The Role of Seasonality, Color, and Habit Formation in the Substitution Possibility of Local and Imported Bell Peppers in the USA Market

Felipe Peguero

The role of **seasonality**, **color** and **habit formation** in the _substitution possibility_ of local and imported bell peppers in the USA market

❖ **Dissertation** *by Felipe Peguero*

❖ Advisor: Dr. P. Lynn Kennedy

❖ Department of Agricultural Economics and Agribusiness

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Increase in demand & Expenditure share per source

Total consumption (expenditure) in Lbs. (US$) of fresh bell pepper in the U.S.
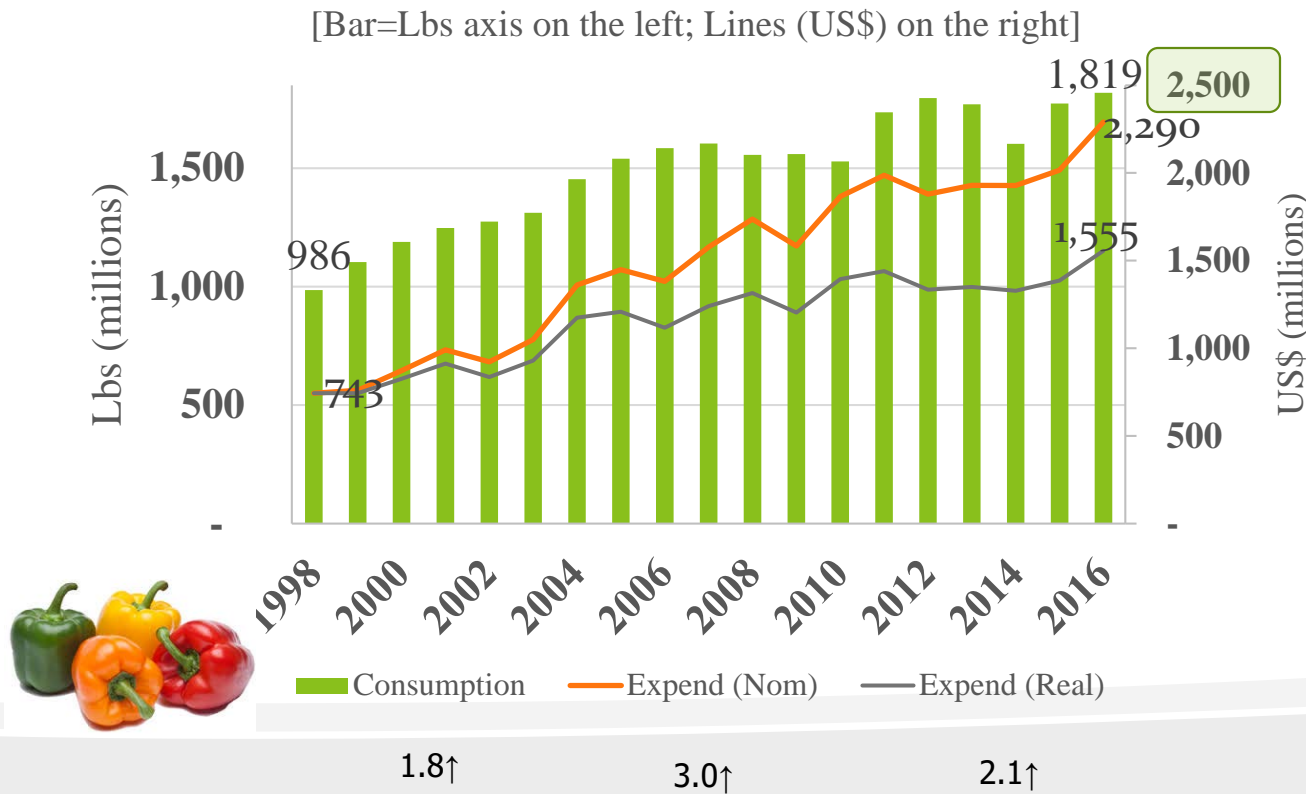
Expenditure shares for US, Mex and ROW 1998-2016 (monthly average/year)
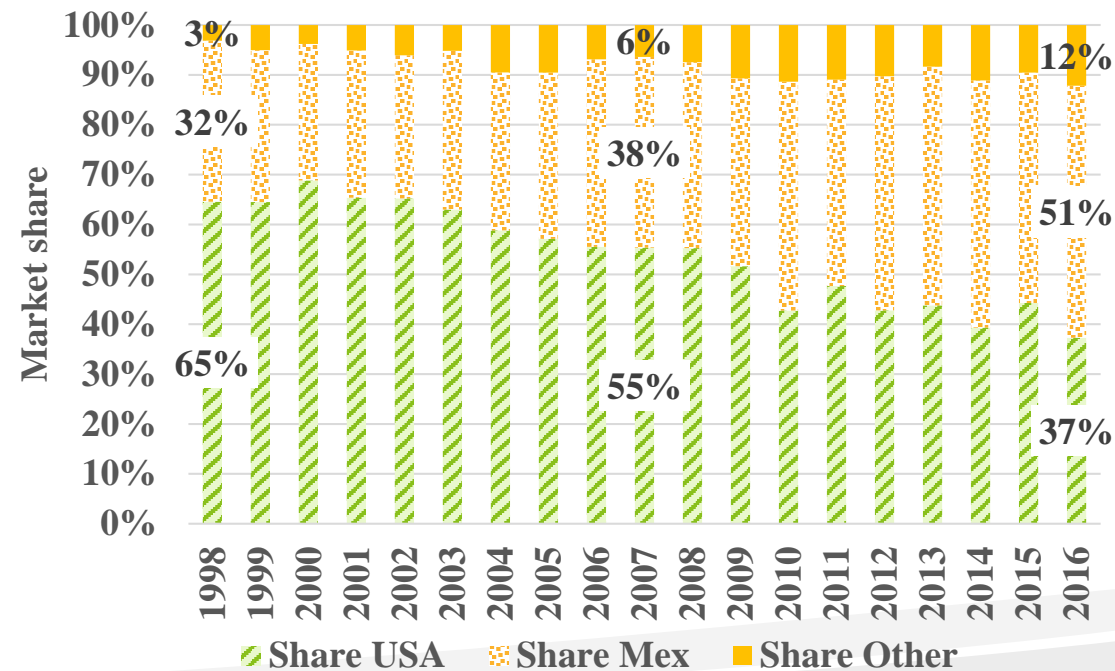
Source: https://marketnews.usda.gov
Source: U.S. Dep. of Labor Bureau of Labor Statistic.

Increase in consumption & Expenditure share per source

Per capita consumption of bell pepper in the United States by source and year

Substitution due to availability

Substitution due to competition

Pounds per capita (monthly mean)

0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
-

0.10
0.20
0.01
0.14
0.29
0.03
0.22
0.21

1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016

⟋ Q USA Perc   ⋰ Q Mex Perc   ▪ Q ROW Perc
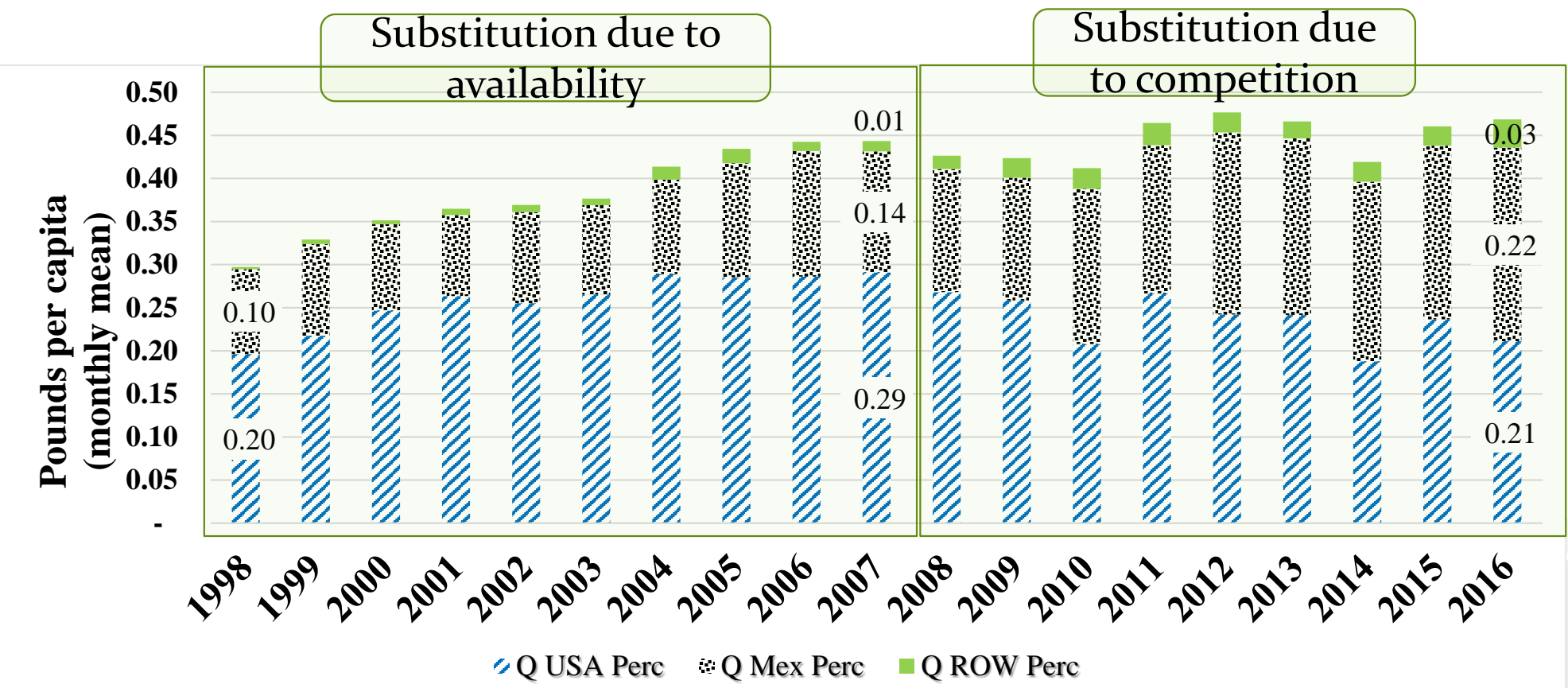
Justification and Benefits of this Study

The knowledge of the rate of substitution, and how **seasonality**, **color** **and** **habit formation** affect its magnitude, could be valuable information:

– For decision makers to take opportunistic decisions,

– For policymakers to aid the industry of bell pepper

– In the eventuality of NAFTA renegotiation

– In the eventuality of a trade dispute

- The U.S. and Mexican vegetable producers have had <u>trade disputes in the past</u>

Holt and Goodwin (1997) Dynamic NL/IAIDS model is improved to account for own- and cross-consumption habits.

Data source:

- Weekly data of fresh bell pepper are obtained from AMS/USDA website

  – https://www.ams.usda.gov/market-news/custom-reports

  - Prices at warehouse level
  - Movement of quantities

  – Data was aggregated by month

  - 228 observations [Source, 1998-2016]

  – Variables:

  - Wi = expenditure share
  - Lnq_i = per capita consumption/month
  - AQI = Aggregated quantity index
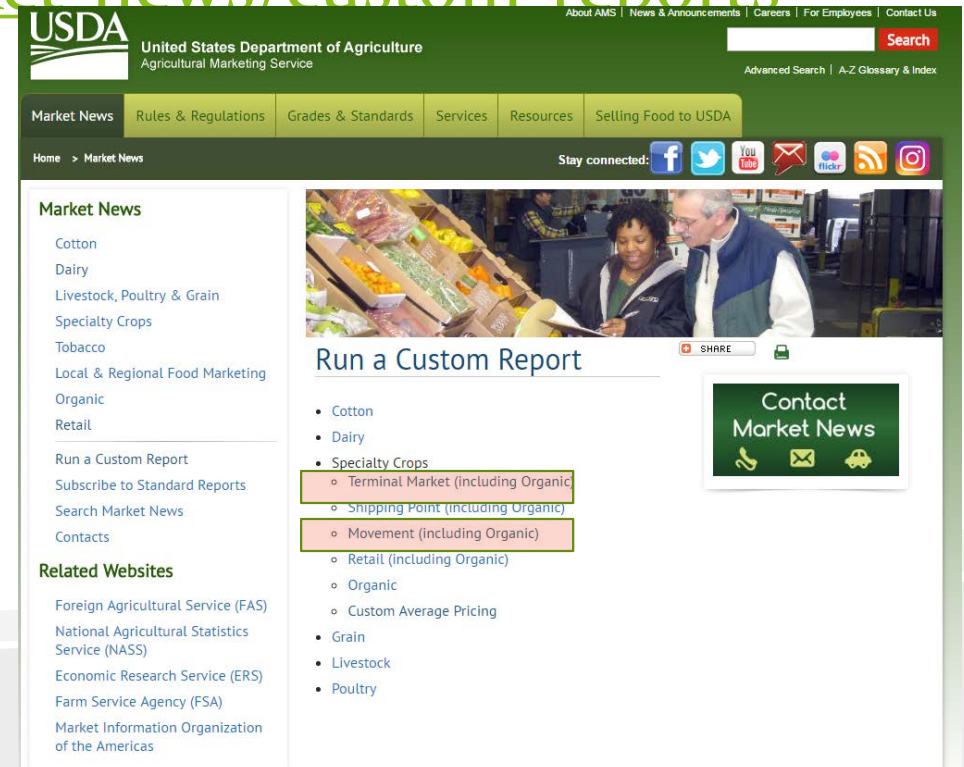
Basic Static Inverse AIDS model

- $w_i = \alpha_i + \sum_{s=1}^{11} \boldsymbol{\delta_{is} D_s} + \sum_j \gamma_{ij} Lnq_j + \beta_i \boldsymbol{LnQ}$

  Eales & Unnevehr, 1991

  - where $\boldsymbol{LnQ} = \alpha_0 + \sum_i [\alpha_i + \sum_{s=1}^{11} \boldsymbol{D_s}] Lnq_i + 0.5 \sum_i \sum_j \gamma_{ij} Lnq_i Lnq_j$

  Moschini & Visa (1992)

- Major findings:

  - Own and cross price flexibilities are all negative & inflexible, fij<|-1|

  - Results show that the U.S. and Mexican bell peppers have higher substitution possibilities than the U.S. and ROW bell peppers.

  - Consumers in the United States substitute more easily the locally produced bell pepper with the imported one than the other way around

The role of seasonality?

Total consumption (expenditure) in Lbs. (US$) of fresh bell pepper in U.S by season

Legend: Lbs - Summer-Fall | Lbs - Winter-Spring | US$ - Summer-Fall | US$ - Winter-Spring
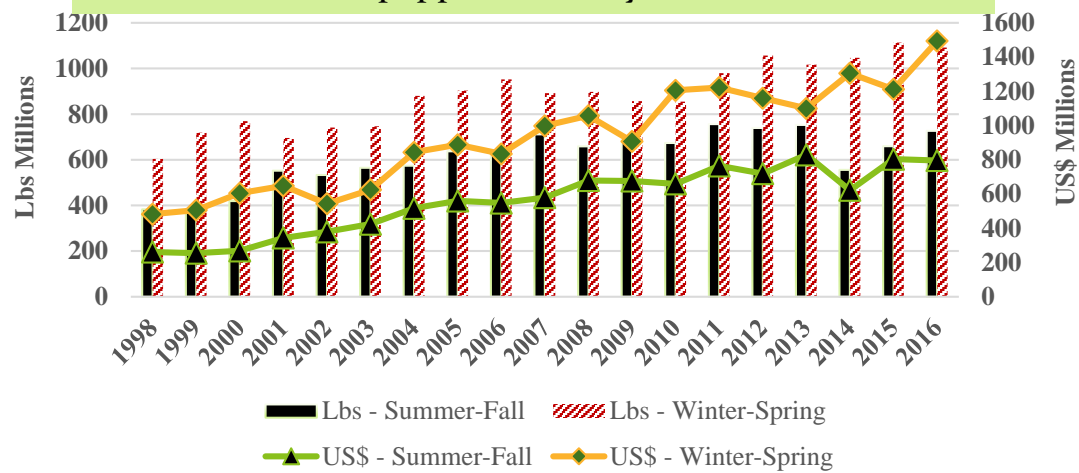
Monthly allocation for bell pepper by source, 1998-2016

Legend: Share USA | Share Mex | Share Other
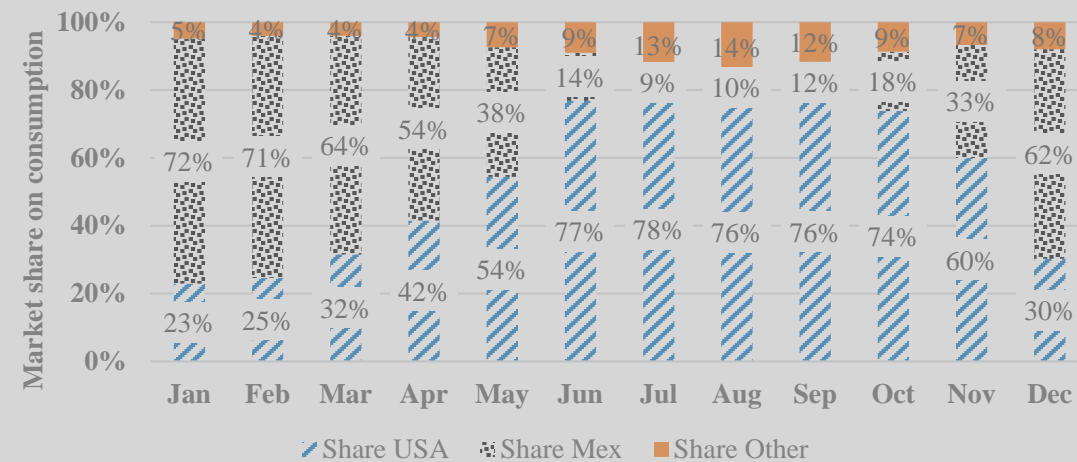
Seasonal fluctuation through time 1998-2016

Source: https://marketnews.usda.gov
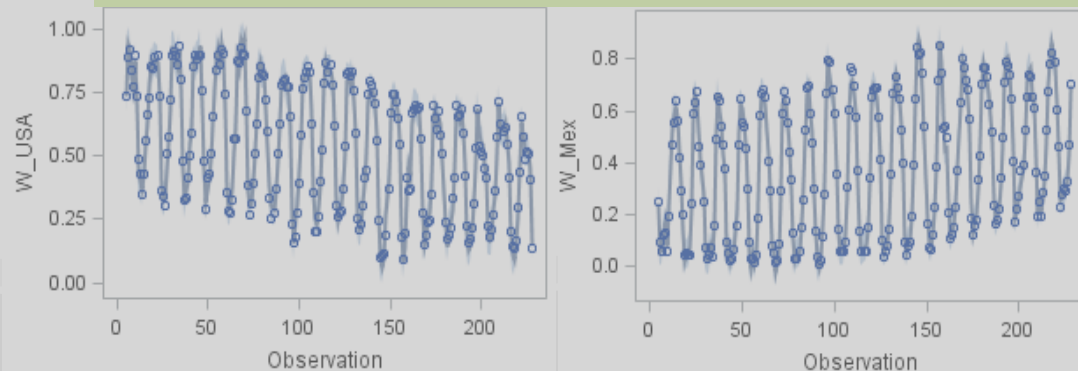
Seasonal effects on the optimal decision rule

$$bundle\ 1 = (q_{mex}^1, q_{usa}^1)$$
$$bundle\ 2 = (q_{mex}^2, q_{usa}^2)$$

$$D_1\ (U_0, q_{s1}) = 0a/0q_{s1}$$
$$D_2\ (U_0, q_{s2}) = 0b/0q_{s2}$$
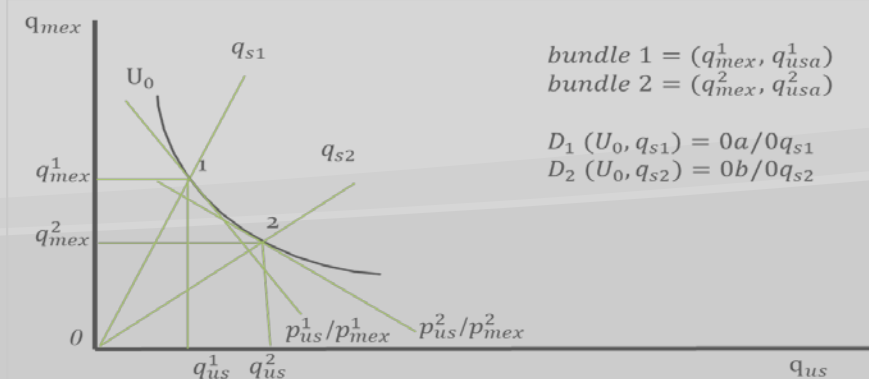
The seasonal LA-IAIDS model

- $w_i = \alpha_i^* + \sum_j (\gamma_{ij} + \sum_{s=1}^3 \boldsymbol{\theta_{sij}} D^s) Lnq_j + (\beta_i + \sum_{s=1}^3 \boldsymbol{\beta_{is}} D^s) + LnQ_t$

  Grant, James. H., Lambert, D. M., & Foster, K. A., (2010)

  - $\alpha_i^* = [a_i + \delta_{i1} D^1 + \delta_{i2} D^2 + \delta_{i3} D^3]$

- In matrix form:

  - $W_t^n = f^n(\phi, X_t) + \boldsymbol{f_s^n(\phi_s, x_t^s)} + V_t^n$

- **Seasonal Own- and cross-price flexibilities %$\boldsymbol{\Delta P_i}$/%$\boldsymbol{\Delta q_j}$**

- $f_{ij}^{winter} = -\lambda_{ij} + \{\gamma_{ij} + \beta_i w^0{}_j\}/w^0{}_i \big|_{D^{Spring}=0, D^{summer}=0, D^{fall}=0}$

- $f_{ij}^S = -\lambda_{ij} + \{\gamma_{ij} + \boldsymbol{\theta_{Sij}} + (\beta_i + \boldsymbol{\beta_{is}}) w^0{}_j\}/w^0{}_i \big|_{D^S=1}$

How my approach is different to Grant et al., 2010?

1) Four seasons, they only had only two
2) They used a HAC matrix to correct for serial correlation, I used a full autoregressive specification to control for serial correlation

- Treatment of serial correlation: Anderson & Blundell, (1982)

  - $W_t^n = f^n(\phi, X_t) + \boldsymbol{f_s^n(\phi_s, x_t^s)} + \begin{bmatrix} R_{11} & R_{12} \\ R_{21} & R_{22} \end{bmatrix} + e_t^n$

Results of the seasonal LA-IAIDS

- **Substitution possibilities between US-Mexico *increase during winter-spring***
  - **when U.S. production of bell pepper is out of season, U.S. consumption is the highest, and most of U.S. production is green.**

- **Substitution of ROW bell pepper with other sources is nearly zero across all seasons**

- U.S. producers compete with Canada, Netherland, Spain and Israel during Summer-Fall
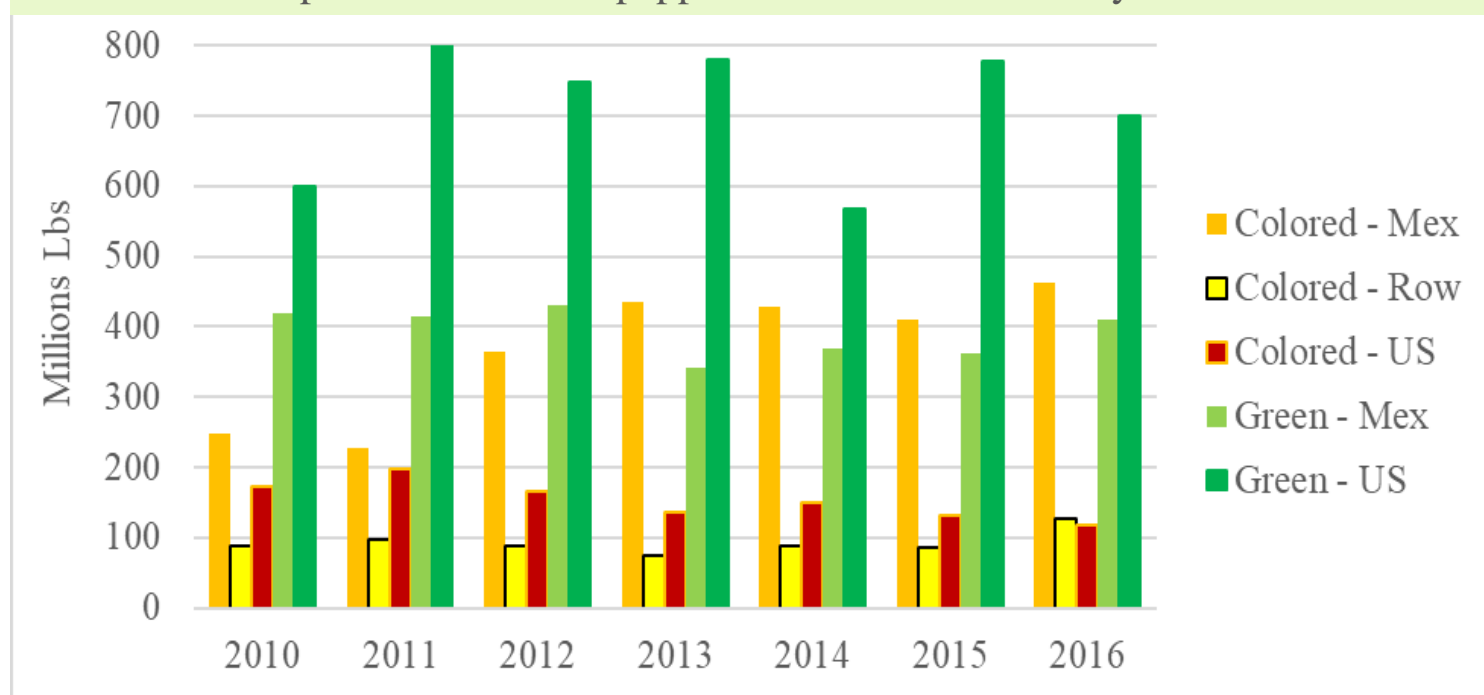
- Mexico producers compete with the Dominican Republic and Central America during Winter-Spring

%ΔPrice	1%ΔQ-Mexico				1%ΔQ-U.S.				1%ΔQ-ROW			
	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall
%ΔP-Mex	-0.50***	-0.40***	-0.80***	-0.68***	-0.29***	-0.37***	-0.12***	-0.19***	-0.35***	-0.31***	-0.06**	-0.20***
	(0.039)	(0.035)	(0.015)	(0.013)	(0.025)	(0.024)	(0.010)	(0.009)	(0.087)	(0.085)	(0.032)	(0.026)
%ΔP-U.S.	-0.32***	-0.37***	-0.19***	-0.18***	-0.74***	-0.71***	-0.73***	-0.78***	-0.15	-0.13	-0.90***	-0.61***
	(0.042)	(0.037)	(0.042)	(0.050)	(0.031)	(0.028)	(0.032)	(0.038)	(0.098)	(0.096)	(0.092)	(0.110)
%ΔP-Row	-0.05***	-0.05***	-0.00	-0.03**	-0.01**	-0.02***	-0.12***	-0.09***	-0.60***	-0.54***	-0.10**	-0.22***
	(0.011)	(0.009)	(0.011)	(0.012)	(0.007)	(0.006)	(0.008)	(0.009)	(0.035)	(0.040)	(0.048)	(0.054)
Scale	-0.88***	-0.83***	-1.00***	-0.89***	-1.06***	-1.11***	-0.98***	-1.06***	-1.11***	-0.99***	-1.06***	-1.03***
	(0.061)	(0.063)	(0.044)	(0.052)	(0.044)	(0.047)	(0.030)	(0.037)	(0.153)	(0.150)	(0.096)	(0.110)
Mean Share	68.5%	52.2%	10.9%	20.9%	25.9%	42.5%	76.9%	70.1%	5.6%	5.3%	12.2%	9.0%

Consumption of green and colored bell pepper

Total consumption of fresh bell pepper in the United States by color and source

Legend:
- Colored - Mex
- Colored - Row
- Colored - US
- Green - Mex
- Green - US

U.S. is the biggest supplier of **Green bell pepper**, while **Mexico** is the biggest supplier for **colored bell pepper**.

Prices

Legend:
- Colored - ROW
- Colored - MEX
- Colored - US
- Green - ROW
- Green - MEX
- Green - US

Green bell pepper is more consumed in U.S. than **colored bell pepper**

Source: https://marketnews.usda.gov
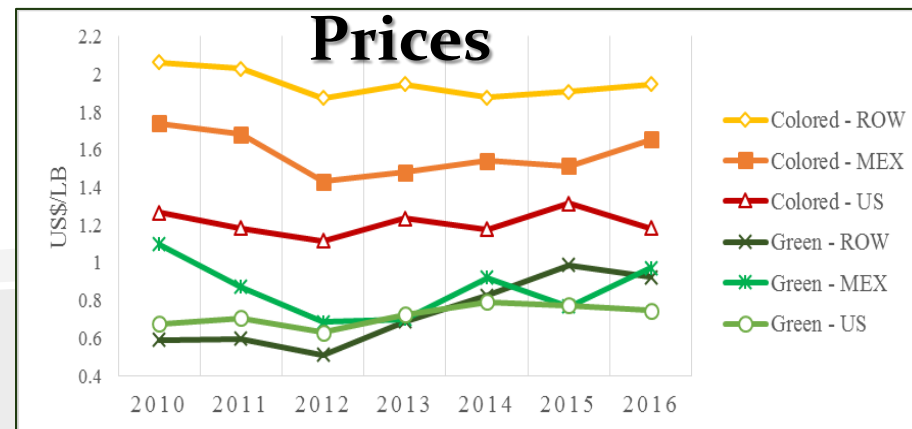
Budget share for bell pepper in the United States by source and color, 2010-2016
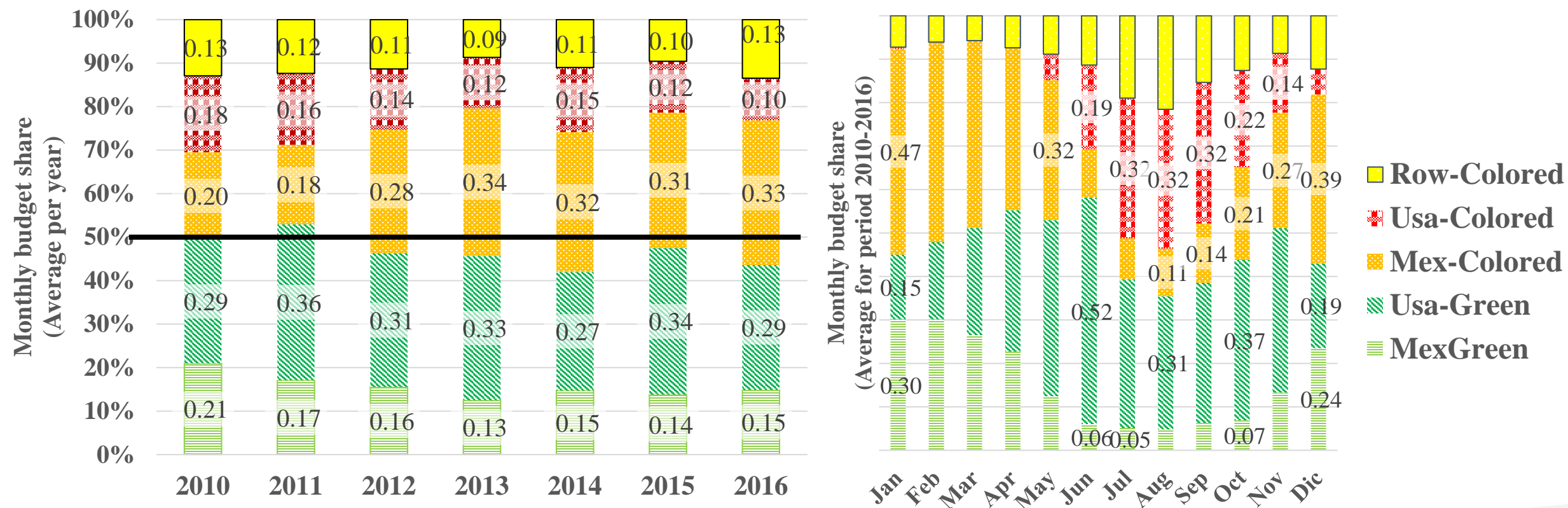
In a yearly basis, <u>the budget allocation</u> for **green** and colored **bell pepper** is nearly the same

Basic LA-IAIDS model for green & colored bell pepper by source

- $w_i = a_i + \sum_{s=1}^{11} \delta_{is} D_s + \sum_j \gamma_{ij} Lnq_j + \beta_i LnQ_t + R^{(n-1)^2} + et$

LA/IAIDS uncompensated price flexibilities by source and color

	1%ΔQ MexG	1%ΔQ MexC	1%ΔQ UsaG	1%ΔQ UsaC	1%ΔQ RowC
	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient
%ΔP_MexG	**-0.565*****	0.018	-0.490***	-0.072**	-0.057
	(0.057)	(0.026)	(0.017)	(0.034)	(0.051)
%ΔP_MexC	-0.116***	**-0.691*****	-0.000	-0.277***	-0.112***
	(0.029)	(0.026)	(0.039)	(0.039)	(0.022)
%ΔP_UsaG	-0.509***	-0.044	**-0.072****	-0.287***	-0.235***
	(0.057)	(0.039)	(0.003)	(0.056)	(0.051)
%ΔP_UsaC	-0.002	-0.001	-0.277***	**-0.992*****	-0.000
	(0.006)	(0.005)	(0.034)	(0.008)	(-0.04)
%ΔP_RowC	-0.125***	-0.068***	-0.287***	-0.133***	**-0.179*****
	(0.038)	(0.014)	(0.039)	(0.019)	(0.066)
Scale	-1.320***	-0.787***	-0.846***	-1.763***	-0.585***
	(0.108)	(0.080)	(0.066)	(0.132)	(0.088)

Flexibilities were calculated using the mean share 16%, 28%, 31%, 14%, 11% in the period 2010-2016 for MexG, MexC, UsaG, UsaC, RowC, respectively.

Why dynamic, why habit formation?

- The static IAIDS model assumes

  – prices adjust immediately when quantities available in the market change

- This approach does not provide a realistic description of how consumers behave.

  – Consumers <u>react with some delay to shocks</u> in quantities

    - **Reasons for the delay:**
      - **Lack of information**
      - **Early commitment**
      - **buying or consumption habits**

Process to incorporate habit formation in the IAIDS

❑Start from the utility distance function

    ❑ $\text{Ln } D(U, q) = (1 - U) * \ln[a(q)] + U * \ln[b(q)]$

        ❑ Following Eales and Unnevehr (1991)

        ❑ Following Ray (1983) and H&G (1997)

            ❑ Introduce a stock of habits in the $LnD(U,q)$

    ❑ Derive the expenditure shares equation conditioned to habits

$$W_t^n = f^n(\phi, X_t) + \boldsymbol{f_h^n(\phi_h, X_{t-m})} + \sum_{s=1}^{11} \boldsymbol{\delta_{is} D_s} + \begin{bmatrix} R_{11} & R_{12} \\ R_{21} & R_{22} \end{bmatrix} + e_t^n$$

$\text{bundle } 1 = (q_{mex}^1, q_{usa}^1)$
$\text{bundle } 2 = (q_{mex}^2, q_{usa}^2)$
$D_1(U_0, q) = 0a/0q$
$D_2(U_1, q) = 0b/0q$
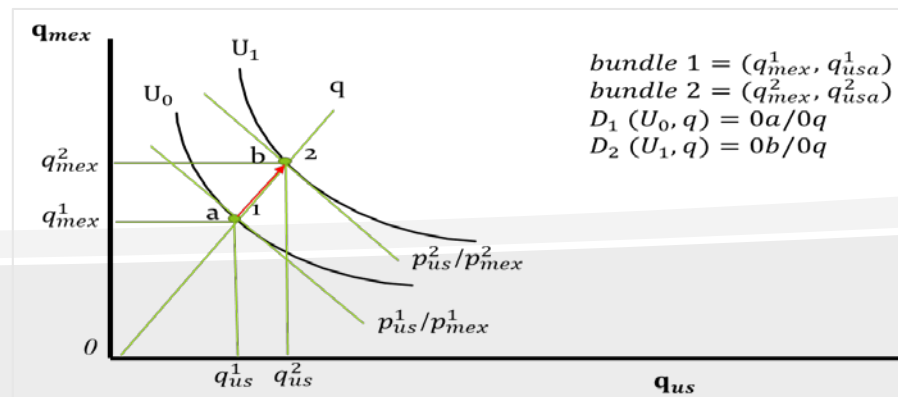
Modeling the Stock of habits

$$w_i = \alpha_i + \sum_j \gamma_{ij} Lnq_j + \beta_i lnQ$$

Where $LnQ = \alpha_0 + \sum_i \alpha_i Lnq_i + 0.5 \sum_i \sum_j \gamma_{ij} Lnq_i Lnq_j$

- **Ray (1983)**

- **Holt & Goodwin (1997)**
  - **Long memory habits**

- **My approach**
  - **Long memory habits**

$$\tilde{\mu}_{t-1} = \begin{bmatrix} lnq_{1_{t-1}} + \delta_1^1 lnq_{1_{t-2}} + \delta_1^2 lnq_{1_{t-3}} + \cdots + \delta_1^m lnq_{1_{t-m-1}} + \\ lnq_{2_{t-1}} + \delta_2^1 lnq_{2_{t-2}} + \delta_2^2 lnq_{2t-3} + \cdots + \delta_2^m lnq_{2_{t-m-1}} + \\ lnq_{3_{t-1}} + \delta_3^1 lnq_{3_{t-2}} + \delta_3^2 lnq_{3_{t-3}} + \cdots + \delta_3^m lnq_{3_{t-m-1}} + \end{bmatrix}$$

Mex=1, USA=2, ROW=3

$$\tilde{\mu}_{j_{t-1}}^* = \begin{bmatrix} lnq_{j_{t-1}} + \delta_j^1 lnq_{j_{t-2}} + \delta_j^2 lnq_{j_{t-3}} + \cdots + \delta_j^m lnq_{j_{t-m-1}} \end{bmatrix}$$

$$\tilde{\mu}_{Mex_{t-1}}^* = \begin{bmatrix} lnq_{1_{t-1}} + \delta_j^1 lnq_{1_{t-2}} + \delta_j^2 lnq_{1_{t-3}} + \cdots + \delta_j^m lnq_{1_{t-m-1}} \end{bmatrix}$$

$$\tilde{\mu}_{USA_{t-1}}^* = \begin{bmatrix} lnq_{2_{t-1}} + \delta_j^1 lnq_{2_{t-2}} + \delta_j^2 lnq_{t-3} + \cdots + \delta_j^m lnq_{2_{t-m-1}} \end{bmatrix}$$

$$\tilde{\mu}_{ROW_{t-1}}^* = \begin{bmatrix} lnq_{3_{t-1}} + \delta_j^1 lnq_{3_{t-2}} + \delta_j^2 lnq_{3_{t-3}} + \cdots + \delta_j^m lnq_{3_{t-m-1}} \end{bmatrix}$$

Comparing both Holt & Goodwin & my approach

- **H&G LR-D-NL/IAIDS**

- $w_i = \alpha_i^* + \boldsymbol{\alpha_i^{**}\widetilde{\mu}_{t-1}} + \sum_j(\gamma_{ij}+\boldsymbol{\theta_{ij}\widetilde{\mu}_{t-1}})Lnq_j + (\beta_i+\boldsymbol{\eta_i\widetilde{\mu}_{t-1}})Ln\tilde{Q}_t^*$

  - $Ln\tilde{Q}_t^* = \alpha_0 + \sum_j(\alpha_j^* + \boldsymbol{\alpha_j^{**}\widetilde{\mu}_{t-1}})Lnq_j + \frac{1}{2}\sum_i\sum_j(\gamma_{ij}+\boldsymbol{\theta_{ij}\widetilde{\mu}_{t-1}})Lnq_iLnq_j$

- *They assume that: The aggregated habits and specific good habits have the same effect on the Wi*

$$\boldsymbol{\alpha_i^{**}\widetilde{\mu}_{t-1} = \alpha_i^{**}\widetilde{\mu}_{mext-1} + \alpha_i^{**}\widetilde{\mu}_{usat-1} + \alpha_i^{**}\widetilde{\mu}_{rowt-1}}$$

$$\boldsymbol{\theta_{ij}\mu_{t-1} = \theta_{ij}\widetilde{\mu}_{mext-1} + \theta_{ij}\widetilde{\mu}_{usat-1} + \theta_{ij}\widetilde{\mu}_{rowt-1}}$$

$$\boldsymbol{\theta_{ij}\eta_i = \eta_i\widetilde{\mu}_{mext-1} + \eta_i\widetilde{\mu}_{usat-1} + \eta_i\widetilde{\mu}_{rowt-1}}$$

Comparing both Holt & Goodwin & my approach

- **Proposed LR-D-NL/IAIDS with Own- and cross-habit formation**

- $w_i = \alpha_i^* + \textcolor{red}{\sum_j \boldsymbol{\alpha_{ij}^{**} \widetilde{\mu}_{j_{t-1}}^*}} + \sum_j (\gamma_{ij} + \textcolor{orange}{\sum_{j_{t-1}} \boldsymbol{\theta_{ijj_{t-1}} \widetilde{\mu}_{j_{t-1}}^*}}) Lnq_j + (\beta_i + \textcolor{green}{\sum_j \boldsymbol{\eta_{ij} \widetilde{\mu}_{j_{t-1}}^*}}) Ln\ddot{Q}_t^*$

  $\textcolor{green}{-} Ln\ddot{Q}_t^* = \alpha_0 + \sum_j (\alpha_j^* + \textcolor{red}{\sum_j \boldsymbol{\alpha_{ij}^{**} \widetilde{\mu}_{j_{t-1}}^*}}) Lnq_j + \frac{1}{2} \sum_i \sum_j (\gamma_{ij} + \textcolor{orange}{\sum_{j_{t-1}} \boldsymbol{\theta_{ijj_{t-1}} \widetilde{\mu}_{j_{t-1}}^*}}) Lnq_i Lnq_j$

- *I assumed that the own- and cross consumption habit affect the W_i in different magnitudes*

$$\textcolor{red}{\sum_j \boldsymbol{\alpha_{ij}^{**} \widetilde{\mu}_{j_{t-1}}^*} = \boldsymbol{\alpha_{i1}^{**} \widetilde{\mu}_{mex_{t-1}}^* + \alpha_{i2}^{**} \widetilde{\mu}_{usa_{t-1}}^* + \alpha_{i3}^{**} \widetilde{\mu}_{row_{t-1}}^*}.}$$

$$\textcolor{orange}{\sum_{j_{t-1}} \boldsymbol{\theta_{ijj_{t-1}} \widetilde{\mu}_{j_{t-1}}^*} = \boldsymbol{\theta_{ij1} \widetilde{\mu}_{mex_{t-1}}^* + \theta_{ij2} \widetilde{\mu}_{usa_{t-1}}^* + \theta_{ij3} \widetilde{\mu}_{row_{t-1}}^*}.}$$

$$\textcolor{green}{\sum_j \boldsymbol{\eta_{ij} \widetilde{\mu}_{j_{t-1}}^*} = \boldsymbol{\eta_{i1} \widetilde{\mu}_{mex_{t-1}}^* + \eta_{i2} \widetilde{\mu}_{usa_{t-1}}^* + \eta_{i3} \widetilde{\mu}_{row_{t-1}}^*}.}$$

Long Run Own- and Cross-price Flexibilities

- Holt & Goodwin model own- and cross-prices flexibilities are as follows:

  - $f_{ij}^{LR} = -\delta_{ij} + \left(\dfrac{\gamma_{ij} + \boldsymbol{\theta_{ij}\widetilde{\mu}_{t-1}}}{w_i}\right) + \left(\dfrac{\beta_i + \boldsymbol{\eta_i\widetilde{\mu}_{t-1}}}{w_i}\right) * \left\{w_j - (\beta_j + \boldsymbol{\eta_j\widetilde{\mu}_{t-1}})Ln\widetilde{Q}_t^*\right\}$

- Proposed own- and cross-prices flexibilities are as follows:

  - $f_{ij}^{\prime LR} = -\delta_{ij} + \left(\dfrac{\gamma_{ij} + \sum_{j_{t-1}} \boldsymbol{\theta_{ijj_{t-1}}\widetilde{\mu}^*_{j_{t-1}}}}{w_i}\right) + \left(\dfrac{\beta_i + \sum_j \boldsymbol{\eta_{ij}\widetilde{\mu}^*_{j_{t-1}}}}{w_i}\right)\left\{w_j - (\beta_j + \boldsymbol{\eta_{ij}} \sum_j \eta_{ij}\widetilde{\mu}^*_{j_{t-1}})Ln\ddot{Q}_t^*\right\}$

<u>Long Run habits Flexibilities</u>

- Habit flexibilities:
  - How changes in consumption habits affect the prices flexibilities

- H&G model aggregated habit flexibilities are as follows:

$$- \frac{\partial f_{ij}^{LR}}{\partial \tilde{\mu}_{t-1}} = \frac{\boldsymbol{\theta_{ij}}}{w_i} + \frac{\boldsymbol{\eta_i}}{w_i} * \left\{ w_j - (\beta_j + \eta_i \tilde{\mu}_{t-1}) LnQ_t^* \right\} + \left(\frac{\beta_i + \eta_i \tilde{\mu}_{t-1}}{w_i} \right) * \left\{ \frac{\partial Ln\tilde{Q}_t^*}{\partial lnq_j} \Big/ \partial \tilde{\mu}_{t-1} \right\}$$

- The proposed model <u>own- and cross-habit flexibilities</u> are as follows:

$$- \frac{\partial f_{ij}'^{LR}}{\partial \tilde{\mu}_{j_{t-1}}^*} = \frac{\boldsymbol{\theta_{ij_{t-1}}}}{w_i} + \frac{\boldsymbol{\eta_{ij}}}{w_i} \left\{ w_j - (\beta_j + \eta_{ij} \sum_j \eta_{ij} \tilde{\mu}_{j_{t-1}}^*) Ln\ddot{Q}_t^* \right\} + \left(\frac{\beta_i + \sum_j \eta_{ij} \tilde{\mu}_{j_{t-1}}^*}{w_i} \right) \left\{ \frac{\partial Ln\ddot{Q}_t^*}{\partial lnq_j} \Big/ \partial \tilde{\mu}_{j_{t-1}}^* \right\}$$

Models comparison

- **The proposed model outperformed the static and H&G's model based on the goodness of fit values.**

	Static Model	H&G D-NL/IAIDS	Proposed *Model*
No. of Parameters	35	45	61
Log Likelihood	1,021	1,074	1,173
Log L. ratio test		105, P<.001	198, P<.001
System Adj R2	94.00%	95.38%	96.79%
Eq. Mex adjR2	98.06%	98.43%	98.79%
Eq. Usa adjR2	97.83%	98.05%	98.23%
Eq. Mex DW	1.12	1.21	1.20
Eq. Usa DW	1.09	1.18	1.28

Durbin Watson (DW) statistics values were estimated before controlling for serial correlation.

Long Run Own- and Cross-price Flexibilities

- Accounting for *specific habit formation generated more inflexible demand of bell pepper*. But, generally larger substitution possibilities

	Mexico quantity			U.S. quantity			ROW quantity		
	NL/IAIDS Static	H&G Agg-Habit	Proposed Model Own-Cross-Habit	NL/IAIDS Static	H&G Agg-Habit	Proposed Model Own-Cross-Habit	NL/IAIDS Static	H&G Agg-Habit	Proposed Model Own-Cross-Habit
Mex Price	-0.785*** (0.024)	-0.759*** (0.061)	-0.691*** (0.034)	-0.135*** (0.016)	-0.141*** (0.016)	-0.161*** (0.023)	-0.109 (0.078)	-0.194 (0.251)	-0.381*** (0.144)
U.S. Price	-0.175*** (0.026)	-0.194*** (0.045)	-0.235*** (0.034)	-0.808*** (0.019)	-0.789*** (0.040)	-0.767*** (0.016)	-0.453*** (0.075)	-0.489*** (0.087)	-0.438** (0.181)
ROW Price	-0.016 (0.012)	-0.038 (0.042)	-0.080** (0.031)	-0.063*** (0.008)	-0.071*** (0.008)	-0.064** (0.027)	-0.500*** (0.044)	-0.340** (0.167)	-0.189 (0.268)
Scale (fi)	-0.977*** (0.046)	-0.991*** (0.047)	-1.006*** (0.019)	-1.006*** (0.032)	-1.002*** (0.047)	-0.993*** (0.012)	-1.063*** (0.114)	-1.024*** (0.174)	-1.009*** (0.072)

H&G Aggregated habit Flexibilities

- According to H&G model, changes in the aggregated stock of habit are more significant for imported bell pepper than for the local. Thus, the demand becomes more inflexible, and substitution possibilities increase.

LR price and Habit flexibilities for U.S, Mexico, and ROW, 1998-2016, [H&G Model]

	$1\%\Delta\uparrow\_Q_{mex}$		$1\%\Delta\uparrow\ Q_{USA}$		$1\%\Delta\uparrow\_Q_{ROW}$	
	Long Run. $LR\text{-}D\text{-}Agg\text{-}Q_{t\text{-}1}$	Agg-habit $\Delta f_{ij}/\Delta U_{t\text{-}M}$	Long Run $LR\text{-}D\text{-}Agg\text{-}Q_{t\text{-}1}$	Agg-habit $\Delta f_{ij}/\Delta U_{t\text{-}M}$	Long Run $LR\text{-}D\text{-}Agg\text{-}Q_{t\text{-}1}$	Agg-habit $\Delta f_{ij}/\Delta U_{t\text{-}M}$
%Δ Mex Price	-0.759*** (0.061)	0.008*** (0.003)	-0.141*** (0.016)	-0.000 (0.001)	-0.194 (0.251)	-0.035*** (0.009)
%Δ U.S. Price	-0.194*** (0.045)	-0.005 (0.005)	-0.789*** (0.040)	0.005 (0.004)	-0.489*** (0.087)	-0.012 (0.009)
%Δ ROW Price	-0.038 (0.042)	-0.005*** (0.001)	-0.071*** (0.008)	0.000 (0.000)	-0.340** (0.167)	0.023*** (0.006)

Own- and Cross-habit Flexibilities

LR own- and cross-habit flexibilities [Proposed LR-D-NL/IAIDS model]

	$1\%\Delta\uparrow$ QMEX $f_{ij}'^{LR}$	Habit effects		$1\%\Delta\uparrow$ QUSA $f_{ij}'^{LR}$	Habit effects		$1\%\Delta\uparrow$ QROW $f_{ij}'^{LR}$	Habit effects	
		Agg-habit $\partial f_{ij}/\partial\tilde{\mu}_{t-M}$	Spec-habit $\partial f_{ij}/\partial\tilde{\mu}_{jt-M}$		Agg-habit $\partial f_{ij}/\partial\tilde{\mu}_{t-M}$	Spec-habit $\partial f_{ij}/\partial\tilde{\mu}_{jt-M}$		Agg-habit $\partial f_{ij}/\partial\tilde{\mu}_{t-M}$	Spec-habit $\partial f_{ij}/\partial\tilde{\mu}_{jt-M}$
%ΔP-Mex	**-0.691***** (0.034)	**0.041*** (0.024)	$h_{111}=$ **0.097*** (0.013)** ; $h_{112}=$ **-0.045** (0.018)** ; $h_{113}=$ **-0.010 (0.012)**	-0.161*** (0.023)	0.001 (0.017)	h_{211} -0.040*** (0.008) ; h_{212} 0.010 (0.012) ; h_{213} 0.026** (0.010)	-0.381*** (0.144)	-0.043*** (0.077)	h_{311} -0.192*** (0.036) ; h_{312} 0.142** (0.067) ; h_{313} -0.126*** (0.030)
%ΔP-US	-0.235*** (0.034)	-0.003 (0.029)	$h_{121}=$ -0.067*** (0.015) ; $h_{122}=$ 0.030 (0.021) ; $h_{123}=$ 0.037** (0.015)	**-0.767***** **(0.016)**	**0.003** **(0.024)**	h_{221} **0.001 (0.012)** ; h_{222} **-0.005 (0.016)** ; h_{223} **0.007 (0.012)**	-0.438** (0.181)	-0.010 (0.065)	h_{321} 0.308*** (0.040) ; h_{322} -0.110* (0.057) ; h_{323} -0.229*** (0.058)
%ΔP-ROW	-0.080** (0.031)	-0.176** (0.016)	h_{131} -0.040*** (0.013) ; h_{132} 0.032** (0.013) ; h_{133} -0.035*** (0.010)	-0.064** (0.027)	-0.031 (0.009)	h_{231} 0.037*** (0.007) ; h_{232} -0.013 (0.008) ; h_{233} -0.035*** (0.009)	**-0.189** **(0.268)**	**0.277***** **(0.087)**	h_{331} **-0.062 (0.049)** ; h_{332} **-0.064 (0.082)** ; h_{333} **0.405*** (0.071)**

Conclusions

- – Color, Seasonality, and habit formation play an important role on the magnitude of the substitution possibilities
  - • Because U.S. colored bell pepper has low substitution possibilities and it is perceived as a luxury good, farmers should concentrate on the production of colored bell pepper and not green if they want to regain market share.

- – The suggested dynamic Inverse AIDS model with own and cross habit formation statistically outperformed Holt & Goodwin (1997) model
  - • Accounting for specific consumption habits generated more inflexible demand of bell pepper than H&G model. And generally larger substitution possibilities.
  - • It offers more information about the habit effect on demand for bell pepper than H&G
  - • *It might be a better approach for highly perishable fruits and vegetables*

- **Questions**
- **Comments**
- **Recommendations**