Submission FAERE

Is seasonal consumption a tool for food sustainability ?
- Fruits and vegetables purchases in France –

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Abstract :

In the perspective of improving food sustainability, seasonal consumption is one of the advises given by environmental agencies. However, little is known on the seasonality of consumption patterns, on the adequacy of such an advice, and on the population targeted. This work is an attempt to analyse seasonality of purchases of fruits and vegetables of French households by using a rich data set which registers continuous purchases all over the year. The study of seasonality as intra-annual variability shows that expenditure and quantities purchased have different seasonality patterns. Comparing the importance of seasonality gaps, price (as unit values) and quantity gaps change all over the year. It cannot be said that consumption seasonality is higher than price seasonality, as in staples markets. Lastly, the impact of heterogeneity of households on purchases seasonality indicates the characteristics of the households more related to seasonal purchasing patterns. The more seasonal purchases are associated with higher age, lower education level, higher income. We find evidence of substitutions impact of own produce consumption and purchases in the production season. The most unexpected result concerns the absence of relationship with location variables, question the relationship between seasonal consumption and locally-grown products, deserving further research.

Introduction

The inadequacy of consumption in a sustainability perspective has been claimed for several decades. Food represents the 2nd greenhouse gas (GHG) emitting sector after the energy one, and deserves subsequent attention. Many aspects can be taken into account from production to final consumption (Wellesley et al. 2015). We will focus here on consumption patterns. For some years, an interest for advising consumers to eat seasonal has raised. Eating seasonal food is being advocated as one element of a sustainable diet, often interpreted as local food (DEFRA 2012, McDiarmid et al. 2013). Production calendars giving information on the periods when fruits and vegetable are available on local markets were disseminated among consumers (for instance from Greenpeace, Good Planet, Interfel). Seasonal consumption may appear as a challenge for a policy aimed at improving sustainability through food consumption behaviours (Food Ethics Council 2007). A review focusing on the question of eating seasonal fruit and vegetables suggested it could have a positive impact on environmental sustainability. However, there could be negative consequences for public health (SDC 2009).

Indeed, seasonality benefit can be two-fold : favouring seasonality of consumption for some seasonal foods may help reduce environmental impacts. For non-seasonal foods, a consumption dependent on seasons may turn inefficient on nutritional and/or environmental grounds.

Seasonal consumption questions important food security issues, associated with price volatility. This is still the case for basic foods, in particular staples, in many third-world countries (Galtier 2011, Gilbert et al. 2017). In the context of industrialised countries, the evolution of the methods of production, of agro-industries processing and the trade globalization induced the de-seasonality of supply. Fresh produce are available all year round on markets, the season being noticeable only through the variation of price, as a signal of the distance or the continent from where they proceed. Simultaneously, this extended availability changes the patterns of consumption, and some traditional seasonal dishes are now in use during the whole year (Chambers et al. 2007).

In this framework, the continuity of supply should induce as well continuity in consumption. And seasonality as a restriction for food consumption disappear. However, consumption surveys still show intra-annual variations, in particular for fresh products, but not only (de Raymond et al. 2013 ; Régnier 2018). It can be an answer to price variation, and in particular it reflects the national or imported origin of the product. In front of continuous availability, seasonality can also be an attribute of choice for consumption, independently of economic reasons of price or availability. These patterns are of interest to understand the leverage for a more sustainable consumption.

In a first part, we will discuss the litterature dedicated to the temporality of consumption by focusing on fruits and vegetables. This product group includes fresh vs preserved products, and raises the issue of substitution. In a second part, we will describe the data used and the method applied to characterise seasonality and analyse the impact of household heterogeneity on seasonal purchases. The third part presents the results. The fourth part concludes.

1- Capturing temporal fluctuations of consumption

Food consumption varies along with seasons, as it can be observed in France through the last dietary intakes surveys : INCA2 2006-07 (AFSSA) and INCA3 2010-11 (ANSES). At a global level, quantities consumed and calories intakes are higher in summer.

At an aggregated level, main food groups show a seasonal peak, concerning the season of production of perishable foods, or intakes based on habits. In particular, in INCA3 survey (2010-11), vegetables peak significantly in summer, fruits in autumn. These results are common to other European studies which share close climatic conditions (Stelmas-Mardas 2016), or North–American ones (Todd 2011).

Seasonality of production is associated to price variability. However, Kaminsky et al. (2014) find that consumption seasonality is higher than price volatility, expressed through the gap between extreme levels (the maximum and the minimum) observed intra-annually. This leads to recognize that consumption fluctuations do not respond only to price changes.

The role of price is one of the main centers of interest in the literature. In the French case, it is difficult to follow the seasonality of consumption prices. Monthly market prices are not published by official sources, which focus on producing annual series corrected from seasonal variations (see IPPAP index methodology, INSEE). Seasonal variations of food prices are observed by FranceAgrimer through the price evolution of 2 sets of fresh products (1 for fruits and 1 for vegetables). They compare the evolution of the production price and the retail price. They showed that the big retailers and distribution chains modify the seasonality of prices through their margin strategy. In the case of fresh fruits, seasonal peaks of prices at the production level and the retail level occur at the same time, but with an opposite trend. When prices increase at the production level, the distributor tends to increase also its margin variation at the retail level (Boyer 2015a). It is the opposite in the case of fresh vegetables, for which big distributors are observed to lower their margin in order to attenuate the retail price (Boyer 2015b).

Economics litterature seems to consider seasonality as a variable to be controlled for and not as an object of study. Apart from price volatility studies, no interest for other determinants of consumption seasonality appears.

2- Data and Method

Most consumption surveys provide annual statistics, though information is recorded on a daily or weekly basis (see nutritional surveys INCA or economic surveys such as Budget de Famille conducted by INSEE). In comparison, panel surveys provide continuous information on household purchases and are the natural tool to study the temporality of purchases.

21-Data

The data used are taken from the Kantar world panel surveys conducted in 2015. This survey was carried out on 26,310 households who register their weekly food acquisition. All participating households register the grocery purchases. Then, a group of household (half of the participating households) is requested to register its purchases for fresh products (meat, fish, fruits and vegetables). These purchasing data delivers quantities and expenditures for a wide range of food products and give insight into the French population food-at-home consumption. It is worth noting that, these data do not provide information for food-away-from-home, nor consumption of own produce.

Our sample

For our study we selected the group of households with completed information on purchases, i.e. who registered their grocery purchases and their fresh products acquisition (N= 13,423). To capture the purchases temporality of a given household, it is important to make sure he participated regularly the whole year. Indeed, Kantar data distinguish 13 periods and each period includes 4 weeks[1]. So we retain only households who registered their food acquisition at least one week at each period. Lastly we exclude households who do not communicate information about socio-demographic and economic variables that we need for our analyses (income, education level etc...). Consequently, the sample that we use in this study includes 7083 households.

The variables studied

The fruits and vegetables group includes fresh fruits, fresh vegetables, fruits and vegetables preserved, frozen fruits and vegetables, dried vegetables, cooked vegetables, and freeze-dried vegetables. It is important to distinguish perishable foods such as fresh fruits and vegetables from preserved forms.

For each of the above categories, we deal with weekly fruits and vegetables quantity and expenditure.

Here seasonality refers to intra-annual variability. To take account of the importance of seasonality, we measure a seasonality gap defined as the difference between the extreme values observed in a year expressed as percentage:

[1] *Period 1 : 29/12/2014-25/01/2015 ; period 2 : 26/01/2015-22/02/2015; period3 : 23/02/2015-22/03/2015 ; period4 : 23/03/2015 -19/04/2015; period5 : 20/04/2015 -17/05/2015; period6 : 18/05/2015 -14/06/2015; period7 : 15/06/2015-12/07/2015; period8 : 13/07/2015-09/08/2015; period9 : 10/08/2015-06/09/2015; period10 : 07/09/2015-04/10/2015; period11 : 05/10/2015-01/11/2015; period12 : 02/11/2015-29/11/2015; period13 : 30/11/2015-27/12/2015.*
Household of the sample registered their purchases at least one week at the first period 1, 2 up to period 13.

$$\text{seasonality gap} = \frac{Max\ \ value\ in\ a\ year - Min\ \ value\ in\ a\ year}{Min\ value\ in\ \ a\ year} * 100$$

Household heterogeneity and in particular socioeconomic determinants are known to have a significant impact on fruits and vegetables consumption (see for instance Amiot-Carlin et al. 2007). We have found no prior work on whether the seasonality of consumption is affected by household heterogeneity. We focus here on status variables, such as income, education, age.

Location variables are important for local production reasons and taste differences. We introduce the size of the area of residence, as well as the region of residence.

Finally, having the possibility of consuming own produce is captured through the availability of fruit trees or vegetables garden at home. It could denote a specific taste for fruits and vegetables, as found by Caillavet et al. (1999) who showed that home producers were also purchasing more fruits and vegetables, or it could evidence substitutions between home production and purchases.

Prices seasonality

Prices are not available within the data. Here, they are approximated by unit values, computed by dividing expenditure with quantities purchased. Accordingly, these prices reflect the choices made by the households concerning the type and quality of the product, the type of retail shop where it is purchased,…)

To measure the respective importance of price seasonality and purchase seasonality, we computed and compared the respective seasonality gaps.

22- Estimation strategy

In order to assess socio demographic and economic variables impact on the fruits and vegetables quantities and on seasonality of purchases, we use OLS regression. All households are consumers, so we do not have zero issues and OLS is an adequate model.

Since prices are here endogenous unit values, they are not introduced in the model.

$$Lnq_i^{fv} = \alpha_0 + \sum_{j=1}^{n} \gamma_j X_j + \varepsilon_i \quad (1)$$

$$Ln(ecart)_i^{fv} = \alpha_0 + \sum_{j=1}^{n} \gamma_j X_j + \varepsilon_i \quad (2)$$

Where q_i^{fv} denotes fruits and vegetables quantities per capita for household i. $(ecart)_i^{fv}$ is the gap between the maximum quantity and the minimum quantity. X_j is a set of sociodemographic and economic variables:

- **Age** of the person who is responsible for the household purchases (3 categories)
- **Education level** of the person who is responsible for the household purchases, i.e. the panelist (4 levels)
- **Monthly income/CU:** Income /Consumption Unit allow us to take into account the demographic variations during the life cycle and compare income of households with different size and composition. Indeed, during a lifecycle, changes to income reflect variations in the size of households, which changes according to the marital status of the household.

It is worth noting that, the survey provides income classes based on family income. From this information we calculated the average income for each family (household) that corresponds to the middle of the income class. For example, if the income of a household is between 2300 and 2699 euros, its average income is (2300 + 2699) / 2.

Then we correct family (household) income in line with the demographic variations, dividing the average income by the number of consumption units in the household according to OECD-modified scale. These consumption units give each member of the household a weighting depending on the age. 1 for the reference individual, 0.5 for individuals over 14 and 0.3 for individuals under 14.

- **County size** (3 categories)
- **Region of residence** (8 regions)

- **To be owner of a fruits tree** (in the main or secondary residence)
- **Vegetables garden at home** (in the main or secondary residence)
- **Household composition** (5 categories)

γ_j denotes sociodemographic parameters to be estimated.

The above models will be run for 3 groups of products: total fruits and vegetables, then perishable categories: fresh fruits; fresh vegetables (see table 1 for descriptive statistics).

Table1 : Descriptive characteristics of the study population

	Total sample	
Variables	N=7083	%
Age Group		
18-44 yrs	2792	39.42
45-64 yrs	2588	36.54
65 yrs et plus	1703	24.04
Education level		
<Post-secondary qualifications	2403	33.93
Post-secondary qualifications	1842	26.01
1st , 2nd ,3rd year university	1474	20.81
Bachelor's degree +	1364	19.26
Monthly income €/CU		
<poverty line	1176	16.60
1015-1692	2643	37.31
1692-2125	1583	22.35
>2125	1681	23.73
Household composition		
Childless couple	1979	27.94
Family+ children18+	873	12.33
Single parent family with children<18	223	3.15
Family + children under 18	1935	27.32
Living alone	2073	29.27
County Size		
Urban cou- from 2000 to 199999 inhabitants	2634	37.19
Urban area of 200000 inhabitants+ and Paris	2342	33.07
Rural area	2107	29.75
Region of residence		
Parisian Basin and region	2482	35.04
East-central	771	10.89
East	681	9.61
Mediterranean	686	9.69
North	542	7.65
West	1132	15.98
Southwest	789	11.14
Fruit tree owner		
No	3687	52.05
Yes	3396	47.95
Vegetables garden at home		
No	3990	56.33
Yes	3093	43.67

3. Results

31-Seasonality of purchases of fruits and vegetables

Expenditure and quantity

As is shown in the following figure 1, the seasonality of *expenditure per capita* appears clearly at the global level of fruits and vegetables, with a peak between period 5 and 6 (*20/04/2015 -17/05/2015 for period 5 and 18/05/2015 -14/06/2015 for period 6*). The intra-annual variations of the main components of this group show there is an earlier peak for fresh vegetables in period 5, and a latter one in period 7 (*15/06/2015-12/07/2015*) for fresh fruits. In comparison the expenditure for preserved fruits and vegetables and to a lesser extent for frozen ones appear flat and non-seasonal, though they register some low decline in period 8 (*13/07/2015-09/08/2015*), as a consequence of peaks in fresh products.

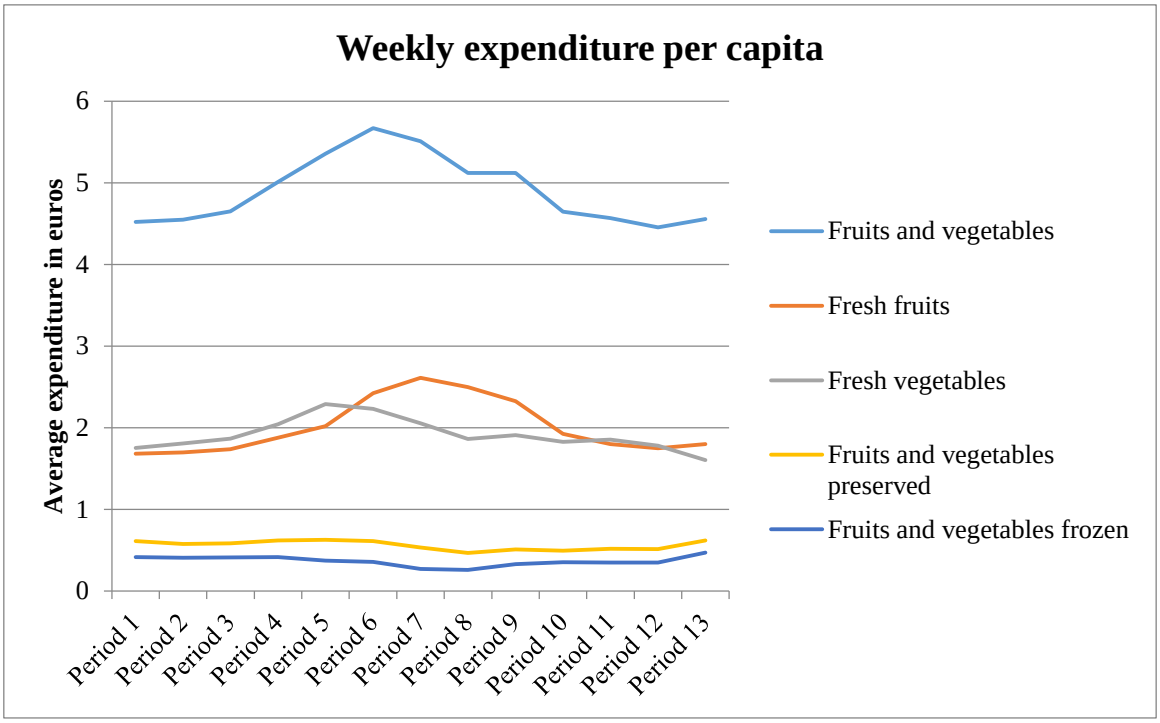
The intra-annual variation of *quantities purchased per capita* offers a different aspect (figure 2). The fresh fruits peak is still here, while fresh vegetables purchases are high during the six first periods. This creates a declining trend for quantities purchased of total fruits and vegetables till period 10 (*07/09/2015-04/10/2015*).

Household heterogeneity

Computing the temporal evolution of purchases according to income, or education, or age group (figure 3), we observe overall a great stability of seasonal consumption. First of all, the ranges of magnitude of the different groups are strictly in accordance with the hierarchy of income quintiles (the highest income, the highest consumption). Education induces a higher consumption at the "under post-secondary qualification" level, which is the lowest level. Concerning age of the panelist, the older generations are known to consume higher quantities. For seasonality, we can say that the global trend is similar whatever the variables modalities, except for some details. Concerning income quintiles, we observe some absence of peak in period 6 (*18/05/2015 -14/06/2015*) for quintile 2 and 3. Regarding education level, the "Bachelor's degree and more level" shows more irregular patterns, with 2 peaks.

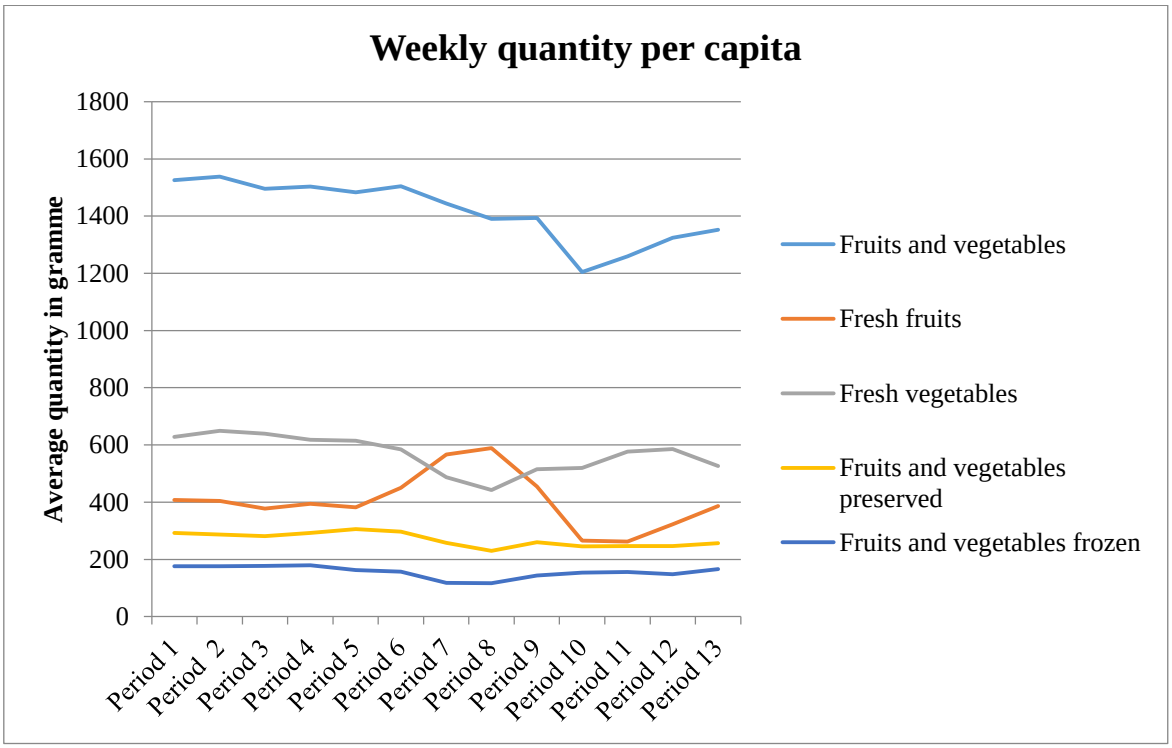
Finally, the county size, and in particular the rural/urban dimension does not change much the seasonal pattern.

Figure 1:



Source: Kantar data 2015, authors' calculations.

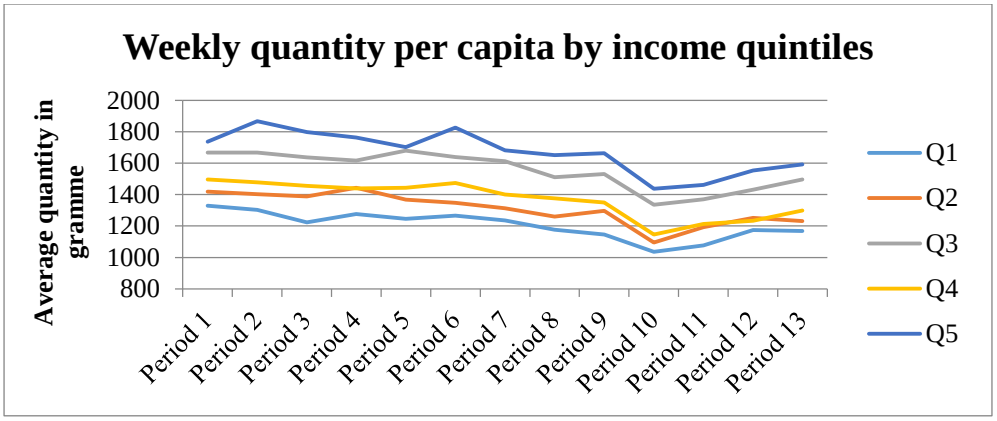
Figure 2:



Source: Kantar data 2015, authors' calculations.

1- Figure 3:

2-



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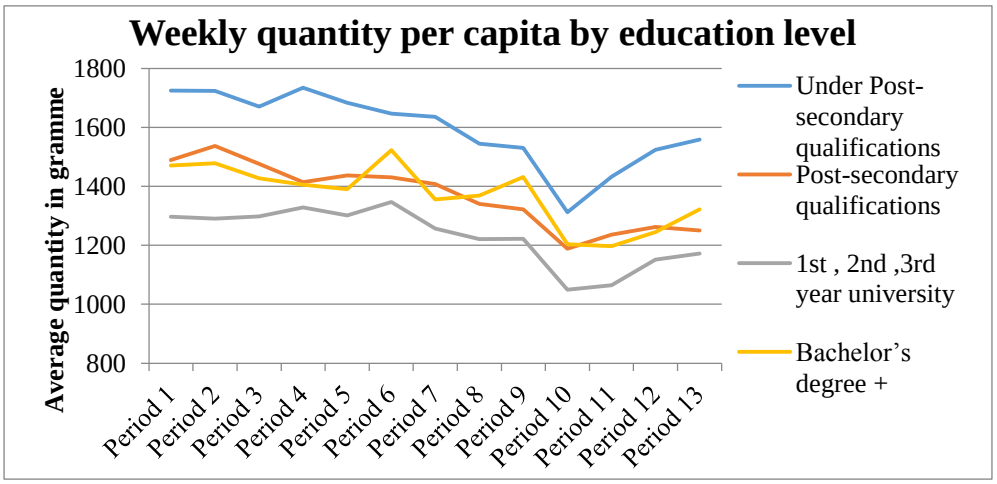

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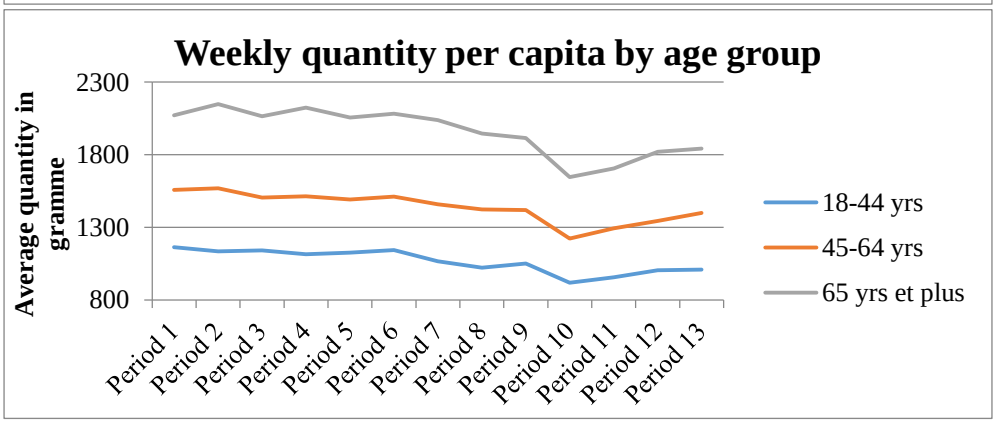
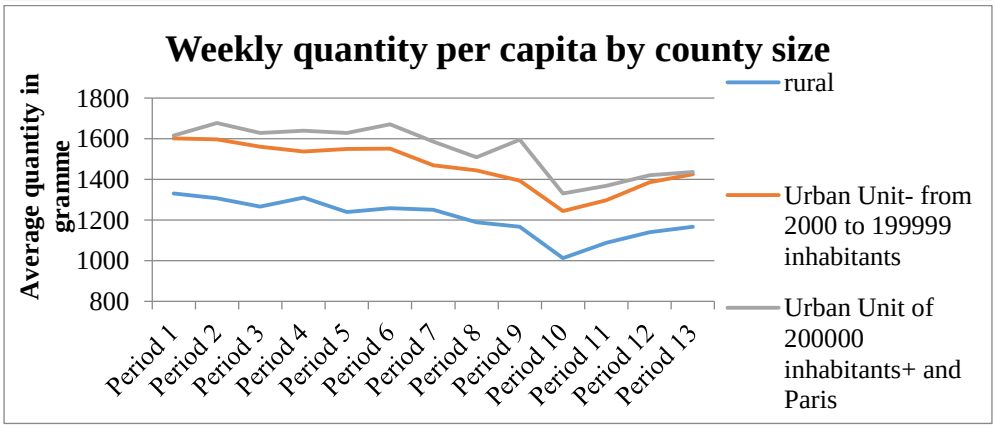




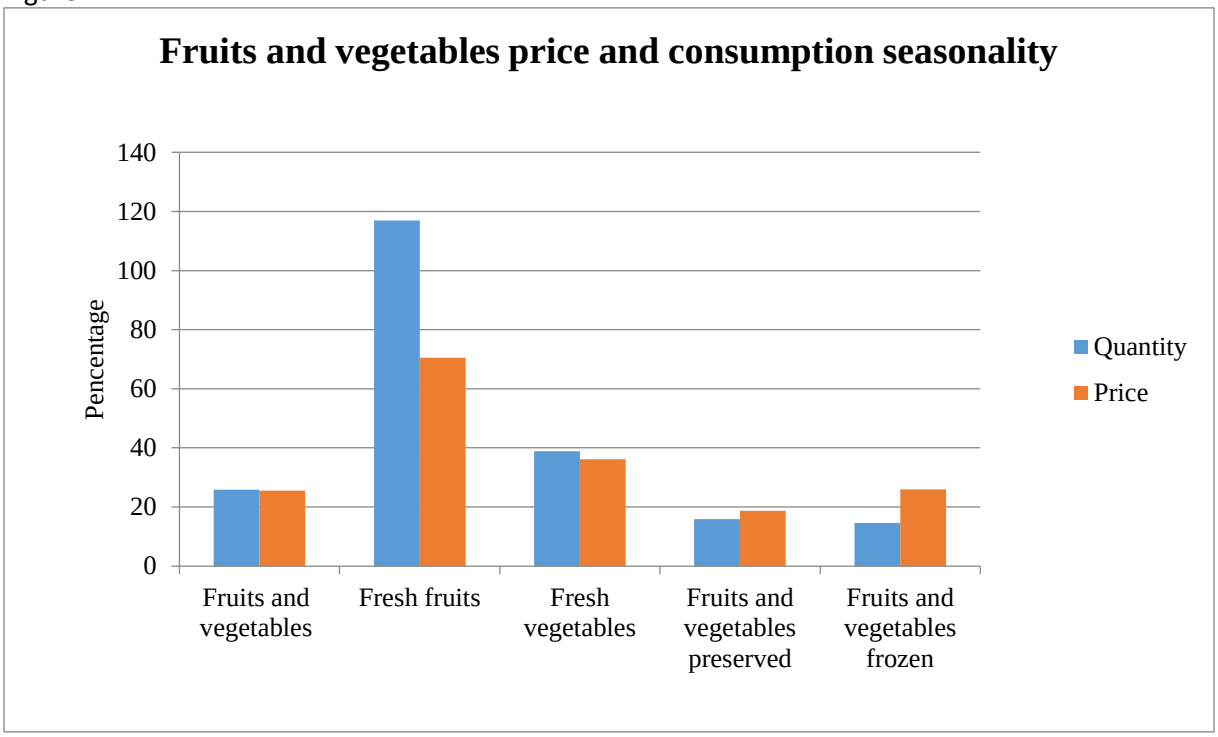
Source: Kantar data 2015, authors' calculations.

32- Prices and consumption seasonality

At the global level, the variability due to seasonality is the same for price and purchases (around 26%). However the different categories show very contrasted patterns (Figure 4). Concerning perishable products, seasonality of purchases is higher than prices one. It is the opposite concerning storable products such as frozen or preserves. Fresh fruits purchases are the more seasonal, and they register a much higher seasonality for quantities (117%) than for prices (70%). More unexpectedly, some seasonality discrepancy is found also in frozen fruits and vegetables purchases, with price variability (26%) exceeding purchases one (14%).

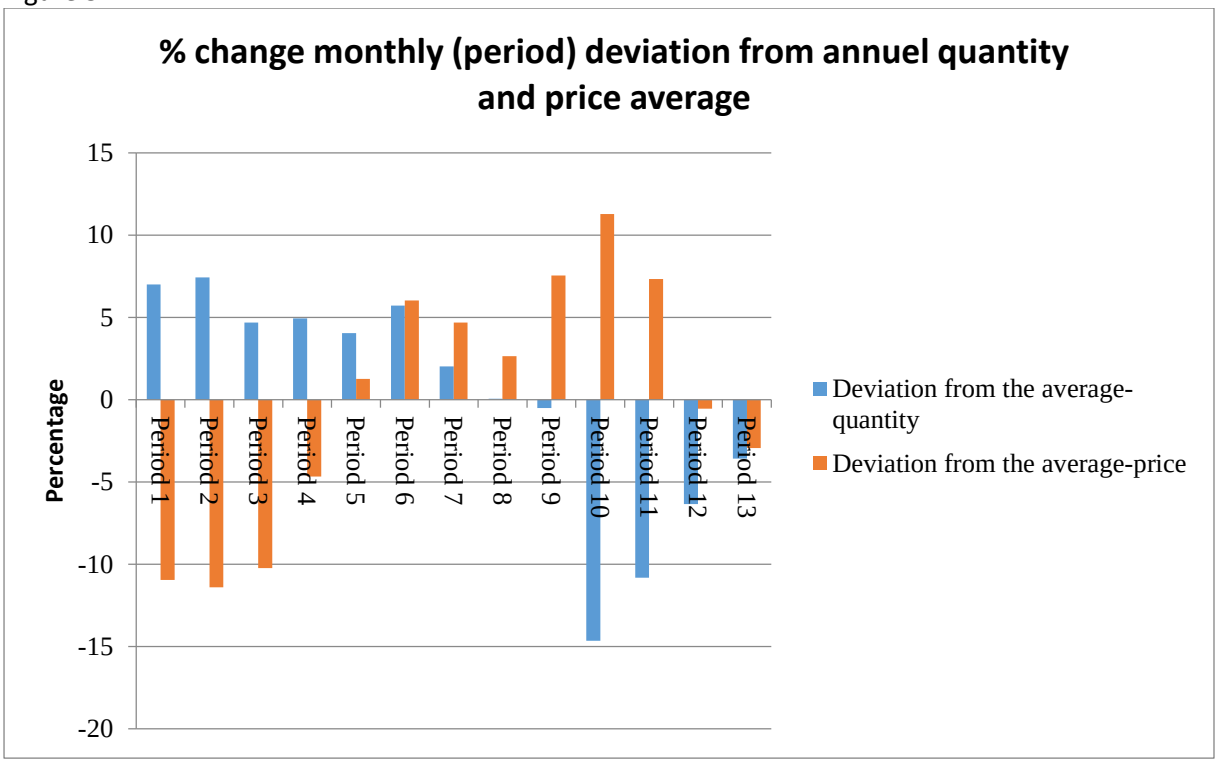
Does this pattern occur at the same period of the year? Figure 4 shows similar seasonality gap in the range of magnitude for fruits and vegetables quantity and price. Computed for each period, deviations from the average for quantity and for price (figure 5) show that that the temporality of seasonal gaps change over the year: period 1 to 3 and period 6 to 9, prices deviation is over quantity deviation; period 4 to 5 and period 10 to 13 the quantity deviation is more important than the prices one. This means that purchases and prices seasonality do not have the same temporality. Part of this phenomenon could be led by the margin strategy of retailers, as studied by Boyer et al. (2015), or by the substitutions between fresh and processed products. Figure 4 showed contrasted patterns for perishable and storable products, and the study of temporality of seasonal gaps for these respective products is yet to be completed.

Figure 4:



Source: Kantar data 2015, authors' calculations. Note: this result is the gap between maximum quantity or price and minimum quantity or price expressed as percentage

Figure 5:



Source: Kantar data 2015, authors' calculations.

33- Impact of household heterogeneity on the seasonality of fruits and vegetables purchases

The results of the OLS regressions are presented in the following tables, for total fruits and vegetables (table 2), fresh fruits (table 3) and fresh vegetables (table 4). In each table, the 3 first columns concern the quantity model and the 3 last columns concern the seasonality model.

Socioeconomic status variables often interact. To control for possible interactions between family income and education level of the panelist, we introduce in a first specification the income only. Then in a second specification, both income and education variables are introduced. The third specification includes as well household composition.

For each dependent variable, we present the above 3 specifications. We analyse first the seasonality dependent variable.

SES variables: income and education

Compared to income deciles 5 to 7, lower deciles and in particular households under the poverty line are negatively associated to purchases seasonality. Higher deciles are significantly and positively associated only when household composition is introduced. This is in line with the impact observed in the quantities regression, and with the literature relating higher income with higher consumption of fruits and vegetables.

The introduction of the education variable does not modify the income effect. Here we observe a positive association of the lowest level (post-secondary qualifications being the reference) with seasonality. Since age (positive association) is controlled for, this result contrasts with the common knowledge that higher education favours healthy eating patterns.

Life-cycle variables: age and household composition

Age of the panelist is positively related to purchases seasonality. When household composition is introduced, the positive impact of age of the panelist is not any more significant for seasonality of total purchases and of fresh vegetables. In all cases, there is a positive association of one-person households and a negative one of all types of families with children (childless couple being the reference).

Location variables: county size, region of residence

Compared to small urban area reference (2,000 to 199,999 inhabitants), being in a rural area has a negative association with seasonality. This cannot be interpreted as more regularity in purchasing since we observe the same effect on the quantity regression.

Regional effects are few: only 2 regions out of 8 show some association with seasonality of purchases. East and Southwest regions are associated positively compared to the West one.

Home production variables: fruit tree, vegetables garden

Home production of fruits fruit trees), as well as of vegetables (vegetables garden), is negatively associated with seasonality of purchases, indicating substitutions of own produce consumption and purchases in the production season. The specification including the household composition cancels this association.

Comparison of the different models

Finally, we can compare the different models presented here.

First, is there a difference between total fruits and vegetables purchases and perishable products? Dealing with seasonality of fresh fruits or fresh vegetables purchases, we find similar associations except for regions. Any of them is no more significant.

Then, we find that seasonality such as it is captured here, is not very different from quantity purchased. Regressions run on the seasonality variable show the same associations than in the regressions run on the quantity.

Table 2 : Sociodemographic and economic determinants of fruits and vegetables acquisition and seasonality

VARIABLES	M1 lqflt	M2 lqflt	M3 lqflt	M4 lecflt	M5 lecflt	M6 lecflt
Age						
Age	0.02***	0.02***	0.0038***	0.01***	0.01***	-0.0002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
County Size						
Rural area	-0.06**	-0.06**	-0.03	-0.06**	-0.06**	-0.02
	(0.025)	(0.025)	(0.024)	(0.024)	(0.024)	(0.022)
Urban area - from 2000 to 199999 inhabitants			*Reference*			
Urban area of 200000 inhabitants+ and Paris	-0.04	-0.04	-0.02	-0.02	-0.02	0.00
	(0.025)	(0.026)	(0.024)	(0.024)	(0.024)	(0.022)
Region of residence						
Parisian Basin and region	0.01	0.01	0.03	0.03	0.02	0.04
	(0.034)	(0.034)	(0.032)	(0.032)	(0.032)	(0.029)
East-central	-0.04	-0.04	-0.01	-0.02	-0.02	0.01
	(0.041)	(0.041)	(0.038)	(0.039)	(0.039)	(0.035)
East	0.03	0.03	0.05	0.07*	0.07*	0.09***
	(0.043)	(0.043)	(0.040)	(0.041)	(0.041)	(0.036)
Mediterranean	0.01	0.02	0.07*	0.04	0.04	0.10***
	(0.043)	(0.043)	(0.040)	(0.041)	(0.041)	(0.037)
North	0.05	0.05	0.10**	0.04	0.03	0.10**
	(0.044)	(0.044)	(0.042)	(0.042)	(0.042)	(0.039)
West			*Reference*			
Southwest	0.09**	0.09**	0.09***	0.10***	0.10***	0.11***
	(0.039)	(0.039)	(0.036)	(0.038)	(0.038)	(0.034)
Fruit tree owner						
No			*Reference*			
Yes	-0.12***	-0.11***	-0.01	-0.11***	-0.11***	0.01
	(0.023)	(0.023)	(0.022)	(0.022)	(0.022)	(0.020)
Vegetables production at home						
No			*Reference*			
Yes	-0.15***	-0.15***	-0.03	-0.14***	-0.14***	-0.00
	(0.024)	(0.024)	(0.022)	(0.023)	(0.023)	(0.020)
Monthly income €/CU						
<poverty line	-0.22***	-0.23***	-0.04	-0.24***	-0.25***	-0.03
	(0.034)	(0.034)	(0.032)	(0.032)	(0.033)	(0.029)
1015-1692	-0.17***	-0.18***	0.02	-0.21***	-0.21***	0.02
	(0.028)	(0.028)	(0.026)	(0.026)	(0.026)	(0.024)
1693-2125			*Reference*			
>2125	0.04	0.04	0.09***	0.03	0.03	0.10***
	(0.032)	(0.032)	(0.030)	(0.031)	(0.030)	(0.027)
Education level						
<Post-secondary qualifications		0.07***	0.05*		0.06**	0.04
		(0.028)	(0.026)		(0.026)	(0.024)
Post-secondary qualifications				*Reference*		
1st , 2nd ,3rd year university		-0.00	-0.01		-0.00	-0.01
		(0.032)	(0.030)		(0.030)	(0.028)
Bachelor's degree +		0.03	-0.00		0.04	-0.00
		(0.033)	(0.030)		(0.031)	(0.028)
Household composition						
Childless couple			*Reference*			
Family+ children18+			-0.42***			-0.43***
			(0.033)			(0.030)
Single parent family with children<18			-0.12**			-0.10**
			(0.054)			(0.051)
Family + children under 18			-0.50***			-0.52***
			(0.029)			(0.027)
Living alone			0.49***			0.60***
			(0.026)			(0.024)
Constant	8.83***	8.84***	9.28***	7.13***	7.13***	7.57***
	(0.049)	(0.056)	(0.061)	(0.047)	(0.053)	(0.055)
Observations	7,083	7,083	7,083	7,083	7,083	7,083
R-squared	0.12	0.12	0.24	0.11	0.11	0.29

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.10
Note:
Estimation method: Ordinary least squares regressions.
Dependent variables: M1, M2, M3: log (fruits and vegetables quantities per capita). M4, M5, M6: log (quantity gap)
Quantity gap is the gap between the maximum quantity in a year and the minimum quantity in a year.
Source: Kantar data 2015, authors' calculations.

Table 3 : Sociodemographic and economic determinant of fresh fruits acquisition and seasonality

VARIABLES	M1 lqffrt	M2 lqffrt	M3 lqffrt	M4 lecffrt	M5 lecffrt	M6 lecffrt
Age						
Age	0.02***	0.02***	0.01***	0.02***	0.02***	0.0038***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
County Size						
Rural	-0.04	-0.04	-0.00	-0.04	-0.04	-0.01
	(0.036)	(0.036)	(0.034)	(0.029)	(0.029)	(0.026)
Urban area- from 2000 to 199999 inhabitants			*Reference*			
Urban area of 200000 inhabitants+ and Paris	-0.00	-0.00	0.02	0.00	0.00	0.02
	(0.035)	(0.035)	(0.034)	(0.028)	(0.028)	(0.026)
Region of residence						
Parisian Basin and region	0.01	0.01	0.02	0.02	0.02	0.04
	(0.044)	(0.044)	(0.041)	(0.035)	(0.035)	(0.032)
East-central	-0.04	-0.04	-0.02	0.01	0.01	0.04
	(0.055)	(0.055)	(0.053)	(0.044)	(0.044)	(0.040)
East	-0.04	-0.04	-0.03	-0.00	-0.01	0.02
	(0.059)	(0.059)	(0.054)	(0.047)	(0.048)	(0.042)
Mediterranean	-0.03	-0.03	0.02	-0.01	-0.00	0.06
	(0.060)	(0.061)	(0.055)	(0.048)	(0.048)	(0.043)
North	-0.02	-0.02	0.03	-0.04	-0.04	0.02
	(0.060)	(0.060)	(0.060)	(0.048)	(0.048)	(0.046)
West			*Reference*			
Southwest	0.05	0.05	0.06	0.07	0.07	0.08*
	(0.053)	(0.053)	(0.052)	(0.042)	(0.042)	(0.040)
Fruit tree owner						
No			*Reference*			
Yes	-0.11***	-0.10***	0.01	-0.10***	-0.10***	0.03
	(0.034)	(0.034)	(0.033)	(0.027)	(0.027)	(0.025)
Vegetables production at home						
No			*Reference*			
Yes	-0.15***	-0.15***	-0.02	-0.15***	-0.16***	-0.01
	(0.035)	(0.035)	(0.033)	(0.028)	(0.028)	(0.025)
Monthly income €/CU						
<poverty line	-0.36***	-0.37***	-0.17***	-0.35***	-0.36***	-0.14***
	(0.048)	(0.048)	(0.045)	(0.038)	(0.038)	(0.035)
1015-1692	-0.23***	-0.23***	-0.02	-0.26***	-0.26***	-0.03
	(0.038)	(0.038)	(0.037)	(0.030)	(0.030)	(0.029)
1693-2125			*Reference*			
>2125	0.05	0.05	0.09**	0.02	0.02	0.08***
	(0.041)	(0.041)	(0.041)	(0.032)	(0.033)	(0.031)
Education level						
<Post-secondary qualifications		0.06*	0.03		0.06*	0.03
		(0.038)	(0.036)		(0.030)	(0.028)
Post-secondary qualifications			*Reference*			
1st , 2nd ,3rd year university		0.02	0.02		-0.00	-0.01
		(0.041)	(0.040)		(0.033)	(0.031)
Bachelor's degree +		0.05	0.02		0.05	0.01
		(0.044)	(0.042)		(0.035)	(0.032)
Household composition						
Childless couple			*Reference*			
Family+ children18+			-0.47***			-0.47***
			(0.048)			(0.037)
Single parent family with children<18			-0.08			-0.06
			(0.083)			(0.064)
Family + children under 18			-0.61***			-0.59***
			(0.044)			(0.034)
Living alone			0.50***			0.58***
			(0.038)			(0.029)
Constant	7.00***	6.98***	7.52***	5.91***	5.91***	6.42***
	(0.070)	(0.077)	(0.087)	(0.056)	(0.062)	(0.067)
Observations	6,983	6,983	6,983	6,983	6,983	6,983
R-squared	0.12	0.12	0.20	0.13	0.13	0.27

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.10
Note:
Estimation method: Ordinary least squares regressions.
Dependent variables: M1, M2, M3: log (fresh fruits quantities per capita). M4, M5, M6: log (quantity gap)
Quantity gap is the gap between the maximum quantity in a year (13 periods) and the minimum quantity in a year (13 periods).
Source: Kantar data 2015, authors' calculations.

Table 4 : Sociodemographic and economic determinant of fresh vegetables acquisition and seasonality

VARIABLES	M1 lqlfrt	M2 lqlfrt	M3 lqlfrt	M4 leclfrt	M5 leclfrt	M6 leclfrt
Age						
age	0.02***	0.02***	0.004***	0.02***	0.01***	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
County Size						
Rural	-0.09***	-0.09***	-0.06*	-0.08***	-0.08***	-0.04*
	(0.032)	(0.032)	(0.031)	(0.027)	(0.027)	(0.025)
Urban area- from 2000 to 199999 inhabitants				*Reference*		
Urban area of 200000 inhabitants+ and Paris	-0.03	-0.02	-0.01	-0.02	-0.02	-0.00
	(0.032)	(0.032)	(0.031)	(0.027)	(0.027)	(0.025)
Region of residence						
Parisian Basin and region	0.01	0.01	0.03	0.01	0.01	0.02
	(0.039)	(0.039)	(0.038)	(0.034)	(0.034)	(0.031)
East-central	-0.04	-0.03	-0.00	-0.04	-0.04	-0.00
	(0.050)	(0.050)	(0.047)	(0.043)	(0.043)	(0.039)
East	0.06	0.05	0.07	0.04	0.03	0.06
	(0.052)	(0.052)	(0.051)	(0.044)	(0.044)	(0.042)
Mediterranean	0.05	0.05	0.11**	0.02	0.03	0.09**
	(0.053)	(0.053)	(0.049)	(0.045)	(0.045)	(0.041)
North	0.05	0.05	0.10*	0.07	0.07	0.13***
	(0.056)	(0.056)	(0.056)	(0.048)	(0.048)	(0.046)
West				*Reference*		
Southwest	0.09*	0.09*	0.10**	0.07	0.07	0.08**
	(0.049)	(0.049)	(0.046)	(0.042)	(0.042)	(0.038)
Fruit tree owner						
No				*Reference*		
Yes	-0.12***	-0.11***	-0.01	-0.13***	-0.12***	-0.00
	(0.031)	(0.031)	(0.029)	(0.026)	(0.026)	(0.024)
Vegetables production at home						
No				*Reference*		
Yes	-0.14***	-0.14***	-0.03	-0.12***	-0.12***	0.01
	(0.031)	(0.031)	(0.029)	(0.026)	(0.026)	(0.024)
Monthly income €/CU						
<poverty line	-0.18***	-0.20***	-0.02	-0.20***	-0.21***	-0.01
	(0.041)	(0.042)	(0.041)	(0.035)	(0.036)	(0.034)
1015-1692	-0.18***	-0.19***	-0.00	-0.20***	-0.21***	0.01
	(0.034)	(0.034)	(0.035)	(0.029)	(0.029)	(0.028)
1693-2125				*Reference*		
>2125	0.07*	0.08**	0.12***	0.03	0.04	0.10***
	(0.037)	(0.038)	(0.037)	(0.032)	(0.032)	(0.030)
Education level						
<Post-secondary qualifications		0.09***	0.07**		0.08***	0.06**
		(0.034)	(0.033)		(0.029)	(0.027)
Post-secondary qualifications				*Reference*		
1st , 2nd ,3rd year university		-0.03	-0.03		-0.02	-0.03
		(0.038)	(0.037)		(0.032)	(0.030)
Bachelor's degree +		0.03	-0.01		0.04	0.00
		(0.040)	(0.038)		(0.034)	(0.032)
Household composition						
Childless couple				*Reference*		
Family+ children18+			-0.43***			-0.44***
			(0.043)			(0.036)
Single parent family with children<18			-0.12			-0.11
			(0.080)			(0.066)
Family + children under 18			-0.50***			-0.51***
			(0.040)			(0.032)
Living alone			0.46***			0.56***
			(0.035)			(0.028)
Constant	7.70***	7.73***	8.18***	6.33***	6.35***	6.79***
	(0.062)	(0.069)	(0.080)	(0.053)	(0.059)	(0.066)
Observations	7,034	7,034	7,034	7,034	7,034	7,034
R-squared	0.09	0.09	0.17	0.10	0.10	0.23

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.10
Note:
Estimation method: Ordinary least squares regressions.
Dependent variables: M1, M2, M3: log (fresh vegetables quantities per capita). M4, M5, M6: log (quantity gap)
Quantity gap is the gap between the maximum quantity in a year (13 periods) and the minimum quantity in a year (13 periods).
Source: Kantar data 2015, authors' calculations.

4-Conclusions and perspectives

In the perspective of improving food sustainability, seasonal consumption is one of the advises given by environmental agencies. However, little is known on the seasonality of consumption patterns, on the adequacy of such an advise, and on the population targeted. This work is an attempt to analyse seasonality of purchases of fruits and vegetables of French households. By using a rich data set which registers continuous purchases all over the year, the study of seasonality as intra-annual variability could be realized with the following results :

Expenditure and quantities purchased show different seasonality patterns. At the level of total fruits and vegetables, descriptive analysis shows a great stability of seasonality patterns. Nor do socioeconomic status variables, nor location factors introduce different patterns. Some substitution appear between perishable categories (fresh) and storage categories (preserves and frozen).

Comparing the importance of seasonality gaps, price (as unit values) and quantity gaps change all over the year. It cannot be said that consumption seasonality is higher than price seasonality, as in staples markets.

The impact of heterogeneity of households on purchases seasonality indicates the characteristics of the households more related to seasonal purchasing patterns : we find positive associations with higher age, lower education level, higher income. Home production of fruits and vegetables is negatively associated with seasonality of purchases, indicating substitutions of own produce consumption and purchases in the production season.

The relationship with location variables is unexpected: the absence of association of regions or county size with purchases of perishable products is surprising, especially in a local market perspective which leads seasonal consumption studies.

This preliminary study of seasonality shows how close it is from the characteristics favouring fruits and vegetables quantity. Furthermore, it allows to question the relationship between seasonal consumption and locally-grown products. These hot environmental issues deserve further research.

References

AFSSA. 2009. Étude individuelle nationale des consommations alimentaires (INCA 2).

Amiot-Carlin M.J, Caillavet F., Causse M., Combris P., Dallongeville J., Padilla M., Renard C., Soler L.G. (eds). 2007. Les fruits et légumes dans l'alimentation, Expertise scientifique collective, INRA.

ANSES. 2017. Étude individuelle nationale des consommations alimentaires 3 (INCA 3).

Boyer P., Montange B. 2015 a. Eléments statistiques sur les prix des fruits et légumes : Fruits. *Lettre de l'Observatoire de la formation des prix et des marges des produits alimentaires*, n°6-1.

Boyer P., Montange B. 2015 b. Eléments statistiques sur les prix des fruits et légumes : Légumes. *Lettre de l'Observatoire de la formation des prix et des marges des produits alimentaires*, n°6-2.

Chambers S., Lobb A., Butler L., Harvey K., Traill W.B. 2007. Local, national and imported foods : a qualitative study. *Appetite* 49 : 208-210-3.

DEFRA. 2012. Understanding the environmental impacts of consuming foods that are produced locally in season. Project FO0412.

Food Ethics Council 2007. 'Food miles' or 'food minutes'. Is sustainability all in the timing ? *Business Forum Meeting Report*, june 2007.

Galtier F. 2011. Que peut faire la communauté internationale pour aider les pays en

développement à gérer l'instabilité des prix alimentaires ? MOISA Mai 2011.

Gilbert C.L., Christaensen L., Kaminski J. 2017. Food price seasonality in Africa : measurement and extent. *Food Policy* 67 : 119-132.

INSEE. Méthodologie de l'Indice des Prix à la Production Agricole P.

http://www.epsilon.insee.fr:80/jspui/handle/1/7289

Kaminski J., Christiaensen L., Gilbert C.L. 2015. Seasonality in local food markets and consumption – Evidence from Tanzania. *Policy Research Working Paper 7520*, World Bank.

Macdiarmid J. I. 2014. Seasonality and dietary requirements: will eating seasonal food contribute to health and environmental sustainability? *The Proceedings of the Nutrition Society* 73: 368–375.

Raymond (de) A.B., Bonnaud L., Plessz M. 2013. Les fruits et légumes dans tous leurs états. La variabilité, la périssabilité et la saisonnalité au cœur des pratiques sociales. *RAESTUD* 2013: 3–12.

Régnier F. 2018. Les variations saisonnières des consommations alimentaires. Permanences et évolutions, pour Adamiec C., Julien M.P, Régnier F. (dir), *L'alimentation au fil des saisons. La saisonnalité des pratiques alimentaires*, manuscript soumis aux PUR.

Stelmach-Mardas M., Kleiser C., Uzhova I., Peñalvo J.L., La Torre G., Palys W., Lojko D., Nimptsch K., Suwalska A., Linseisen J., Saulle R., Colamesta V., Boeing H., 2015. Seasonality of food groups and total energy intake : a systematic review and metaanalysis, *European Journal of Clinical Nutrition* 70: 700–708.

Sustainable Development Commission. 2009. Setting the table : advice to government on priority elements of sustainable diets.

Todd J., Leibtag E., Penberthy C. 2011. Geographic differences in the relative price of healthy foods. USDA-ERS n°EIB-78.

Wellesley L., Happer C., Froggatt A. 2015. Changing climate, changing diets. Chatham House Report, London.