make a scree plot of the within groups sum of squares[7] by the number of clusters. The premise consists on trying to find a bend in the plot to identify the number of clusters [8, 11]. Thus, our scree plot (see Fig. 4) suggests between two or three groups for our standardized data set. In our opinion three groups seem to be an appropiate measure of similarity grouping; however, we also obtain results for two and four groups (see Table 3). In all cases the United States of America is a singleton as a consecuence of its very high OTT penetration and a great consumption of contents with respect to the rest of countries. The different agglomeration methods (*Centroid, Complete* and *Ward*) of the cluster analysis place China in its own group; while the rest of countries, including Mexico, are in the third group when we take three clusters (G_3). With respect to Mexico's OTT video market it seems to have some resemblances with Russian market given that they are always placed in the same branch for the different dendrograms (see Fig. 5). To a lesser extent, according to *Ward* method, Mexico's market seems to approach

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[6] The R Project for Statistical Computing: https://www.r-project.org/

[7] $SSW = \sum_{g=1}^{G} \sum_{j=1}^{p} \sum_{i=1}^{ng} (x_{ijg} - \bar{x}_{jg})$, where x_{ijg} is the *j-th* variable in the *i-th* item of the *g-th* group; $\bar{x}_{jg}$ stands for the sample mean of this variable in the group and *ng* are the number of items in the *g-th* group.

to those of Indonesia, Spain, India and Italy. Finally, the other two methods (*Complete* and *Centroid*) express that Mexico's market is more comparable to those of emerging countries such as Nigeria, Turkey, South Africa and Saudi Arabia.

On the other hand, increase the number of groups is a double-edge sword since it can result in smaller error function values, but also in an increasing risk of overfitting. Nonetheless, we include four clusters in our analysis obtaining different results for each agglomeration method (see Table 3). In *Ward* method G_4 is defined by developed countries such as Canada, France, Germany, Japan, South Korea and United Kingdom; and an emerging economy, Brazil. Mexico is in the same group as Spain, India, Italy, Turkey and Russia. The case of Brazil is special since this country has generally lower OTT video revenues than Mexico's market (e.g. OTT video revenues by movies segment in year 2015: Brazil, US$52.50 millions; Mexico, US$58.97 millions), however its number of active OTT devices is much larger than Mexico's total (e.g. total active devices in year 2015: Brazil, 78.82 millions; Mexico, 15.37 millions). Therefore, we can conclude than Brazil is more a sort of outlier than a regional comparable country to Mexico. For the case of *Complete* method, we find that France, Germany and South Korea are no longer grouped in G_4, while Mexico remains in G_3. Lastly, for *Centroid* method only Canada and the UK remain in G_4; while the rest of countries are now in G_3 group, including Mexico.
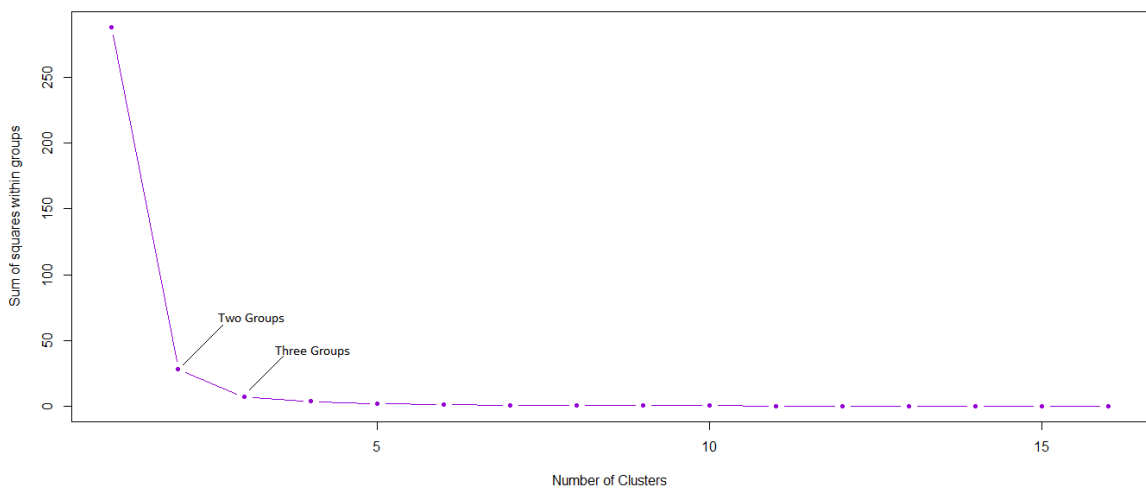

Fig. 4 Scree Plot

Table 3. Hierarchical clustering by type of agglomeration method

|	Groups	Ward	Complete	Centroid
1	G_1	USA	USA	USA
	G_2	The rest of countries	The rest of countries	The rest of countries
2	G_1	USA	USA	USA
	G_2	China	China	China
	G_3	Nigeria, Turkey, Saudi Arabia, South Africa, Mexico, Russia, Indonesia, Spain, India, Italy, Canada, UK, South Korea, France, Germany, Brazil, Japan	Indonesia, Spain, India, Italy, South Korea, France, Germany, Nigeria, Turkey, Saudi Arabia, South Africa, Mexico, Russia, Brazil, Japan, Canada, UK	Mexico, Russia, Nigeria, Turkey, Saudi Arabia, South Africa, France, Indonesia, Spain, India, Italy, Japan, Brazil, Germany, South Korea, Canada, UK
3	G_1	USA	USA	USA
	G_2	China	China	China
	G_3	Nigeria, Turkey, Saudi Arabia, South Africa, Mexico, Russia, Indonesia, Spain, India, Italy	Indonesia, Spain, India, Italy, South Korea, France, Germany, Nigeria, Turkey, Saudi Arabia, South Africa, Mexico, Russia	Mexico, Russia, Nigeria, Turkey, Saudi Arabia, South Africa, France, Indonesia, Spain, India, Italy, Japan, Brazil, Germany, South Korea
	G_4	Canada, UK, South Korea, France, Germany, Brazil, Japan	Brazil, Japan, Canada, UK	Canada, UK
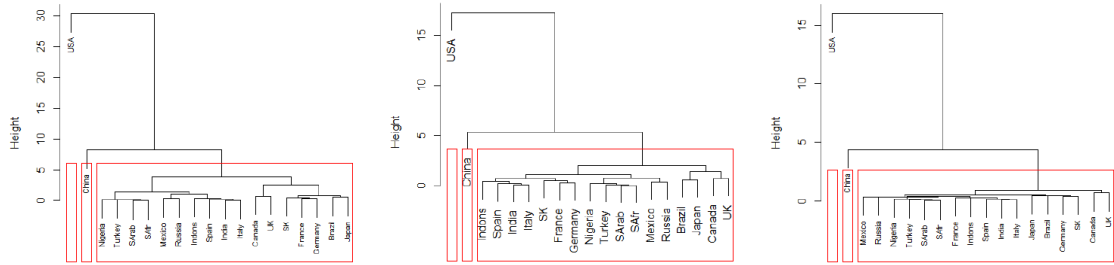
Fig. 5 Dendrograms by agglomeration method: a) Left plot, Ward, b) Center plot, Complete and c) Right plot, Centroid.

Retaking the similarities between Mexico's OTT video market and the rest of countries considered in our sample, it is remarkable that it is comparable to the Russian OTT video market, being one of those with most growth potential over the next years. According to Pyramid Research´s OTT video report[8] Russia ranks second just after China, in its OTT Video Market Attractiveness Index for emerging markets. Its sizeable broadband market and its state of the art infraestructure are considered as the main strengths of Russian OTT video market. Furthermore, in 2014 Russia's total OTT video revenues reached US $145 millions, figure that is expected to double (US $305 millions) by year 2019 (see Fig. 6). Regarding the number of subscriptions video on-demand (SVOD) it reached 2.5 millions in year 2014, while by year 2019 it would surpass the 5 millions of subscribers (see Fig. 6). Then, it is evident that OTT companies can exploit the potential benefits of a growing market such as Russian for coming years. In the case of Mexico we observe a positive trend in its OTT video TVOD revenues for the next years (see Fig. 7), specifically for electronic sell-through service (OTT EST), e.g. Apple iTunes, and digital rental or paid temporary access to on-demand content (TVOD). Thus, we can conclude that both markets follow a similar path, and both are considered as emerging markets with high perspectives in OTT video market.

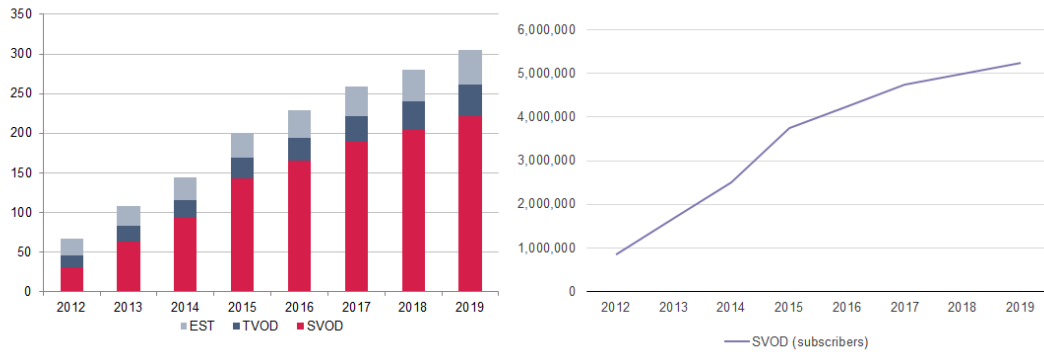[8] OTT Video Market Attractiveness Index: Worldwide Country Rankings, Market Drivers and Positioning Strategies in http://www.pyramidresearch.com/

Fig. 6 a) Left graph, total OTT video revenues; b) Right graph, SVOD subscribers in Russia (from OVUM. https://www.ovumkc.com/).
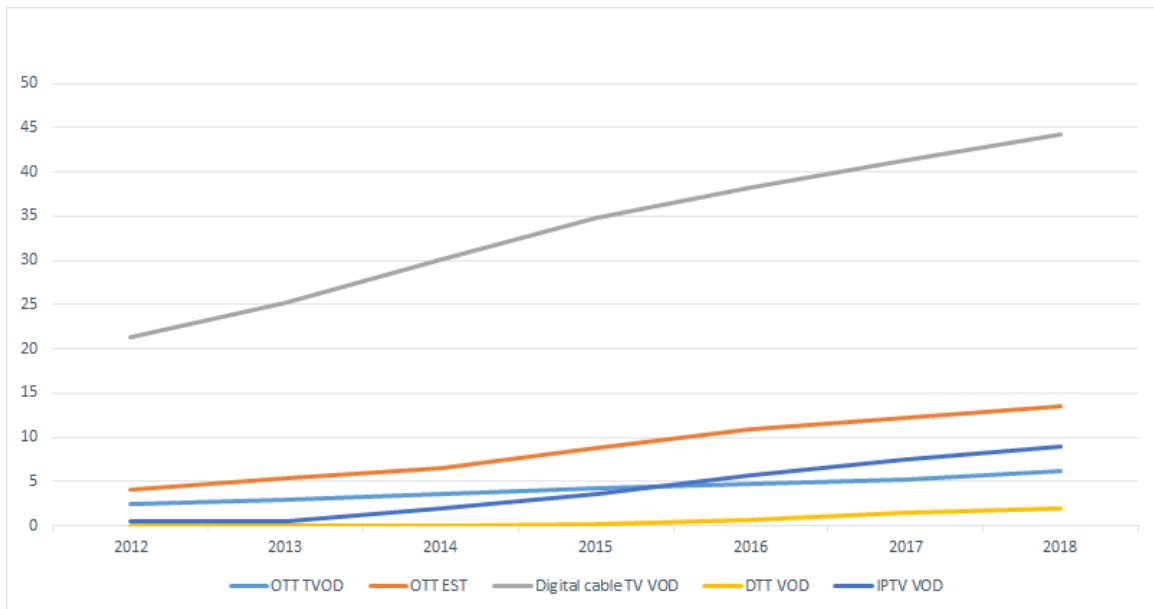
Fig. 7 Mexico total pay TV and OTT video TVOD revenues (source OVUM. https://www.ovumkc.com/)

Besides previous results that places Mexico's OTT video market along with the aforementioned emerging countries, we must consider the demographic aspect. The particular importance of this information lies on the fact that younger cohorts are the most willing to shift their consumption habits of video contents and to adapt their schedules [2]. In that respect, Mexico exhibits a population growth rate of 1.37% from year 2010 to year 2015 (see Fig. 8). For the case of Russia its population growth rate is very close to zero (0.04%) for the same time period. Turkey, Nigeria and Saudi Arabia have considerable population growth rates, while South Africa and Indonesia are behind Mexico. According to Mexico's Consejo Nacional de Población's

(CONAPO) proyections[9] by year 2020 the age group between 15 and 64 years old would approximately represent the 66% of Mexico's total population. This percentage is greater than the existing on year 2010 (65.5%). Then, the potential number of OTT video content users would represent a considerable share of the total population. Thus, we can conclude that Mexico's OTT video market shows an optimistic perspective for the future by bearing some resemblance to other potential OTT markets and by expecting a positive growth rate of its population by age group.
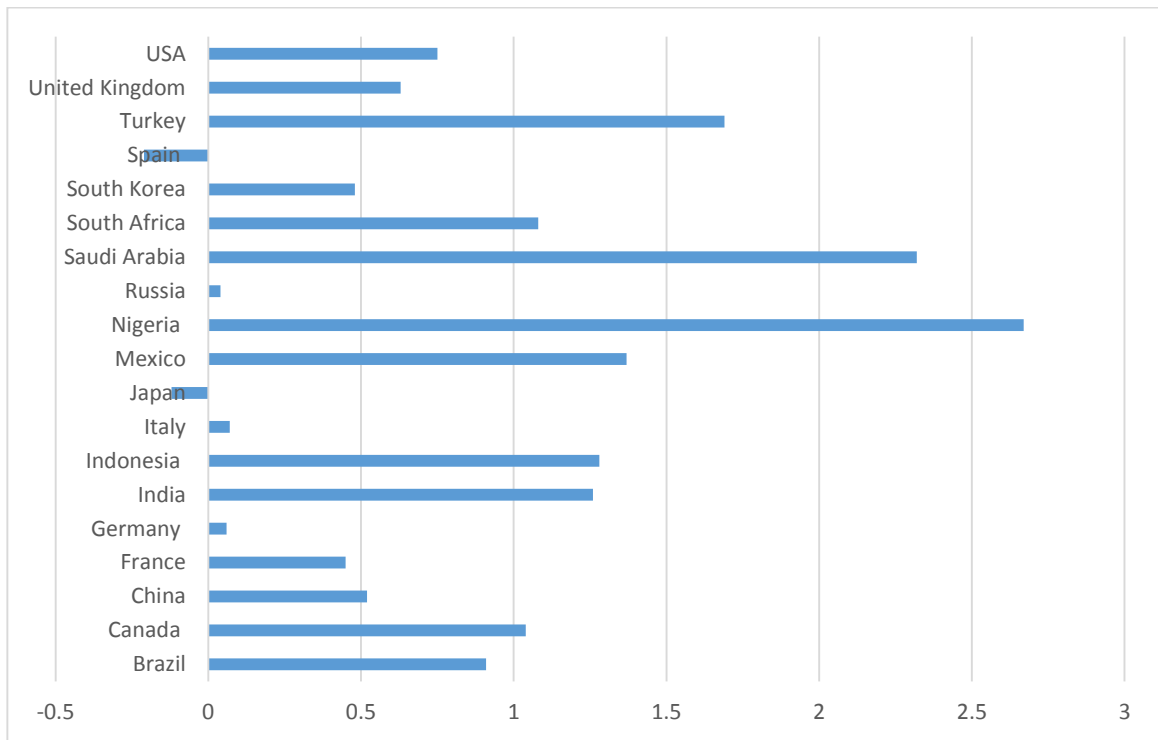

Fig 8 Population Growth Rate 2010-2015 (Source: UN World Population Prospects, the 2015 revision)

5   Regulation Considerations for OTT services

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[9] Informe de ejecución. Programa de Acción de la Conferencia Internacional sobre la Población y el Desarrollo 1994-2009. CIPD + 15. http://www.conapo.gob.mx/

The fact that Mexican OTT video market shows similarities to other international emerging markets is relevant in order to obtain a glimpse into future performance expectations of the industry and the applications of possible regulation scenarios.

A worldwide perspective about OTT services refers to the imbalanced ecosystem generated by them through the limitation or elimination of security and privacy of the end users. One of the main discussions is about net neutrality and the effects of its regulation on investment incentives for ISPs. ISPs are having to invest massively in higher and higher capacity infrastructure to meet the demand generated by OTT services. The fact that ISPs are not yet able to charge a cost to OTT companies derived of traffic priorizations is creating a lot of controversy. Another main issue is about tax collection and the complications derived from the nature of OTT companies as global entities which are able to explote transfer pricing advantages in order to allocate profits in countries with lower tax rates.

There is a trend in the market toward a vertical integration between ISPs and OTT services which must be taken into consideration by the Mexican telecomm regulator if it decides to implement a regulation. In that respect we consider that it would be the prevailing scenario in between operators and OTT in video market.

6   Conclusions

In this article we implement a data mining analysis technique known as hierarchical clustering algorithm aimed at analyzing the development of Mexico's over-the-top (OTT) video market from an international perspective. The main idea is to identify from a multidimensional point of view if Mexican OTT video market is comparable to other markets showing considerable growth potential. By using variables such as OTT video total revenues by content segment and total active devices by type, the three agglomeration methods (*centroid, complete* and *ward*) applied to the algorithm suggest that Mexico's OTT video market shows resemblances with an emerging country such as Russia. To a lesser extent Mexico's OTT market seems to be similar to those of Nigeria, Turkey, South Africa and Saudi Arabia. Regarding Russian OTT video market

it has been ranked as the second most attractive emerging market in the world[10] and it is expected to sum total revenues of US $305 millions by year 2019. Then, it is clear that Russian market is a promising hot spot for worldwide OTT video market. Even though Latin America region still exhibits low broadband penetration levels with respect to developed countries [9], the facts indicate that Mexico's OTT video market closely resembles to promising OTT video markets. Furthermore, the diffusion of OTT's services in Mexico is benefited by an increase in the number of active devices and by a positive population growth rate, especially in the case of age groups considered as potentital OTT video content users.

Thus, the Mexican regulator must consider that OTT video market has developed so well up to now without any regulation and in some way it is comparable to main emerging international OTT markets. Furthermore, it must considers the fact that ISPs are starting to recognize the relevance of OTT services by vertically integrating with OTT services. Also, it should be pointed out the risks of an excessive regulation which could avoid the appearance and development of new applications or added value services. Then, from regulator's perspective it is a double-edge sword that should be taken into account.

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