RevPARnomics: *The sensitivity of Revenue Per Available Room of Amsterdam to GDP of its source markets*

Master Thesis

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Author: Steven Smit

Tutor: Martijn Dröes

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1. Introduction

Over the period between 2003 – 2015, tourism to the Netherlands grew steadily at 3.4% while tourism to Amsterdam grew at 4.2% annually (CBS, 2016). Over the same period the average share of international visitors for the Netherlands was 37%, while for Amsterdam this was 84%. In comparison, the development of Revenue Per Available Room ("RevPAR", Revenue Per Available Room = Average Daily Rate x Occupancy), a measurement for hotel performance, grew by 1.9% annually in Amsterdam (STR, 2016), and by 1.4% in NL (STR, 2016) over the same period.

The question is which arguments could be found to explain this divergence. Macro-economic variables are underlying factors that drive the performance of tourism. Amsterdam is exposed to a different set of macro-economic variables than the country as a whole, because of the different set of origin markets of tourists (further: "source markets"). Macro-economic variables are calculated and estimated to a large extent and could therefore be used to explain performance. Many macro-economic factors have been tested and some have been identified as relevant (Peng, Song, Crouch & Witt, 2015). GDP is the most identified, used and tested macro-economic variable in previous research. The additional strength of using GDP in this research is that GDP in relation to hotel performance in Amsterdam is exogenous. It is unlikely that developments in the Amsterdam hotel market have a serious impact on, for example, German GDP. This exogeneity of GDP allows to test for a causal relationship.

2. This study

This study aims to test the sensitivity of RevPAR to foreign and domestic economic development in source markets, measured by GDP, over the period 2003 – 2015 in Amsterdam. The sensitivity is estimated by using two different approaches. In both approaches, the percentage growth of GDP and the percentage growth of RevPAR are used. The approaches differ in that one is a Separate Variable Regression ("SVR") approach, whereby relevant GDP growth variables from key source markets are used separately. The other is based on a calculated weighted average growth of GDP, based on the source market's share in Arrivals and in Room Nights. This approach is referred to as a Weighted Variable Regression ("WVR"). By including source markets in the equation the weighted GDP is tailored to a specific destination, Amsterdam in this case, and is dynamic over time. By using both approaches it can also be determined if a model with a Weighted Dynamic Variable ("WDV") leads to higher explanatory power and more robust results. Amsterdam is an excellent market for such analysis as over 80% of visitors come from foreign economies.

The potential of a WDV is that *if* the model holds and is robust with such a WDV, commonalities among specific types of destinations could be made comparable and could be used as intelligence to make investments and/or operational decisions. In previous research, GDPs of most important markets have generally been tested as separate explanatory variables at a country level. Some research exists on city level, but it can be concluded that combing GDPs of relevant source markets in a single variable has not yet been done. Markets of origin have been used in previous research, but only for the matter of

selecting data. Researchers have had to make choices in the many variables that can be, and have been, used for identifying relationships. No study, that was part of this research, has used source markets to reduce the number of factors. This could result in several benefits: (1) the model becomes less complex, (2) the variables are integrated according to their relevance, (3) their relevance is dynamic for a specific period and (4) this could increase the explanatory power and/or robustness of the model. The result is a dynamic variable that is tailored to a specific destination. This dynamic variable could provide additional insights into how RevPAR development in Amsterdam is sensitive to GDP development of source markets.

For this research, GDP data is gathered from key source markets for Amsterdam. Growth of GDP is determined and combined with the RevPAR growth of Amsterdam to determine the sensitivities. With the GDP and RevPAR growth variables multi-variate regression-tests will be performed to define if GDP separately or as WDV provides better explanatory power for RevPAR development in Amsterdam. The explanatory power is measured by an improved R-squared and the robustness of the model by interpreting the consistency of coefficients and the consistency of their significance.

By using data from sources such as the International Monetary Fund ("IMF"), STR Global ("STR" – the worlds' largest hotel market data base) and the Dutch Central Bureau of Statistics ("CBS"), clarity is provided on the explanatory power of GDP. This approach is relevant for both owners (institutional investors, private investors, owner-operators) and operators (hotel companies, tenants, franchisees, management companies, etc.) or combinations of both.

The WVR approach proves to be a more robust for understanding development at market level based on ME factors, but does not lead to a higher Adj. R^2. The WVR approach leads to more consistent results and a better forward looking capacity. GDP has a clear relationship with RevPAR and the WVR approach is a robust and insightful technique for tailoring them to any destination and implanting macro-economic variables in explanatory models for both historic and forecasting purposes.

In chapter 3, this thesis starts with a review of literature on the topics of economics, hotel markets and the relevance of this topic in the real estate field, including the relationship between tourism, economics and macro-economic variables. A case will be made for why using RevPAR as dependent variable is correct. To use weighted variables, several calculations need to be done. These calculations are set out in chapter 4. The actual structure of the SVR and WVR models are explained in chapter 5 and are analysed in chapter 6. Finally in chapter 8, the implications of the analysis are discussed including opportunities for further research.

3. Literature review

3.1 Economics, hotel markets and the relevance for real estate

The 'exposure profile' of a specific market allows incumbents or entrants to formulate a view on the sustainability and movement of a specific market. Such analysis is one of the first steps in the decision making process to expand in, or enter, a market.

To determine the income potential for an asset, both owners and operators look at markets before looking at property or firm level. The better a market performs, the more opportunities there are for properties in that market by making the right strategic choices. Good market performance results in income opportunity and sustainability of the income potential.

The fact that hotel performance, resulting in increased earnings capacity, impacts the value of the underlying real estate asset makes sense. More income results in more value. The income level a hotel can allocate (in terms of rent, or cash flow) depends on how well the hotel is able to generate revenue from customers and its capacity to turn this revenue into income. Higher income in general, means higher income allocation potential towards real estate. Turning revenue into cash is an operational execution and is out of scope of this research.

A market is a widely used term, nevertheless it has various definitions in the literature. In previous research concerning hotel performance, it has been observed that in most circumstances a 'market' is often a country (Reichel & Haber 2005; Gursoy & Swanger 2007; Peng, Song, Crouch & Witt, 2015). Country markets can however differ largely from 'local' markets, such as a city or a specific recreational area. To understand such local markets, and the sustainability of performance, it is key to know which economies that market is exposed to. If, for example, Amsterdam is mainly exposed to the Dutch economy, the development of that economy should be the most relevant. If Amsterdam is more exposed to foreign economies, those respective economies should be more relevant (Pacheco, 2016).

Peng, Song, Crouch & Witt (2015) determined in their meta study on demand elasticities of tourism that empirical studies demonstrate that income has a positive effect on demand, in accordance with economic theory. So by understanding in which source market(s) income will grow most, properties can best position themselves to benefit from that income growth. This activity in turn makes the properties more interesting for owners, from a real estate perspective.

Understanding the demand profile (i.e. source markets), best positions operators to ultimately benefit from market performance and allows real estate investors to select the best markets and time their investments based on economic expectations of relevant economies.

3.2 Economic structure and hotel supply

3.2.1. The Otus theory of supply and demand

The shape and state of an economy does provide insight into the structure of hotel supply, but provides too little insight into the international influences affecting that market.

Slattery (2008) wrote extensively on the topic of how the composition of an economy impacts the structure of the hotel market in the "Otus theory of supply and demand". According to Slattery (2008), the Otus theory predicts that within an economy, there is a positive relationship between the contribution of services business to Gross Domestic Product ("GDP") and the domestic demand for hotels. The contribution of the services business to GDP also positively impacts the level of leisure tourism, the supply of hotels and brand concentration within a market.

While the study is focused on the role of tourism within an economy, it does hint at the impacts of foreign dependence. Slattery (2008) concludes that the greater the production of demand from foreign tourists, the more the hotel supply at property level is shaped according to this demand. This is in line with what is described earlier: if properties understand where demand is coming from, they adequately position themselves. The impact of this is visible in France, where the hotel supply ratio is very high, as the hotel market depends to a relatively high extent on foreign tourism (Slattery, 2008).

Based on this research we can conclude that economic structure and foreign dependency shape hotel supply in a certain country. We can however not conclude what the impact is on performance, or which countries are relevant for a specific location. Only country level has yet been analysed. Simply separating only foreign and domestic does not provide the level of insight that is needed for an explanatory view on performance of a local market such as Amsterdam. Before we go deeper into the relevance of source markets for specific destinations, it should be further understood what comes first in economic growth: the growth of the economy resulting in tourism growth, or vice versa. The next paragraph therefore focuses on economy-driven tourism growth versus tourism-driven economic growth.

3.2.2. Chicken or the egg: economy-driven or tourism-driven development

Economic growth and tourism are interconnected, but the relationship cannot be clearly identified because international dependency is left out of the equation.

There are substantial benefits of tourism for an economy. Examples of which are foreign exchange earnings, income, employment and taxes (Archer, 1995; Belaguer & Cantavelle-Jorda, 2002; Dritsakis, 2004; Dubarry, 2002). Tourism is an active theme in many countries for its benefits. The hotel industry is a key sector within tourism, for its fundamental position within an the tourism industry. Accommodation (i.e. hotels) are the most basic requirement for tourists after reaching their destination (Bresciani, Alkis & Vrontis, 2015, referencing to Orfila-Sintessa et al., 2005).

While an extensive amount of research has been done on this topic, to date the results cannot be deemed conclusive. It has been difficult to prove which comes first, economic growth or tourism growth.

In Greece a bi-directional relationship was identified by Dritsakis (2004). Oh (2005), however, defined economy-driven tourism growth in Korea.

The differences in results, raises questions about if the tourism (or hotel) performance can be related only to the local economy of that country. Romero & Molina (2013) also note this tension in their review of empirical literature. From their sample of 87 studies on the topic, 55 showed a univocal relationship, 16 identified a bi-directional relationship, 9 indicated a flow from economic growth to tourism and 4 did not identify a relationship at all. Studies show that there is a relationship between economy and tourism, and that the weight of the industry in an economy impacts the relationship (Romero & Molina, 2013). The study looks at the 'internal' relationships, but does not mention the potential dependence on foreign economies.

The Dutch tourism industry also impacts the country's economy. The vice versa relationship seems to depend on the share of the Dutch visitors in the Dutch tourism industry. For Amsterdam, the Dutch economy should be 16% relevant, as this is the percentage of visitors coming from within the country. Kim, Chen and Jang (2006) also noted this. In line with this study's view, they suggest to compare "inter-country relationships between economic development and tourism activity" (Lee & Chang, 2008, referencing to Kim, Chen & Jang, 2006).

Previous research on the economic relationship between tourism and an economy has not provided the conclusive evidence researchers have been looking for. It did lead to additional views on the international dependency, including the impact of foreign economies in identifying a relationship between economics and tourism development. It seems, however, that for foreign dependent tourism-, or hotel, markets it could pay off to look at the macro-economic variables of relevant foreign markets.

3.3 The explanatory power of macro-economic variables

3.3.1. Research on relationships with macro-economic variables

The association between business, economy and performance of hotel firms is a topic less studied, particularly in the case of European countries (Pacheco, 2016). Studies on macro-economic variables in relation to the performance of a market have been done, but they have not been able to provide conclusive results. A reason for this could be that these studies have not balanced the impact of macro-economic variables on the basis of origin of visitors. This could be a defining factor.

In a market with a relatively high weight of foreign travellers, the (financial) performance is dependent on the broader economic developments (Pacheco, 2016). This seems very relevant for Amsterdam, as 84% of visitors to the city come from foreign economies. Pacheco (2016) studied the determinants of RevPAR for Portuguese hotels on the basis of global and local factors. His study is based on a previous study done in Hong Kong by Liu, Moulton & Quan (2013).

Both studies have a different outcome. In the study of Hong Kong global factors (mainly U.S. consumer confidence) seem to provide explanatory power for the development of RevPAR. In the Portuguese study, however, only local factors can be determined relevant. Pacheco (2016) indicated that

a reason for the difference in results could be that there "could be the intrinsic difference between travellers to a mega city such as Hong Kong and guests traveling to Portuguese hotels". What is not addressed is that the foreign dependency in both markets is quite different. In Portugal around 58% of tourists (OECD, 2016) were foreign, while in Hong Kong the foreign dependency was 92% (Commerce and Economic Development Bureau de Government of the Hong Kong Special Administrative Region, 2016). This could be the 'intrinsic difference' in market composition that Pacheco is referring to, yet this is not explicitly mentioned in the paper.

The different outcomes of the studies could thus be caused by the different foreign dependency of the hotel markets and how this impacts demand development (measured by RevPAR growth). Both studies fail to address to international dependency factors explicitly, while this could be a deciding factor. If, for example, the global and local factors could have been weighted according to their relevance the impact of both influences could have been adjusted for the foreign dependency. This could have yielded different results. Additionally, the Hong Kong study is technically done for a country, but as Pacheco rightly questions, it is difficult comparing the results of a country like Portugal to Hong Kong which is better described as a mega metropolitan city.

3.3.2. The case for RevPAR as dependent variable

Quite a few measurements for indicators of demand could be taken such as tourist arrivals and/or departures, tourist expenditures, travel exports and imports, length of stay and/or nights spent at tourist accommodation (Lim, 1997). Additional to these more macro demand variables are some hotel market performance measurements that could be more interesting, especially from the owner and operator perspective. Examples of these are RevPAR, RevPAC (Revenue Per Available Customer), TrevPAR (Total RevPAR) and GOPPAR (Gross Operating Profit Per Available Room).

Both Liu et al. (2013) and Pacheco (2016) use RevPAR as its dependent variable. They argue that RevPAR combines both ADR and Occupancy in one metric and factors out the strategic choice made by operators to aim for rate or for occupancy. Additionally RevPAR is widely used within the hotel industry as a measurement of performance (Liu, Moulton and Quan, 2013). As RevPAR is so widely used, it is also widely available and therefore provides good sample data.

Slattery (2002) presents several arguments why RevPAR should be reformed. His view is that RevPAR is unreliable because room supply and demand measures are faulty and connection between RevPAR and cash is to variable for the metric to be fully effective. Other metrics such as TrevPAR and GOPPAR are increasingly used (Younes & Kett 2004; Banker, Potter & Srinivasan, 2005) in the industry and do provide more insight into the profitability and performance in relation to cash for a property.

This study has chosen to take RevPAR for several reasons: (1) this is the most widely used indicator in the industry, (2) RevPAR factors in occupancy and Average Daily Rate ("ADR"), but factors out the strategic choice of operators to steer on either one, (3) RevPAR has proven to be strongly affected

by crises which is very relevant for the chosen time period and lastly (4) RevPAR is the focus indicator for the hotel real estate industry, for both owners and operators, to obtain a view on the aggregated market performance.

3.3.3. Defining relevant macro-economic variables

GDP is the best explanatory variable as it compares ”an aggregate with an aggregate”.

Depending on the level of data or a specific segment that one is looking for, specific variables can be chosen. Popular explanatory variables that have been used are income, relative prices (Peng, Song, Crouch & Witt, 2015) and transportation costs (Lim, 1997). Of these, income in the origin country has been used most frequently as the explanatory variable.

As income measure, the majority of researchers have used real, personal, disposable or national (per capita) income and GDP or Gross National Product (“GNP”) (or proxies) in the origin country. In their meta-analysis of international tourism demand elasticities, Peng, Song, Crouch & Witt (2015) came to similar conclusions. They too found that most researchers use either nominal or real GDP or GNP. Other variables have been used such as real consumption per capita (Dritsakis, 2004), foreign travel budgets (Smeral & Witt, 1996), consumer confidence (Knowles & Egan, 2001), industrial production indices (Gonzalez & Moral, 1995) and real household disposable income (Lim, 1997). GDP of source markets seems to be the leading explanatory variable of choice.

An option could be to use proxies for GDP or GNP. This is what Liu, Moulton & Quan (2013) did in their study on Hong Kong. In their study, the researchers use trade balance as a proxy for income growth. Trade balance is, however, only a best fit indicator associated with business tourism demand (Turner & Witt, 2001) and thus does not capture all associated data with the entire hotel market. It would be better to use fully aggregated indicators on an aggregated dependent variable such as RevPAR for an entire market. In the research of Liu, Moulton & Quan (2013) the proxy for growth is deemed insignificant in 6 out of 8 instances. It could therefore be questioned if proxies actually work.

Apart from GDP being the chosen factor by researchers, it has also proven to be a key determinant of the cutback decision on tourism expenditure (Eugenio-Martin & Campos-Soria, 2014). This means that in a downturn, GDP should be the right metric to include in the analysis as the period under review includes the Global Financial Crisis. GDP is also at an aggregation level where both business or leisure tourism and all market classes (from luxury to midscale) are covered.

4. Data

4.1 Data to be used for research

Data from three main sources will be used to perform this study. Hotel demand and RevPAR have been provided by STR Global ("STR"). STR is the world's largest hotel database, that also gathers data from hotels in Amsterdam. Source market data for Amsterdam comes from the Dutch Statistics Office ("CBS"). The CBS gathers all statistical data for the Netherlands, including the visitor statistics for Amsterdam from 1999 to today. Lastly, the macro-economic data used is from the International Monetary Fund ("IMF"). The IMF is an organisation consisting of 189 countries and has a vast amount of reliable historic economic data available.

Due to the availability of data from all 3 sources combined, the period under review is 2003Q1 – 2015Q4. For obtaining the best results quarterly periods are used in the analysis (Choi, 2003). Furthermore, a comprehensive set of variables has been chosen. The choice for using quarterly data over monthly or annually, and a comprehensive variable set over a large set with many variables, is driven by the outcome of the meta research of Peng, Song, Crouch & Witt (2015). They showed that the number of variables, as well as the timing interval, in a model has proven to affect the results of the model.

As this research is focused on comparing growth to growth, the growth of each factor is still to be obtained. As data is available from 2003Q1, quarter-on-quarter ("q-on-q") growth figures can be calculated from 2004Q1 onwards. Throughout this study the q-on-q Growth Percentages ("G") for each variable is calculated in the same way:

(1) $$G_t = \frac{Variable_{n,t}}{Variable_{n,t-1}} - 1$$

G_t: Growth at time t

$Variable_{n,t}$: Variable n in period t

$Variable_{n,t-1}$: Variable n in period t-1

4.2 Hotel Market data: STR Global

STR is the owner of the largest database of hotel performance data in the world and the best source for hotel market data for Amsterdam. Due to its size, STR is able to provide the best sample sets over a specific time period. The different hotel categories STR uses indicate the segment of the market a hotel is operating in. STR publishes these segments on an annual basis. Each category is used as input variable, except the economy segment. For Amsterdam, STR only has data on this segment from 2016Q1. This period is out of scope for the period under review in this research.

4.2.1. Input variables

The STR sample received includes 332 hotels in 2015, this represents 80.4% of the total 413 hotels in Amsterdam (Amsterdam Marketing, 2017). An overview of the sample and the growth between 2003 – 2015 is provided below:

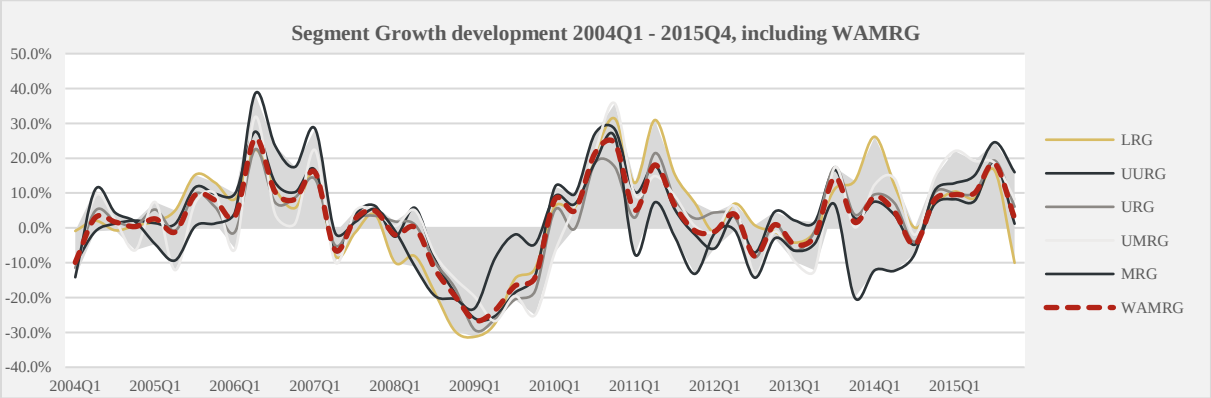
Table I: Overview of Segments classifications, weighted and growth including demand and RevPAR per segment

Segment		**FY demand in RNs**		**FY RevPAR**		**CAGR**		**Demand weight**	
Name	*Abbr.*	*2003*	*2015*	*2003*	*2015*	*Demand*	*RevPAR*	*2003*	*2015*
Luxury	L	237,359	355,526	169.7	231.4	3.4%	2.6%	4.1%	3.9%
Upper Upscale	UU	1,394,921	1,809,594	96.2	134.0	2.2%	2.8%	24.1%	20.0%
Upscale	U	2,129,270	3,462,769	79.3	97.6	4.1%	1.7%	36.8%	38.2%
Upper Midscale	UM	941,510	1,824,302	59.3	75.1	5.7%	2.0%	16.3%	20.1%
Midscale	M	1,075,997	1,602,958	53.6	58.7	3.4%	0.8%	18.6%	17.7%
Economy	E	-	-	-	-	n.a.	n.a.	0.0%	0.0%
Total		**5,779,057**	**9,055,149**	**79.1**	**98.7**	**3.8%**	**1.9%**	**100.0%**	**100.0%**

***Note**: Segment indications in column "Abbr.", indicate abbreviations of segments used throughout this document*

For each of these categories the RevPAR and Demand have been compared to determine the overall development of the segment. All segments have grown significantly in both demand and RevPAR meaning each segment has improved strongly over the years. Strong growth most notably occurred in between 2010Q1 – 2011Q2, 2013Q3 – 2014Q2 and again in 2014Q4 – 2015Q4:

Chart I: Growth per segment over the period 2003 – 2015



***Note**: L = Luxury, UU = Upper Upscale, U = Upscale, UM = Upper Midscale, M = Midscale, RG = Rate Growth*

The figures provided in the set, allow to calculate the necessary variables that can be used to obtain a market figure for both demand and RevPAR so they can be used in the analysis.

4.2.2. Calculated variables

While the variables per segment offer an interesting view in the development, the source markets for each segment are not available. The set can however be used to calculate a proxy for the "market". This is relatively easy for Demand ("D"), it can be summed up resulting in Total Demand ("TD"). Total demand growth is calculated in accordance with equation 1 and is indicated as "TDG".

RevPAR cannot simply be added up, nor could a simple average be used to accurately reflect the market. By doing this, the luxury segment would be overinfluencing the simple average. The luxury segment has a high RevPAR, but only has a small part of the market. A weighted average to account for the size of the segments in the markets would more accurately reflect the overall market performance. To obtain the weighted figures two steps should be taken. Firstly, the weight of the segment in total demand should be calculated. This weight is then used to determine the weighted share of RevPAR for the total market. The weighted Demand Share ("DS") is calculated for each segment by dividing the demand of the segment in period *t* by the sum of total demand for the market of Amsterdam in the same period:

(2) $$DS_t = \frac{D\ Segment_t}{D_{market_t}}$$

DS_t: Demand Share at time t

D $segment_t$: Demand of the segment at time t

D $market_t$: Demand of the market at time t

The Weighted Average Market RevPAR ("WAMR") in period *t* is then obtained by the sum of RevPARs per segment, times the DS of that segment:

(3) $$WAMR_t = RevPAR_{L,t}\ x\ DS_{L,t} + RevPAR_{UU,t}\ x\ DS_{UU,t} + \cdots$$

$WAMR_t$: Weighted Average Market RevPAR at time t

$RevPAR_{L,t}$: Revenue Per Available Room of the Luxury segment (L) at time t

$DS_{L,t}$: Demand Share Luxury Segment (L) at time t

$RevPAR_{UU,t}$: RevPAR of the Upper Upscale segment (UU) at time t

(combination for RevPAR and Demand Segment is done for each segment as defined in table 1)

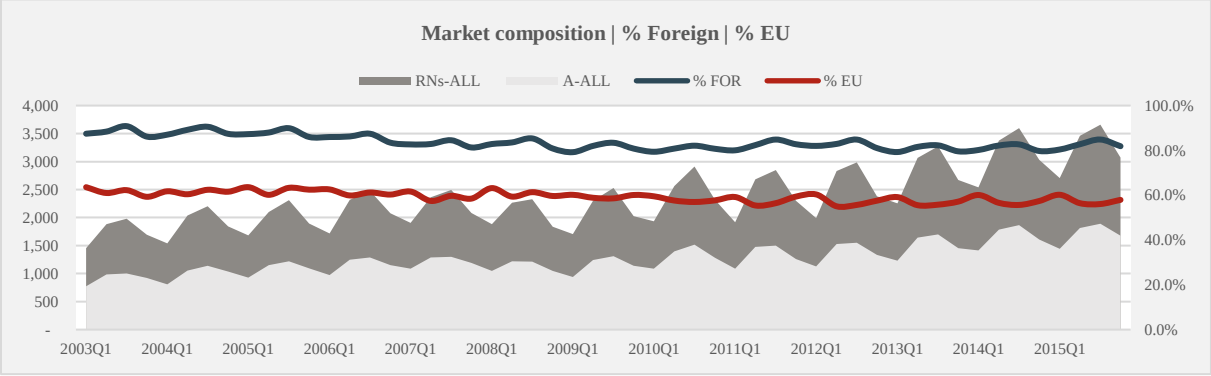
The WAMR growth per quarter is calculated in accordance with equation 1. WAMR growth is indicated as "WAMRG".

4.3 Source market data: Central Bureau of Statistics ("CBS")

4.3.1. Input variables

The data on room nights spent per country come from CBS, the Dutch statistics office. The CBS produces an overview of Room Nights ("RN") and Guests (further "Arrivals" or "A") per country, per quarter from 1999 to 2016Q3. When using the sample data (2003Q1 – 2015Q4), it can be confirmed that the Amsterdam market is dependent on foreign tourism for both RN and A:

Chart II: Market composition based on Arrivals and Room Nights, including % foreign and % EU of total visitors



***Note**: RNs-ALL = Total Room Nights all markets, A-ALL = Total Arrivals all markets, %FOR = percentage foreign tourists of total market, %EU = percentage European tourists of total market*

The majority of tourists to Amsterdam, around 80% on average, come from foreign countries. The share of NL visitors is lower than 20%, although it has increased over the years. While the foreign dependency of Amsterdam has decreased since 2003Q1, the average dependency is still over 80% in 2015Q4. Interesting to note, yet out of scope of this analysis is the seasonality structure of the

Amsterdam market. Each year, Q2 and Q3 show strong peaks in both room nights and arrivals as compared to Q1 and Q4. The second and third quarter of each year are the highest demand months.

For the purpose of this analysis, the top 10 source markets based on the average over the 2003Q1 – 2015Q4 period have been selected. Together this group of countries including the Netherlands consists of around 75% of the entire market when looking at either RN or A. The actual number of room nights spent and guests from each specific country will be the basis for calculating the required variables for this analysis.

4.3.2. Calculated variables

The GDP of each selected source market will be weighted according to its share in the market (based on RN: Weight Room Nights, or "WRN" and A: Weight Arrivals, or "WA"). The weights need to be calculated from the provided data for each quarter. The basis for calculating the weight is the total of the entire market ("RN-ALL" or "A-ALL"), including the countries not considered for the top 10. The weight percentage is the "exposure" of Amsterdam to that respective source market. The weight per country *i* in period *t* is calculated as follows:

(4) $$WRN_{i,t} = \frac{RN_{i,t}}{RN_{ALL,t}}$$

WRN = Weight based on room nights for country i at time t

$RN_{i,t}$ = Number of room nights of country i at time t

$RN_{ALL,t}$ = Total room nights of market at time t

(5) $$WA_{i,ti} = \frac{A_{i,t}}{A_{ALL,t}}$$

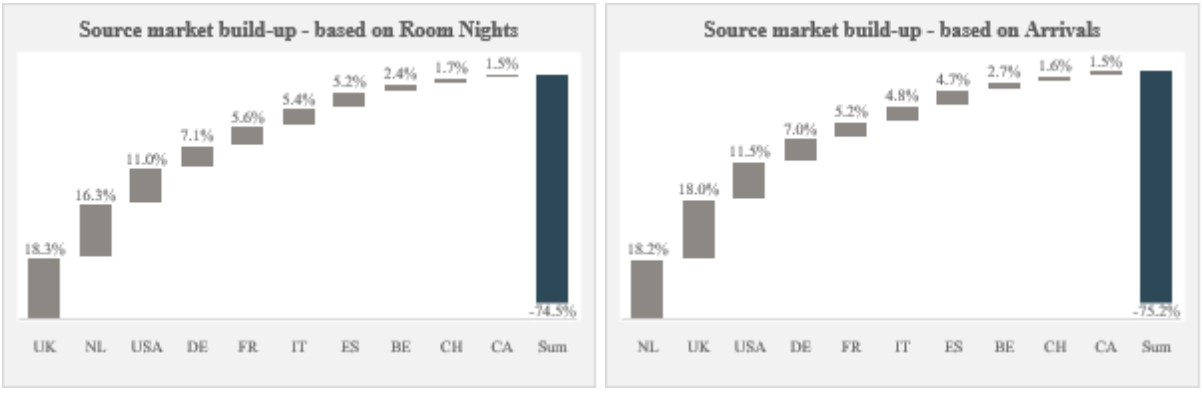
WA = Weight based on arrivals for country i at time t

$A_{i,t}$ = Number of arrivals of country i at time t

$A_{ALL,t}$ = Total arrivals of market at time t

What is interesting to observe is that when looking at either room nights or guests a different source market composition occurs:

Chart III:Build-up of source markets based on Room nights and Arrivals



***Note**: UK = United Kingdom, NL = Netherlands, USA = United States of America, DE = Germany, FR = France, IT = Italy, ES = Spain, BE = Belgium, CH = Switzerland, CA = Canada, Sum = Sum of markets shares of total market.*

When source markets are determined on the basis of RN, the UK seems to be the leading market. However, when source markets are determined on the basis of Arrivals (A), the Netherlands is the leading market for Amsterdam. Also, the sum of shares for RN is lower than for A.

This difference is caused by the length of stay of a guest. The difference in the Netherlands is the most profound. This seems to make sense: Dutch arrivals tend to stay shorter than foreign arrivals, i.e. more arrivals spend less room nights. This difference could impact the relationship with RevPAR growth as the weights of each is different and thus results in a different weighted GDP. This difference is to be incorporated in this research by calculating two different weighted averages based on the different source market composition to identify which source market determination leads to the best results. The respective calculated weights will be used as input to determine the weighted GDP growth, tailored to the Amsterdam market.

4.4 Macro-economic GDP Data (IMF)

Gross Domestic Product ("GDP"), a monetary measure of the market value of all final goods and services produced in a period, is the most commonly used macro-econometric measure of economic growth. GDP is calculated from 4 elements and 5 components (Liu, Moulton & Quan, 2013):

(6) $$GDP = C + I + G + (X - M)$$

C: Private consumption

I: Investment

G: Government spending or consumption

X: Exports

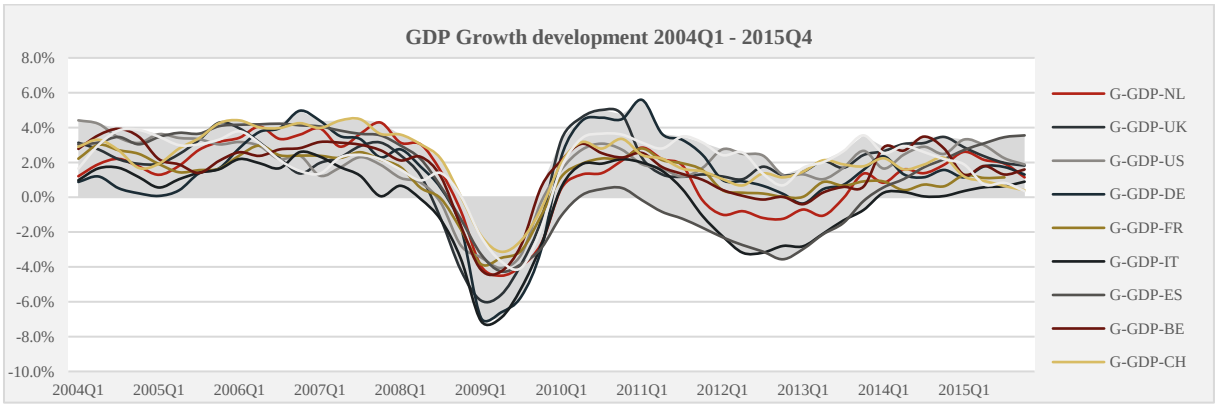
M: Imports

GDP provides insight into the state of spending (private and public), investments and trade (export – import) and is the best aggregated measurement for economic development in a country. GDP of each selected country that fall within the top 10 source markets has been extracted from the IMF data base and is used in the analysis of relationships with GDP in this research. GDP per country is indicated by "GDP-[country]". The q-on-q growth of GDP is calculated in accordance with equation 1 and is indicated as "G-GDP-[country]".

4.4.1. Input variables

GDP data is derived from the IMF. It does not have to be extensively described that in the period under review, both up turns and down turns are included. Visually in a chart, each and every reader shall recognise the start of the Great Depression that set in around 2007Q2 and reached all-time lows between 2009Q1 – 2009Q3. Having such a period in the review period, will provide additional insight into how the variables behave in a downturn, and a subsequent upturn.

Chart IV: GDP growth development over the period 2004 – 2015 of key source markets



***Note**: G-GDP = percentage growth in GDP, country code abbreviations are the same as Chart III*

With the GDP data of each selected country, the required variables can be calculated for the purpose of this research.

4.4.2. Calculated variables

After calculating the WRN and WA for each of the countries, the weighted GDP based on the 2 factors can also be calculated by combing the CBS and IMF data, starting with the Weighted Average Growth based on Room Nights ("WAGGRN") in period *t*. The calculation is similar to equation 3, whereby the weighted components for each country are summed, only the elements differ:

(7) $$WAGGRN_t = GGDP_{NL,t}\ x\ WRN_{NL,t} + GGDP_{UK,t}\ x\ WRN_{UK,t} + \cdots$$

$WAGGRN_t$: Weighted Average GDP Growth based on room nights at time t

$GGDP_{i,t}$: GDP Growth percentage of country i at time t

$WRN_{i,t}$: Source market share based on room nights for country i at time t

The same calculation can be done for the Weighted Average Growth based on Arrivals ("WAGGA"):

(8) $$WAGGA_t = GGDP_{NL,t}\ x\ WA_{NL,t} + GGDP_{UK,t}\ x\ WA_{UK,t} + \cdots$$

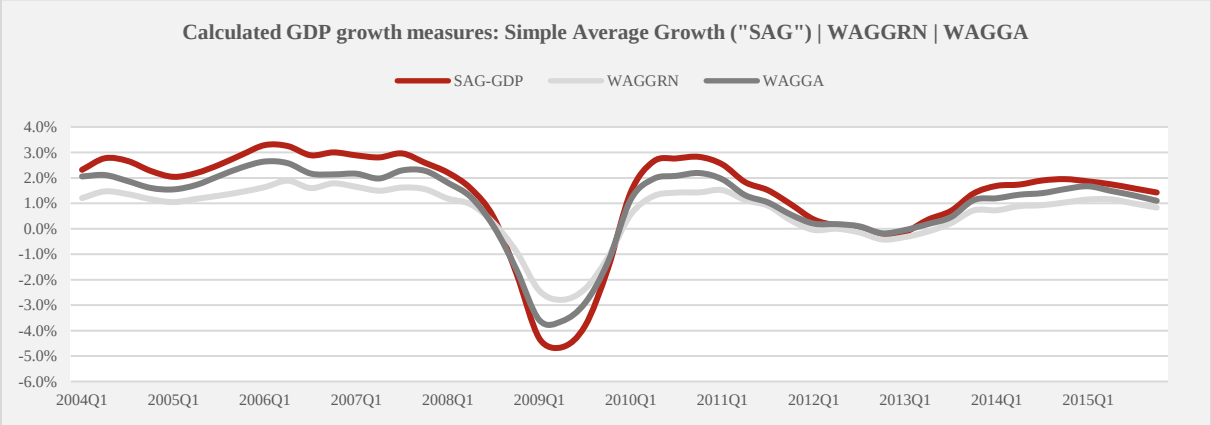
$WAGGA_t$: Weighted Average GDP Growth, based on arrivals at time t

$GGDP_{i,t}$: GDP Growth percentage of country i at time t

$WA_{i,t}$: Source market share based on arrivals for country i at time t

Plotting the outcome of the q-on-q growth of each of the calculated variables clearly shows that both figures could yield different relationships. When including the simple average growth it can be observed that weighing the GDP growth per country seems to flatten the pattern, i.e. the range between high and low becomes smaller. This effect is visible when weighing on the basis of Arrivals. Weighing on the basis of Room Nights seems to have a further flattening effect, which could yield different results.

Chart V: Calculated GDP percentage growth measures of key source markets



***Note**: SAG-GDP = Simple Average percentage Growth.in GDP, WAGGRN as in equation 7, WAGGA as in equation 8*

With the calculated weighted GDP growth figures the variable set for the analysis is complete and initial tests on relationships can be done.

4.5 Data correlations

Correlation for GDP growth per country and the weighted variables (both RevPAR and GDP) are analysed for their correlations. For the purpose of this analysis, a correlation higher than 0.75 of considered high.

4.5.1. Key Correlations: Market segments

Additional to the expected correlations between the weighted average growth and the growth of each segment, the correlation among the market segments shows another interesting pattern: the upper market segments are more strongly correlated with each other suggesting that their interrelationship is more dominant than for the Midscale segment. The Midscale segment is also lower correlated with the Weighted Average.

Table II: Correlations between rate growth per segment

Correlations: Segments and Weighted Average Market RevPAR							
	LRG	*UURG*	*URG*	*UMRG*	*MRG*	*TDG*	*WAMRG*
LRG	-	0.878	0.871	0.782	0.538	0.787	0.905
UURG		-	0.926	0.850	0.728	0.817	0.977
URG			-	0.900	0.689	0.803	0.973
UMRG				-	0.677	0.729	0.905
MRG					-	0.699	0.765
WAMRG						-	0.838
TDG							-

***Note**: L = Luxury, UU = Upper Upscale, U = Upscale, UM = Upper Midscale, M = Midscale, RG = Rate Growth*

4.5.2. Key Correlations: Top 10 GDP Growth

With global economies becoming more integrated, it can be expected that the correlation of these economies is relatively high. This assumption is confirmed in the below table:

Table III: Correlations between GDP growth percentages and calculated weighted averages

Correlations: GDP growth of various countries	G-GDP-NL	G-GDP-DE	G-GDP-FR	G-GDP-IT	G-GDP-ES	G-GDP-BE	G-GDP-CH	G-GDP-UK	G-GDP-US	G-GDP-CA
G-GDP-NL	-	0.822	0.857	0.904	0.865	0.838	0.877	0.723	0.662	0.678
G-GDP-DE		-	0.877	0.865	0.531	0.797	0.832	0.809	0.681	0.757
G-GDP-FR			-	0.931	0.705	0.894	0.862	0.844	0.839	0.825
G-GDP-IT				-	0.804	0.920	0.846	0.826	0.771	0.740
G-GDP-ES					-	0.749	0.714	0.566	0.602	0.464
G-GDP-BE						-	0.824	0.832	0.800	0.746
G-GDP-CH							-	0.784	0.691	0.749
G-GDP-UK								-	0.896	0.814
G-GDP-US									-	0.823
G-GDP-CA										-
SAG-GDP	0.924	0.889	0.959	0.964	0.793	0.936	0.910	0.899	0.858	0.834
WAGGRN	0.950	0.891	0.951	0.964	0.817	0.923	0.894	0.864	0.834	0.808
WAGGA	0.924	0.878	0.951	0.954	0.795	0.923	0.903	0.914	0.871	0.820

***Note**: G-GDP: growth in GDP, SAG: Simple average growth, WAGGRN as in equation 7, WAGGA as in equation 8*

Looking at the above it is also interesting to see that the economies denominated in euros are, with the exception of Spain, more closely correlated than the economies denominated in different currencies. Also, economies located further away are less closely correlated than close by, the UK and Switzerland show higher correlations than the US and Canada.

It follows logic that all GDP variables are strongly correlated with the averages both weighted and simple.

4.5.3. Key Correlations: Demand, RevPAR and Weighted GDP growth

Based on the below table, several key observations can be highlighted. Below a correlation table of the key variables are presented:

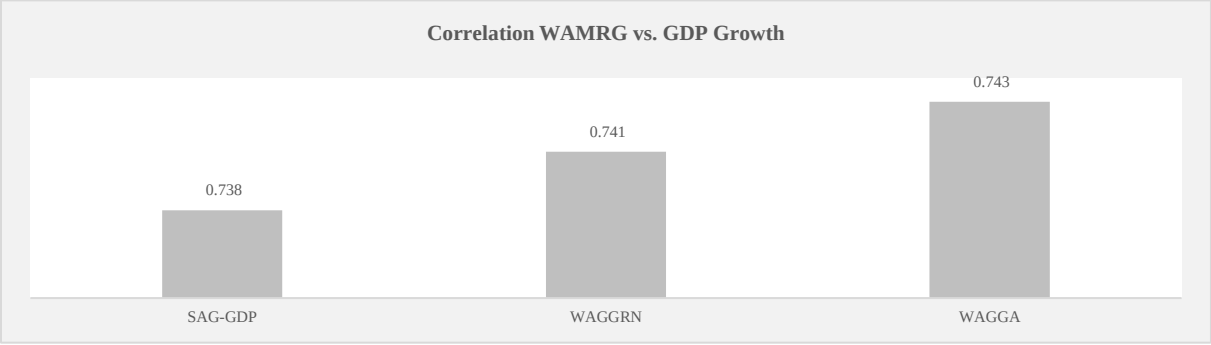
Table IV: Correlations demand, market rate growth and wimple and weighted averages

Correlations: Demand, Weighted RevPAR, Weighted GDP Growth	TDG	WAMRG	SAG-GDP	WAGGRN	WAGGA
TDG	-	0.838	0.564	0.537	0.574
WAMRG		-	0.738	0.741	0.743
SAG-GDP			-	0.994	0.997
WAGGRN				-	0.991
WAGGA					-

***Note**: TDG: Total Demand growth, WAMRG as in equation 3, SAG: Simple average growth, WAGGRN as in equation 7, WAGGA as in equation 8*

Going from top to bottom, the first is that TDG is most closely correlated with WAMRG. The key variables are the weighted variables for RevPAR (WAMRG) and GDP growth (SAG-GDP, WAGGRN and WAGGA). WAMRG seems to be correlated to each variable to the same degree. Differences, however, do occur when looking more closely:

Chart VI: Correlation coefficients among calculated GDP growth variables



***Note**: SAG: Simple average growth, WAGGRN as in equation 7, WAGGA as in equation 8*

The difference between taking a simple average over a weighted average, seems to improve the correlation between the factors and could therefore lead to better results. While the differences are quite small, the impact could still be significant. The significance of each of the factors is to be determined in the regression analysis in the following chapter.

5. Methodology

Now that all variables have been arranged, they can be used in the regression analysis to identify relationships. The analysis is run with the individual factors and a weighted GDP factor, using different regressions and comparing the differences that occur.

5.1 Serial correlation and regression type

In time series analysis, there are risks of Serial Correlation ("SC"). SC is described as 'the relationship between a given variable and itself over various time intervals'. In short this means that when SC occurs the future value of a variable is impacted by the current value of that same variable. This affects the standard errors.

One way to measure SC is by using the Durbin-Watson ("DW") test developed by James Durbin and Geoffrey Watson in 1950 and 1951. With this test, it is possible to determine positive and negative SC in a time series analysis. The outcome of this test is a number from 0 – 4. In case the DW statistic is 2, there is no serial correlation. When the outcome of the test is lower than 2 this means that there is evidence of Positive Serial Correlation ("PSC"). If DW is higher than 2, there is evidence for Negative Serial Correlation ("NSC"). In case the DW statistic indicates evidence of SC, it can be remedied by using the "Cochrane–Orcutt ("CO") procedure. This procedure was developed by statisticians Donald Cochrane and Guy Orcutt after which the procedure is named in 1949. A disadvantage of this approach is that it loses an observation in the regression when using the CO procedure. A modification has been designed by Sigbert Prais and Christopher Winstein in 1954, which allows to keep the first observation in the analysis.

To correct for serial correlation and keep all observations in the analysis of market RevPAR and GDP, the Prais-Winstien estimation is used for all regressions. Also, for each of the regressions the DW statstic will be calculated and provided.

5.2 Research model

5.2.1. The base model

The base model consists of three key elements: (1) Market RevPAR, (2) GDP of source markets and (3) Total Demand Growth for hotels in the Amsterdam market. The determination of each has been fully set out in the previous chapters. For each of the approaches, i.e. Separate Variable Regression ("SVR") and Weighted Variable Regression ("WVR"), a regression formula is setup. The variables in the regression are all percentage growth variables calculated as defined in equation 1. Percentage growth is used because GDP is a non-stationary variable. This means that, if nominal values should be used in the analysis, there is a risk of bias and spurious regression results. The equations are as follows:

(9) $$WAMRG_t = \alpha_t + \beta GGDP_{NL,t} + \beta GGDP_{UK,t} + \cdots + TDG_t + \varepsilon_t$$

(10) $$WAMRG_t = \alpha_t + \beta WAGGRN_t + TDG_t + \varepsilon_t$$

(11) $$WAMRG_t = \alpha_t + \beta WAGGA_t + TDG_t + \varepsilon_t$$

$WAMRG_t$:	Weighted Average Market RevPAR percentage growth at time t
$GGDP_{c,t}$:	Sum of separate GDP percentage growth per country at time t
$WAGGRN_t$:	Weighted Average GDP Growth based on room nights at time t
$WAGGA_t$:	Weighted Average GDP Growth, based on arrivals at time t
TDG_t:	Total demand percentage growth at time t
ε_t:	Error term at time t

Where equation 9 is for individual factors, 10 is based on Room Nights and 11 is based on Arrivals.

5.2.2. Lagged and dynamic models

By further expanding on each of the base models, the models can be made dynamic. For example, by including GDP with a lag of one or more periods it can be tested if the results of the model improve. Should a lagged GDP variable lead to better results, this could indicate that the GDP of the previous period can be an important indicator for RevPAR growth in the next period.

To test for robustness and a potential timing effect, the GDP and TDG variables will be lagged in two variations to the model. The GDP lag could provide insight into a timing effect of GDP developments. Additionally the dependent variable is to be lagged, to get insight into how the model behaves over time.

The main objective of lagging variables in the model and making the model dynamic is to test if relationships hold and/or potentially improve. If relationships and sensitivities remain comparable, the model can be deemed relatively robust.

6. Results

Each of the described regressions, is done for the 3 combinations and the results are compared on the basis of Adjusted ("Adj.") R^2, and the significance of variables.

Significance is indicated with * for significance at 10% level, ** for significance at the 5% level and *** for significance at the 1% level. The impact of the Prais-Winstein estimation remedy is measured by two different DW statistics, Original and Transformed, to determine SC. For the DW statistic, DW = 2 means no serial correlation, DW < 1.5 means "High PSC", DW > 2.5 means "High NSC" and 1.9 > DW > 2.1 means "limited PSC/NSC".

For each of the output tables the "Normal" column refers to the output of equation 9, with individual GDP factors, as WAGGRN and WAGGA have not been part of this equation, the spaces for output are left blank in the Normal column. The other columns "Room Nights" and "Arrivals" refer to equation 10 and 11 respectively. As the individual GDP variables have not been part of these equations, these spaces are left blank in the Room Nights and Arrivals columns. Each of the equations used in the lagged and dynamic analysis are variations and/or extensions of equations 9, 10 and 11.

6.1 Base model results

The base model regressions for each of the combinations mentioned in 5.2.1 have been executed. The regression outcomes are presented in the following table:

Coëfficient table - "No Lag" regression			
Per country	*Normal*	*Room nights*	*Arrivals*
R-squared	0.951	0.800	0.779
Adj R-squared	0.936	0.791	0.769
G-GDP-NL	1.451		
G-GDP-UK	0.882		
G-GDP-US	-0.984		
G-GDP-DE	**1.564		
G-GDP-FR	0.642		
G-GDP-IT	0.858		
G-GDP-ES	1.116		
G-GDP-BE	***-3.399		
G-GDP-CH	***-2.311		
G-GDP-CA	**1.452		
WAGGRN		***4.186	
WAGGA			***2.908
TDG	***0.934	***1.091	***1.097
SC Original	High NSC	High PSC	High PSC
SC Transformed	NSC	Limited NSC	Limited NSC

From top to bottom, the interpretation begins with the Adj. R^2, which for all regressions is higher than 0.75. For all regressions the explanatory power of the GDP factor is higher than 75% of the movements in WAMRG. By itself, this is a very interesting observation. This means that foreign GDP movements explain more than 75% of the RevPAR development for Amsterdam. Thus, answering the question if RevPAR is sensitive to foreign GDP development with a hard yes. This supports the case for

GDP being an excellent metric to explain, and possibly forecast, the movements of RevPAR in Amsterdam.

In the base model with separate GDP factors, the Adj. R^2 is higher than for the weighted variables. The Adj. R^2 for Room Nights results in higher than for Arrivals. The higher Adj. R^2 could be explained by the country influences that are taken into account individually in the SVR. The WVR evens out these influences by making a weighted average. That said, it should also be mentioned that the coefficients for the individual factors do not take the interaction with the share in the market into account. This could result in over- or understatement of the coefficients and explanatory power of the model.

Not all individual GDP factors can be deemed significant for the movements in WAMRG. Belgium ("BE") and Switzerland ("CH") have the highest level of significance, at 1%. Interestingly, both coefficients are negative. This suggests that in case GDP grows in each country, they have a negative impact on the RevPAR in Amsterdam. The coefficient for Belgium is -3.399 and for Switzerland this is -2.311, meaning that for each one percent movement in GDP growth RevPAR in Amsterdam is negatively impacted by 3.4% from Belgium and 2.3% from Switzerland. Germany and Canada are significant at 5% and have a positive coefficient of 1.564 and 1.452, respectively. Similar to Belgium and Germany this means that for a 1% movement in GDP the impact on RevPAR is positive by 1.6% for Germany and 1.5% for Canada. None of the other factors, including the error term are significant. Using separate variables, thus provides insight into the movements of each specific economy.

It is evident that not all GDP movements in each country have a positive impact. It could very well be that if the Swiss or Belgian economy grows strongly, natives decide to travel elsewhere to destinations in Southern Europe, or to other continents, or that if those respective economies grow, natives decide to spend their holiday in their own country. Broader RevPAR and economic analysis is required to further explain such movements.

While the weighted variables show a lower Adj. R^2, the independent variables have a much higher significance level. They do not capture the individual impact of the economies, but these models clearly show that GDP is a very important independent variable in explaining RevPAR movements in Amsterdam. These variables provide an aggregated insight just as WAMRG does. Both weighted variables show that the impact of aggregated GDP movements has a positive impact on the movement of WAMRG. Both weighted variables are significant at 1%. At 4.186, the Room Nights coefficient is higher than the Arrivals coefficient at 2.908. A movement in Room Nights has a bigger impact than a movement in Arrivals. Furthermore, the Adj. R^2 of the Room Nights model is higher. The Room Night WVR proves to be a better approach. One of the reasons for this could be the difference in market composition as explained in Chart III: Build-up of source markets based on Room nights and Arrivals.

The TDG coefficient, significant in all regressions indicated that growth in demand, does have a positive impact on the development of WARMG. With the coefficient hovering around 1, it seems that movements in total demand have a one-on-one impact on WAMRG.

The DW statistic is different in the equation with separate variables and a weighted variable. What is interesting to observe is the impact of the remedy, which reduces the SC in the weighted variable regressions to a limited level, but does not reduce SC to a limited level in the separate variable regression.

6.2 Robustness: Causality and lagged GDP

Lagging variables in the regressions, both SVR and WVR, the models and variables can be tested for robustness. Furthermore, lagging variables provides insights into the timing effect of the development of economic variables and their respective impact on the dependent variable. If relationships hold, the model can be deemed robust. This is done is two ways, (1) lagging the GDP growth variable by one period and (2) lagging both GDP and TDG by one period. With lagged GDP, the sensitivity of RevPAR to GDP can again be confirmed.

6.2.1. Lag1: GDP of 1 quarter before Market RevPAR and TDG growth

Coëfficient table - "Lag1 in GDP" regression			
Per country	*Normal*	*Room nights*	*Arrivals*
R-squared	0.920	0.842	0.835
Adj R-squared	0.894	0.835	0.828
G-GDP-NL	0.086		
G-GDP-UK	0.677		
G-GDP-US	-0.824		
G-GDP-DE	0.043		
G-GDP-FR	1.311		
G-GDP-IT	*2.078		
G-GDP-ES	0.856		
G-GDP-BE	***-2.728		
G-GDP-CH	-0.582		
G-GDP-CA	0.635		
WAGGRN		***3.992	
WAGGA			***2.931
TDG	***1.244	***1.269	***1.238
SC Original	NSC	PSC	PSC
SC Transformed	NSC	Limited NSC	Limited NSC

The above output is the result of the following regression equations:

(12) $$WAMRG_t = \alpha_t + \beta GGDP_{NL,t-1} + \beta GGDP_{UK,t-1} + \cdots + TDG_t + \varepsilon_t$$

(13) $$WAMRG_t = \alpha_t + \beta WAGGRN_{t-1} + TDG_t + \varepsilon_t$$

(14) $$WAMRG_t = \alpha_t + \beta WAGGA_{t-1} + TDG_t + \varepsilon_t$$

$WAMRG_t$: Weighted Average Market RevPAR percentage growth at time t

$GGDP_{c,t}$: Sum of separate GDP percentage growth per country at time t-1

$WAGGRN_t$: Weighted Average GDP Growth based on room nights at time t-1

$WAGGA_t$: Weighted Average GDP Growth, based on arrivals at time t-1

TDG_t: Total demand percentage growth at time t

ε_t: Error term at time t

While the Adj. R^2 for the separate variable regression decreases, for the weighted variables it improves. The Adj. R^2 is still the highest for the SVR approach, weighing on Room Nights also still yields a better result than on Arrivals. Lagging GDP by one period improves the Adj. R^2 in the WVR approach, but is to the disadvantage of the SVR.

Additional to the changes in Adj. R^2 for the SVR, it also deems less variables as significant. To put it bluntly, the variables are all over the place and do not prove to be robust. Belgium still shows a negative and significant relationship with a coefficient of -2.728, compared to -3.399. Italy, however, is now significant at the 10% level with a coefficient of 2.078. The relationship between WAMRG and foreign economies seems to change when lagging GDP growth. In essence this makes sense: while foreign economies are linked, they are not the same. Their growth patterns might be similar, but they are not the same. It could be for example that growth occurs earlier in the Italian economy than in the Swiss, hence now that GDP is lagged, the Swiss GDP growth variable is no longer significant.

The weighted variables retain their significance and have a relatively stable coefficient. This provides first insight into the robustness of the model. The weighted variables prove to be more robust than individual variables. Furthermore the explanatory power of the weighted variables improves, the coefficient changes somewhat, but the significance is the same. The WVR approach is more robust than the individual approach. As in the individual approach, the timing of economic growth plays a role. In the WVR this timing effect is included in the weighted variable by accounting for the share in the market.

TDG remains significant in all three regressions. Though the TDG coefficient is higher it is relatively consistent in all regressions.

While SC is less high in the lagged regression, the SC is still more profoundly present in the separate variable regression. SC in the variable regression cannot be fully remedied. The weighted regressions are exposed to limited SC after applying remedial measures.

6.2.2. Lag GDP & TDG:

Should lagging GDP and TDG yield to a better result in terms of Adj. R^2, it could be that GDP growth and demand growth occur in the same timeframe and that WAMRG growth is impacted one period later by both these developments. If so, it should lead to an improved Adj. R^2. The below output is the result of the following regression equations:

(15) $$WAMRG_t = \alpha_t + \beta GGDP_{NL,t-1} + \beta GGDP_{UK,t-1} + \cdots + TDG_{t-1} + \varepsilon_t$$

(16) $$WAMRG_t = \alpha_t + \beta WAGGRN_{t-1} + TDG_{t-1} + \varepsilon_t$$

(17) $$WAMRG_t = \alpha_t + \beta WAGGA_{t-1} + TDG_{t-1} + \varepsilon_t$$

$WAMRG_t$: Weighted Average Market RevPAR percentage growth at time t

$GGDP_{c,t}$: Sum of separate GDP percentage growth per country at time t-1

$WAGGA_t$: Weighted Average GDP Growth, based on arrivals at time t-1

$WAGGRN_t$: Weighted Average GDP Growth based on room nights at time t-1

TDG_t: Total demand percentage growth at time t-1

ε_t: Error term at time t

Coëfficient table - "Lag on GDP & TDG" regression			
Per country	*Normal*	*Room nights*	*Arrivals*
R-squared	0.652	0.601	0.615
Adj R-squared	0.540	0.582	0.597
G-GDP-NL	**-4.55		
G-GDP-UK	1.621		
G-GDP-US	***5.902		
G-GDP-DE	0.357		
G-GDP-FR	**7.367		
G-GDP-IT	*4.625		
G-GDP-ES	-1.295		
G-GDP-BE	-2.052		
G-GDP-CH	-0.469		
G-GDP-CA	***-5.159		
WAGGRN		***3.593	
WAGGA			***2.976
TDG	***-0.928	***0.848	***0.773
SC Original	Limited NSC	NSC	NSC
SC Transformed	PSC	Limited PSC	Limited PSC

This regression does not result in a higher Adj. R^2 in any of the regressions. What is interesting is that the Adj. R^2 for the weighted variable regressions is higher than for the separate variable regression. For all models, however, the Adj. R^2 is much lower, meaning less explanatory power than in the GDP lagged regressions.

What is interesting to observe is that again the individual factors show little to no consistency. Compared to the lagged GDP regression, none of the same variables are significant. This supports the previous conclusion that the SVR is less robust than the WVR. Compared to the base model, only Canada holds up with a coefficient of 5.159, but Canada is not consistent in different models. For the first time, the Netherlands is significant as a variable with coefficient of -4.55. The coefficient is negative. The same counts for the US and France, which have positive coefficients of 5.902 and 7.367 respectively.

The weighted variables, however, maintain their significance at different coefficients. While the impact and explanatory power is much less than when only lagging GDP the variable show to be robust and relatively consistent.

TDG is, as in every instant significant. The coefficient in the separate regression, however, shows to be negative, suggesting that growth in demand in one quarter negatively impacts WAMRG in the next. Again, SC is more profoundly present in the SVR and cannot be fully remedied. The weighted regressions are exposed to limited SC after applying remedial measures.

6.3 Extension: a dynamic model

By including a lagged dependent variable, WARMG, the model can be made fully dynamic to test how the model behaves over time. This is a test for robustness as well, if the relationship holds. Also in the fully dynamic model, the sensitivity of RevPAR to GDP is confirmed. The below output is the result of the following regression equations:

(18) $$WAMRG_t = \alpha_t + WAMRG_{t-1} + \beta GGDP_{NL,t}\, \beta GGDP_{UK,t} + \cdots + TDG_t + \varepsilon_t$$

(19) $$WAMRG_t = \alpha_t + WAMRG_{t-1} + \beta WAGGRN_t + TDG_t + \varepsilon_t$$

(20) $$WAMRG_t = \alpha_t + WAMRG_{t-1} + \beta WAGGA_t + TDG_t + \varepsilon_t$$

$WAMRG_t$: Weighted Average Market RevPAR percentage growth at time t

$WAMRG_{t-1}$: Weighted Average Market RevPAR percentage growth at time t-1

$GGDP_{c,t}$: Sum of separate GDP percentage growth per country at time t

$WAGGRN_t$: Weighted Average GDP Growth based on room nights at time t

$WAGGA_t$: Weighted Average GDP Growth, based on arrivals at time t

TDG_t: Total demand percentage growth at time t

ε_t: Error term at time t

Coëfficient table - "Dynamic Model" regression			
Per country	*Normal*	*Room nights*	*Arrivals*
R-squared	0.957	0.819	0.796
Adj R-squared	0.941	0.806	0.781
G-GDP-NL	1.439		
G-GDP-UK	0.457		
G-GDP-US	-0.467		
G-GDP-DE	2.171		
G-GDP-FR	***0.788		
G-GDP-IT	0.947		
G-GDP-ES	1.289		
G-GDP-BE	*-3.701		
G-GDP-CH	***-2.58		
G-GDP-CA	***1.534		
L1.WAMRG	**-0.167	*-0.153	-0.117
WAGGRN		***5.416	
WAGGA			***3.564
TDG	***0.968	***1.135	***1.134
Error term	0.006	***-0.048	***-0.049
SC Original	High NSC	PSC	Limited PSC
SC Transformed	NSC	Limited PSC	Limited PSC

Interestingly, the model improves when made fully dynamic. The Adj. R^2 improves in all the models and is higher for all regression approaches than the base model. While the Adj. R^2 is still lower for the WVR approaches, we also observe improvements here. For each of the approaches the dynamic model results in an improved Adj, R^2. The fully dynamic model accounts for the full effect of the market dynamic and takes into account potential shock movements.

The lagged dependent variable $WAMRG_{t-1}$ has a different impact in each of the models. In the SVR model, the coefficient of the lagged dependent variable is highest and most significant. The variable becomes less significant at the 10% level in the WVR approach based on Room Nights. In the

WVR Arrivals model, the variable is no longer significant. The coefficient is, however, relatively consistent when significant, at -0.16. As this coefficient is not positive, which would be expected, it could be that there is some seasonality in the data. As discussed in Chart V:, this seasonality effect is lowered by weighing the variables. This could be because of the timing effect of individual economic developments on WAMRG in Amsterdam. The impact and significance could be lower in the WVR approach as this timing effect is partially accounted for in the Weighted Dynamic Variable in both regressions.

In line with "Robustness: Causality and lagged GDP" it seems that the inconsistency in significance of variables in the SVR approach is the consistent factor. For the SVR approach, the dynamic model not only leads to the best Adj. R^2, but also results in the most significant variables. While this is a good observation, there is still quite some inconsistency among the different models in the SVR approach. Robustness cannot be confirmed. The significant coefficients are in line with the base model. It can be expected, and is confirmed, that significant variables are comparable to the base model as most of the model remains unchanged. The Belgian and Swiss coefficients are again negative, although the impact of the Swiss coefficient is now lower at -2.783 compared to 2.311. This could indicated that the timing effect of the Swiss coefficient, as highlighted before, works different than the Belgian timing effect. The German coefficient has improved in significance level, and also in value at 1.858. Also the coefficient of Spain has become significant with a coefficient of 1.543.

The WVR approach, yields comparable and consistent results. The increased Adj. R^2 is a plus on top of the consistently significant variables. The coefficients remain relatively stable in each regression as well. In the dynamic model, the Room Nights weighted GDP growth coefficient and the Arrivals weighted GDP growth coefficient are in between the level of the base model and the lag model. The Adj. R^2 is still lower than the SVR approach as the effect of individual movements are taken out of the weighted dynamic growth variables.

In all three regressions, the TDG variable shows the same pattern: highly significant and with a coefficient of around 1.1 in the WVR approach and around 1 in the SVR approach. The SC observations also remain relatively consistent in that SC is more profoundly present in the SVR and cannot be fully remedied. The weighted regressions are exposed to limited SC after applying remedial measures.

7. Limitations and further research

Robustness and insightfulness is proven for the WVR approach for the Amsterdam market. Many researchers have been using GDP as an economic variable for quite some time and the outcome has been shown to be different for various markets. The WVR approach allows to apply the same approach across many destinations. It should be further tested though, if what has been identified for the Amsterdam market holds in other markets. The expectation is that it yields a similar impact, as the economic exposure is tailored to that destination. The truth, however, remains to be proven.

A key element that is missing in the separate variable regression is the interaction between the coefficients and the weight a specific country has in that market. This interaction should be tested in further research to correct the coefficients for this interaction. The Weighted variable approach attempts this, but does not lead to a better model in terms of Adj. R^2. It could be that the decrease in Adj. R^2 is caused by this 'interaction effect' but this should empirically be proven in additional research.

This research has been done in a relative isolated matter, looking mostly at GDP and also at TDG. As discussed, GDP is a aggregated factor. It does not provide insight into specific market segments such as business or leisure from a traveller perspective. Additional research should be done, applying the WVR approach to other economic variables, to obtain deeper insights in markets. Furthermore, this research has looked at the market as a whole with market RevPAR. Exposure per segment could be different as segments are exposed to different economic forces and could have different source markets. While this could provide ground breaking insights, the data on source markets is to high-level for such analysis.

There could also be other factors at play for explaining market RevPAR at a destination. As GDP covers the larger scope of economic impact, and as mentioned GDP could be split and further specified for additional insights, other impacting variables are expected to be of non-economic nature. Factors such as the number of tourist attractions, municipal marketing activities, competitiveness of the destination and other variables could further improve the model for explaining market RevPAR development.

Lastly, the sample of this research is strong and a good representation of the market as a whole. It should be noted however, that this does not include the entire market for accommodations in Amsterdam. Most notably, the economic hotel segment is not included in the sample. Furthermore, quite relevant in these days, the number of Airbnb units (and their respective pricing and demand) are not included in the analysis. A final category is that the illegal properties in a market are not included. These las two examples, and mostly Airbnb, are expected to increase in relevance in the years to come.

This research then, as insightful as it is, leaves room for further academic exploration of the road to fully understanding each and every variable that drives RevPAR at each destination.

8. Conclusion & Discussion

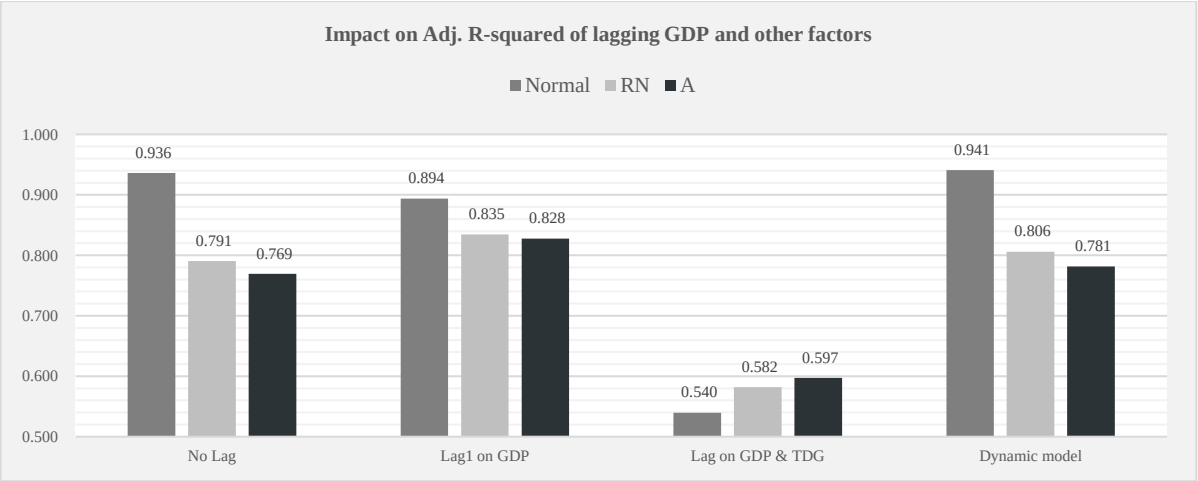
This study aimed to test the sensitivity of hotel market performance, measured by RevPAR, to foreign and domestic economic developments in source markets. Economic developments, measured by GDP, have been analysed over the period 2003 – 2015 together with market RevPAR of the hotel market in Amsterdam. With over 80% of visitors coming from foreign economies, Amsterdam is the perfect destination for this analysis.

The sensitivity has been estimated using two different approaches: a Separate Variable Regression ("SVR") with separate GDP growth variables and the Weighted Variable Regression ("WVR") with a calculated weighted GDP growth variable based on source market weights of both Room Nights and Arrivals. By using both approaches it could also be determined if a model with a Weighted Dynamic Variable ("WDV") leads to better explanatory and more robust results.

No matter the approach, sensitivity of RevPAR to foreign GDP seems evident as it is confirmed in each regression. The explanatory power of foreign GDP on RevPAR moments is very strong in terms of the Adj. R^2. By applying a Separate Variable Regression ("SVR") approach and a Weighted Variable Regression ("WVR") approach new insights have been gained. While not resulting in a higher Adj. R^2, the WVR approach proves to be a more robust approach for understanding development at market level.

As approach a WVR provides more robust and consistent insights and allows to shed light on the potential future development of RevPAR, based on macro-economic variables drivers in the Amsterdam market. The WVR approach leads to more consistent results and an improved forward looking capacity. Lagging the GDP variable improves the model. As it uses individual variables, the SVR approach provides insights on a more detailed level resulting in a higher Adj. R^2. The results are, however, difficult to rely on as variables move all over the place in terms of coefficients and significance. The consistency in WVR variables as opposed to the SVR approach provides a better basis for reliance, while realising that with the lower Adj. R^2 it is concluded that more than just macro-economic variables impact Market RevPAR in Amsterdam. Furthermore, the WVR allows to better apply the SC remedy to further improve the interpretation potential of the model.

It can be quickly observed that the Adj. R^2 in each of the regressions is higher in the SVR. Therefore, solely on the basis of this metric, weighing economic variables does not lead to more explanatory power. Amendments to the regression's variables does however change the Adj. R^2 and in the SVR this is not for the better. The below chart provides an overview:



When lagging GDP the WVR results improve, but the SVR does not. While this is an interesting finding, weighing economic variables does not lead to an improve model based on Adj. R^2. The higher Adj. R^2 in the SVR model is likely caused by the effect of details in the separate variables that have been evened out in the WVR. The metric is determined on the basis of the sum of squared errors, which are quite low on the SVR because of the higher level of detail. This could be because the GDP factors have a relative high correlation among each other, resulting in lower error terms as the variables move relatively in the same way, however not exactly at the same time. The WVR combined all these factors, and perhaps impacts the correlations among variables, by applying weights. This in turn leads to a less correlated figure and this a lower explanatory power.

Considering the coefficients in the SVR and WVR, the SVR shows very little consistency in both relevant factors and the significance of these factors. The WVR provides a much more consistent view on the variables:

Variable significance *Variables*	**No Lag**	**Lag1** *GDP*	**Lag1** *GDP & TDG*	**Dynmaic** *model*
Separate Variable Regression				
G-GDP-NL	1.451	0.086	**-4.55	1.028
G-GDP-UK	0.882	0.677	1.621	1.117
G-GDP-US	-0.984	-0.824	***5.902	-1.258
G-GDP-DE	**1.564	0.043	0.357	***1.858
G-GDP-FR	0.642	1.311	**7.367	1.026
G-GDP-IT	0.858	*2.078	*4.625	0.648
G-GDP-ES	1.116	0.856	-1.295	**1.543
G-GDP-BE	***-3.399	***-2.728	-2.052	***-3.491
G-GDP-CH	***-2.311	-0.582	-0.469	***-2.783
G-GDP-CA	**1.452	0.635	***-5.159	**1.428
L1.WAMRG	n.a.	n.a.	n.a.	**-0.167
TDG	***0.934	***1.244	***-0.928	***0.928
Error term	0.006	0.003	0.075	0.013
Weighted Variable Regression				
Room nights				
WAGGRN	***4.186	***3.992	***3.593	***4.017
L1.WAMRG	n.a.	n.a.	n.a.	*-0.153
TDG	***1.091	***1.269	***0.848	***1.142
Error term	***-0.046	***-0.049	**-0.031	***-0.044
Arrivals				
WAGGA	***2.908	***2.931	***2.976	***2.723
L1.WAMRG	n.a.	n.a.	n.a.	-0.117
TDG	***1.097	***1.238	***0.773	***1.155
Error term	***-0.047	***-0.051	***-0.035	***-0.045

Confidence intervall	
10%	*
5%	**
1%	***

From the above table, two observations are clear, (1) the SVR provides more detail and insight into movements and relationships on separate economies and (2) the WVR shows to be a lot more robust than the SVR. The variables in the SVR are all over the place and their reliability should be questioned. The SVR approach does provide better insight into the economy of a specific source market and the WAMRG. Most notably is the indication by Belgium as highlighted in the previous chapter. There seems to be a balance of sacrifice, more robust and consistent outcomes over level of detail.

The reasons for the shift in significance of separate coefficients, could be that the regression does not compare apples with apples. Furthermore, there could be a timing impact that makes individual variables significant at a different time. By using the WVR approach, both these impacts are corrected for. Additionally, as the weight of the economy (the 'exposure') is dynamic, the weighted variable also accounts for a timing impact. This effect is shown in the improvement of the Adj. R^2 as opposed to the base model. But these benefits to robustness have an impact on the explanatory power in terms of Adj. R^2.

It is clear to observe that, even though the overall explanatory power is lower with the WVR approach, the approach is much more robust. The robustness provides ample opportunity for implementing this approach in multiple locations to obtain more comparable views on the sensitivities of GDP and RevPAR across the globe.

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