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

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# The role of seasonality, color and habit formation in the *substitution possibility* of local and imported bell peppers in the USA market


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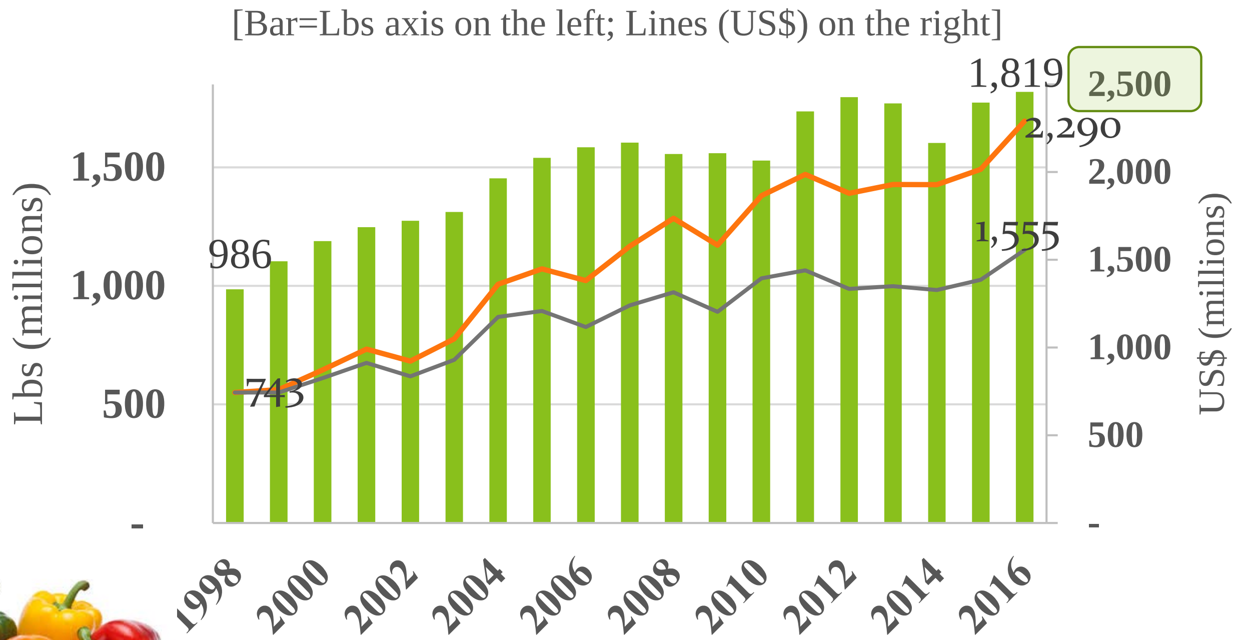
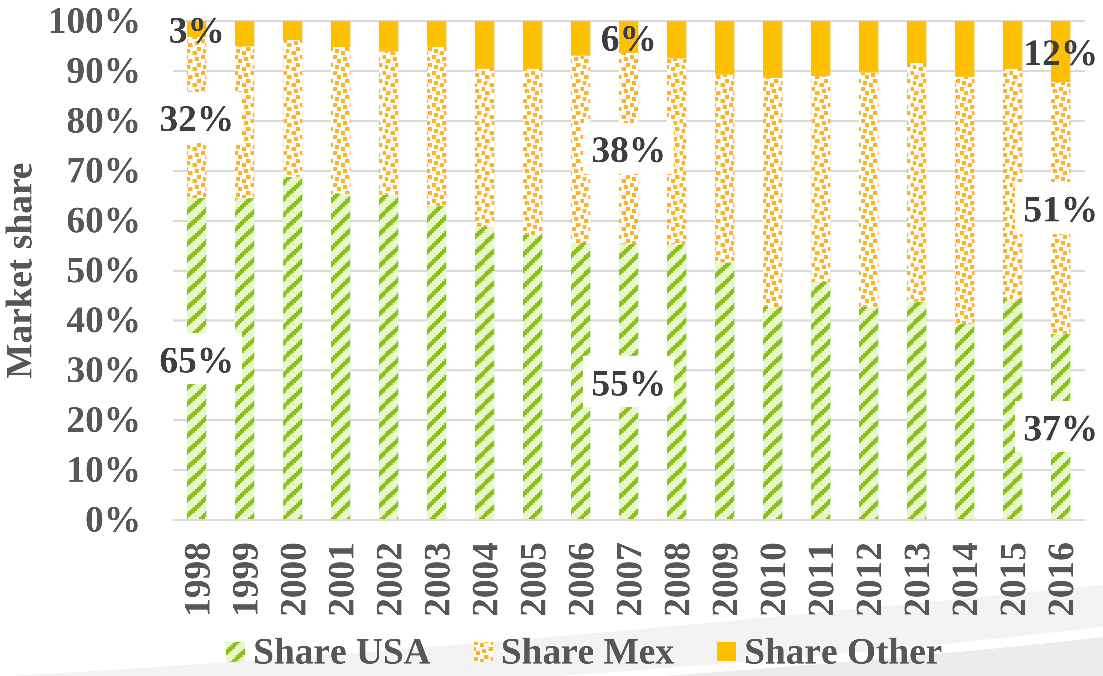
# Increase in demand & Expenditure share per source

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




1.8↑ 3.0↑ 2.1↑

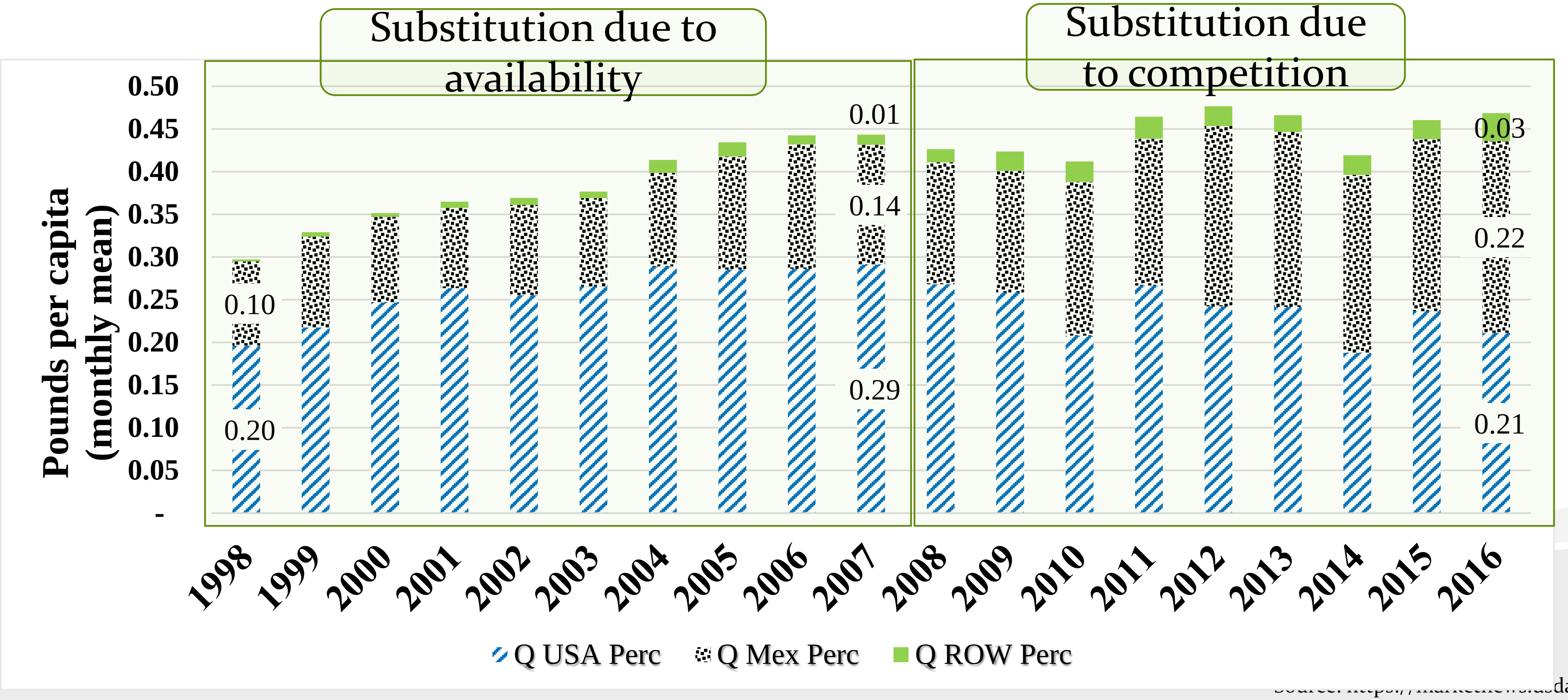
**Expenditure shares for US, Mex and ROW 1998-2016 (monthly average/year)**




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**




Source: https://marketnews.usda.gov
Source: U.S. Dep. of Labor Bureau of Labor Statistic.

# 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 trade disputes in the past

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

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

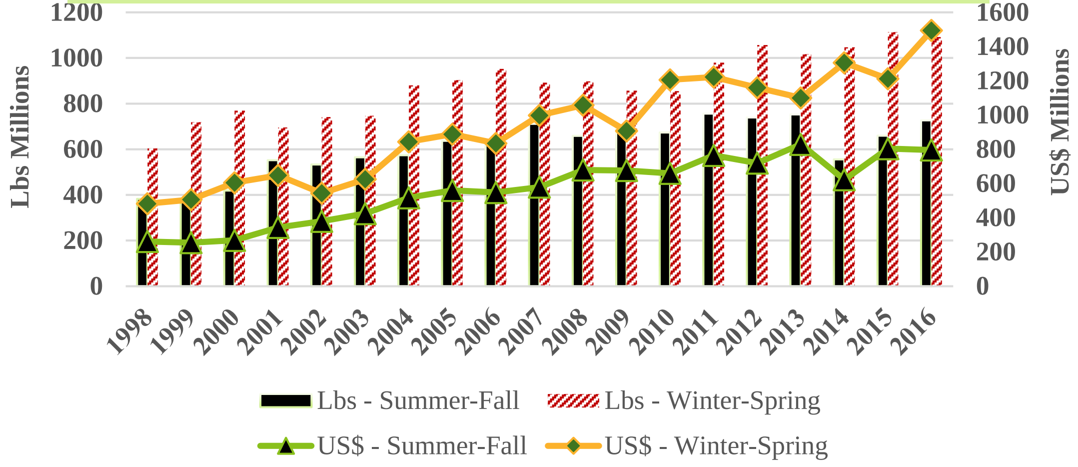
Eales & Unnevehr, 1991

Moschini & Visa (1992)

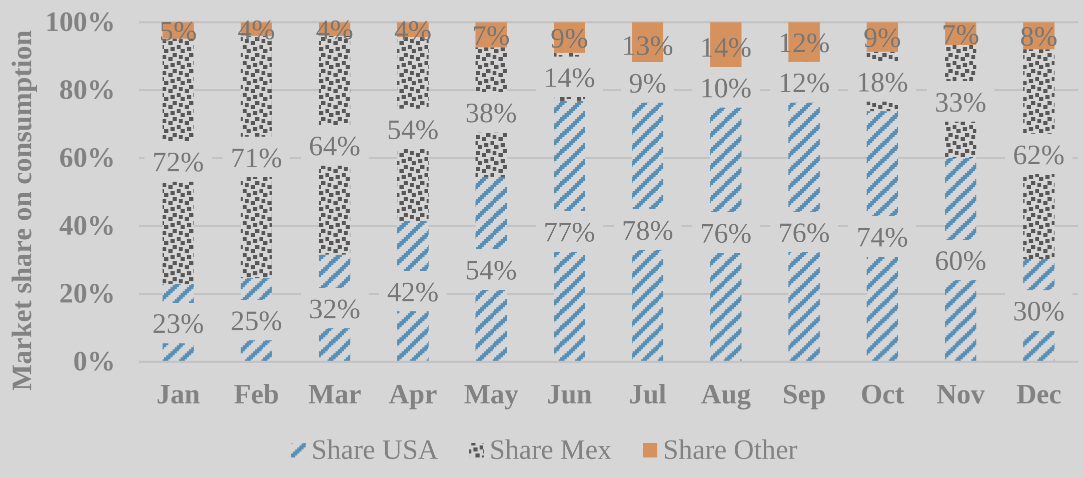
- Major findings:
  - Own and cross price flexibilities are all negative & inflexible, fij<|-1|
  - Results show that the U.S. and Mexican bell peppers have higher substitution possibilities than the U.S. and ROW bell peppers.
  - Consumers in the United States substitute more easily the locally produced bell pepper with the imported one than the other way around

# The role of seasonality?

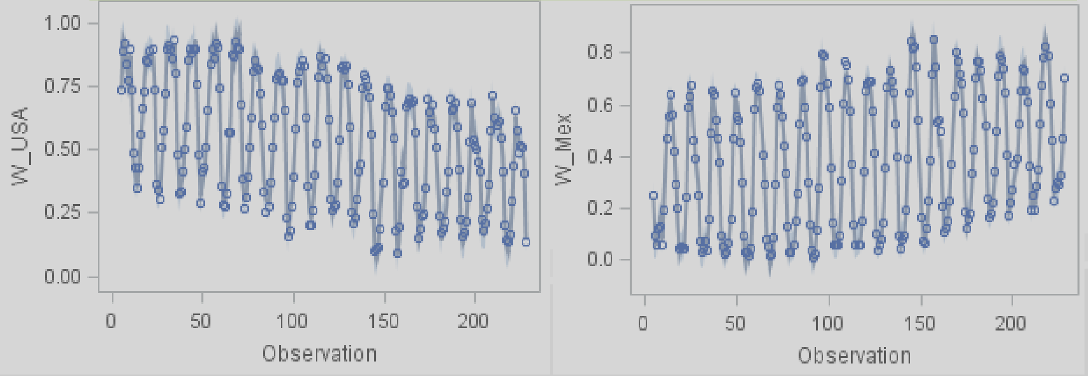
Total consumption (expenditure) in Lbs. (US$) of fresh bell pepper in U.S by season




Monthly allocation for bell pepper by source, 1998-2016

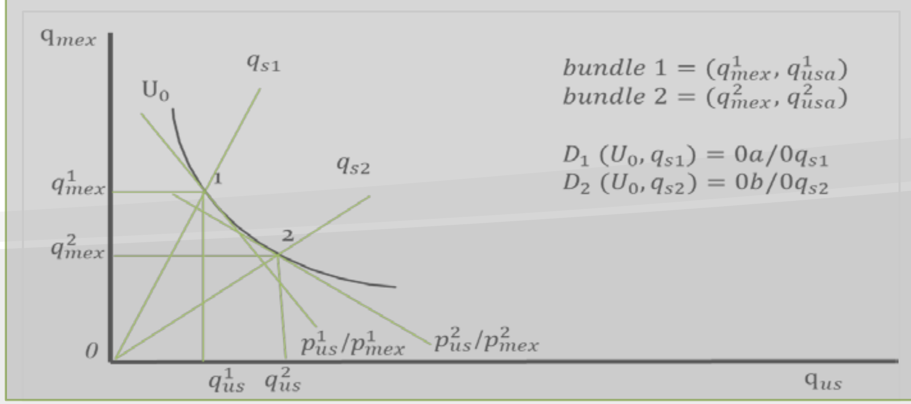



Seasonal fluctuation through time 1998-2016




Source: https://marketnews.usda.gov

Seasonal effects on the optimal decision rule



# The seasonal LA-IAIDS model

- $w_i = \alpha_i^* + \sum_j(\gamma_{ij} + \sum_{s=1}^{3} \boldsymbol{\theta_{sij}} D^s) Lnq_j + (\beta_i + \sum_{s=1}^{3} \boldsymbol{\beta_{is}} D^s) + LnQ_t$
  - $\alpha_i^* = [a_i + \delta_{i1} D^1 + \delta_{i2} D^2 + \delta_{i3} D^3]$

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

- 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 $\%\Delta P_i / \%\Delta q_j$**
- $f_{ij}^{winter} = -\lambda_{ij} + \{\gamma_{ij} + \beta_i w^0{}_j\} / w^0{}_i \Big|_{D^{Spring}=0,\ D^{summer}=0,\ D^{fall}=0}$
- $f_{ij}^{S} = -\lambda_{ij} + \{\gamma_{ij} + \boldsymbol{\theta_{Sij}} + (\beta_i + \boldsymbol{\beta_{iS}}) w^0{}_j\} / w^0{}_i \Big|_{D^S=1}$

- Treatment of serial correlation: Anderson & Blundell, (1982)
  - $W_t^n = f^n(\phi, X_t) + \boldsymbol{f_s^n(\phi_s, x_t^s)} + \begin{bmatrix} R_{11} & R_{12} \\ R_{21} & R_{22} \end{bmatrix} + e_t^n$

**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

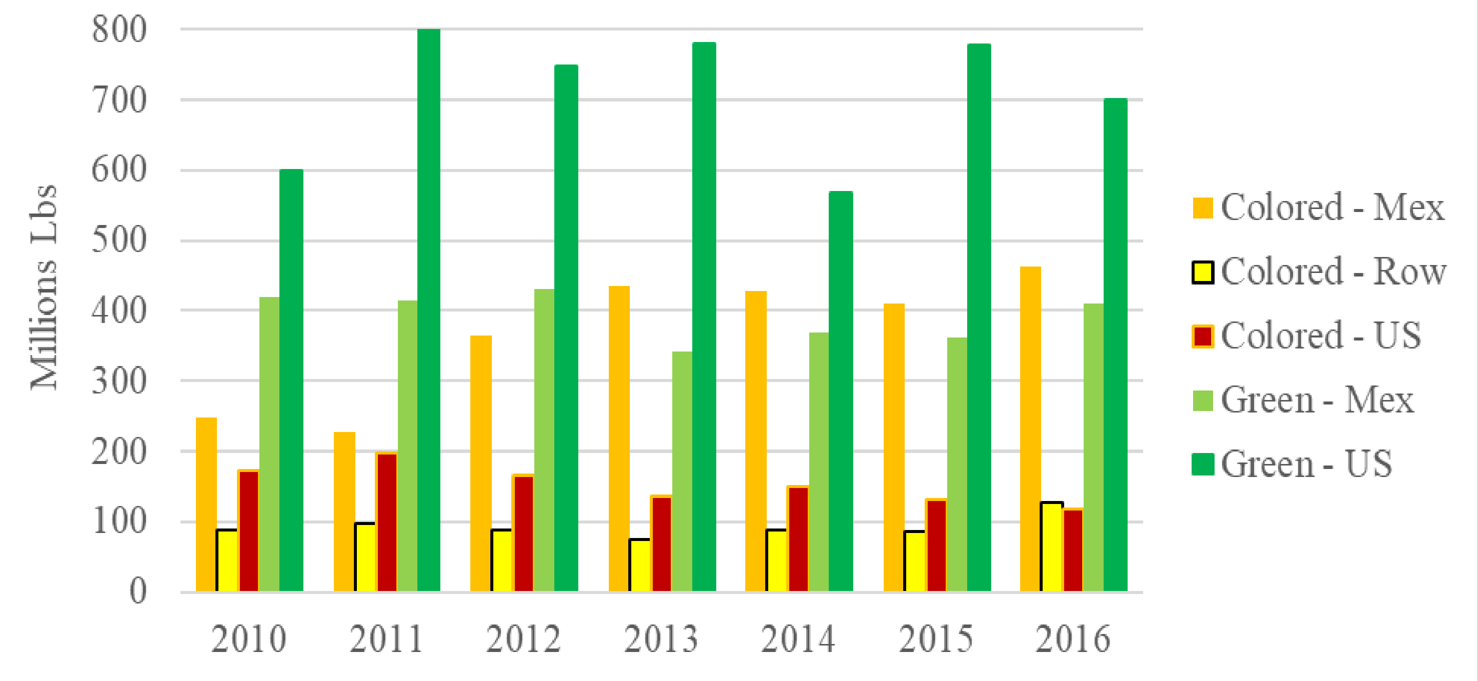
# Results of the seasonal LA-IAIDS

- **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

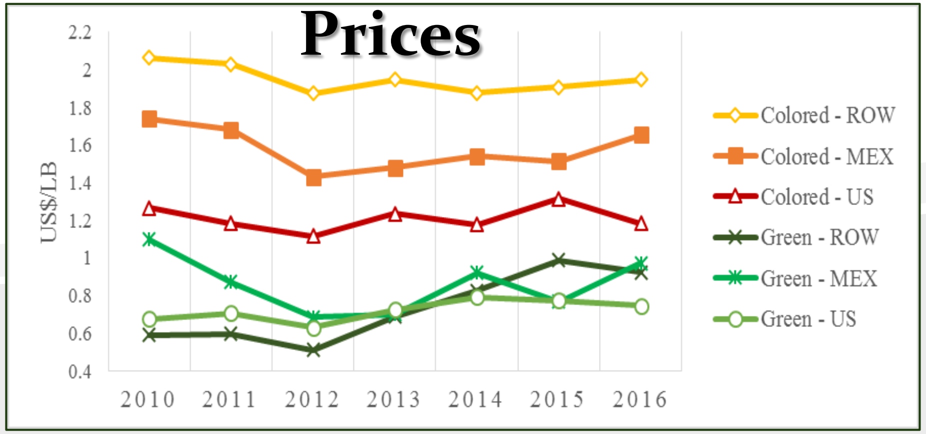
| | 1%ΔQ-Mexico | | | | 1%ΔQ-U.S. | | | | 1%ΔQ-ROW | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| %ΔPrice | Winter | Spring | Summer | Fall | Winter | Spring | Summer | Fall | Winter | Spring | Summer | Fall |
| %ΔP-Mex | **-0.50*** (0.039)** | **-0.40*** (0.035)** | **-0.80*** (0.015)**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



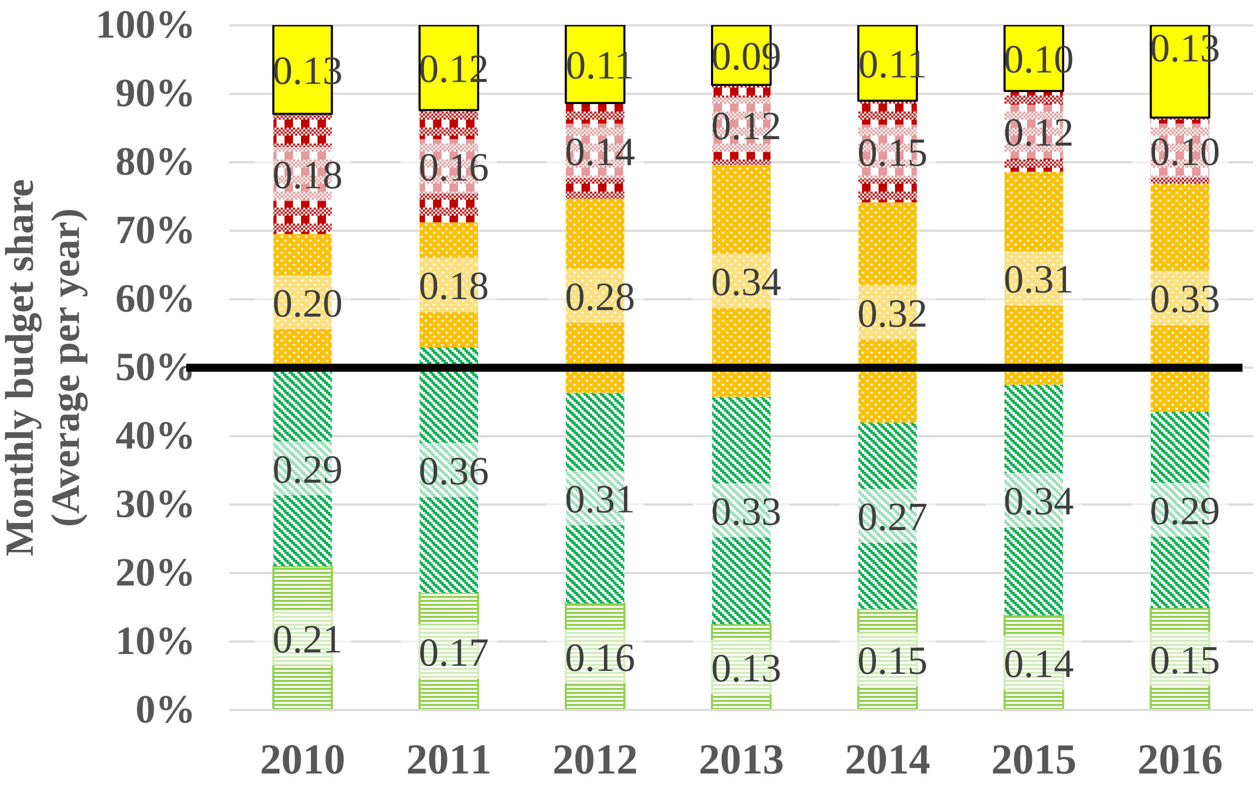

**U.S.** is the biggest supplier of **Green bell pepper**, while **Mexico** is the biggest supplier for **colored bell pepper**.

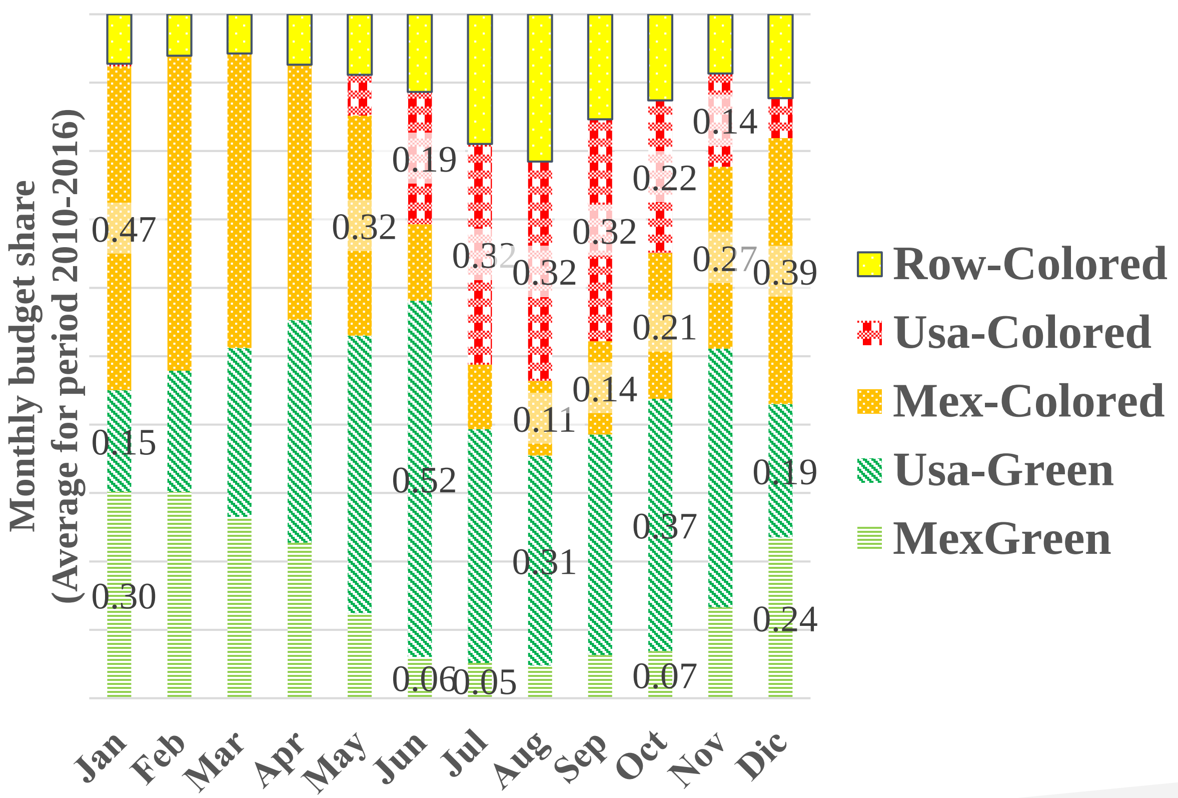



**Green bell pepper** is more consumed in U.S. than **colored bell pepper**

Source: https://marketnews.usda.gov

# Budget share for bell pepper in the United States by source and color, 2010-2016




In a yearly basis, the budget allocation for **green** and colored **bell pepper** is nearly the same

Source: https://marketnews.usda.gov

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

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

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

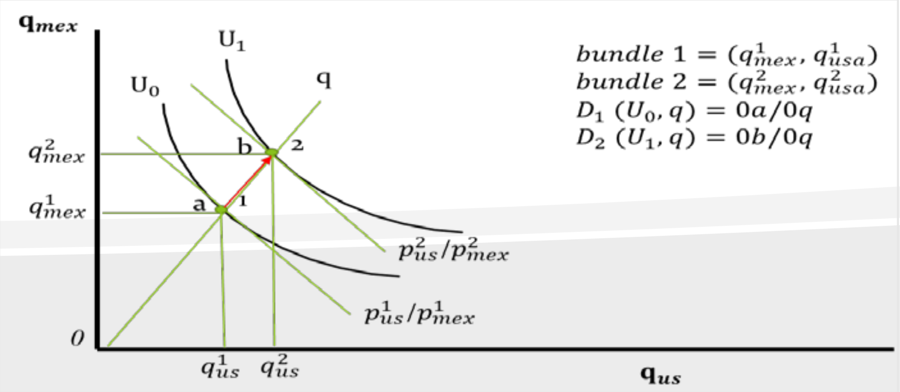
Flexibilities were calculated using the mean share 16%, 28%, 31%, 14%, 11% in the period 2010-2016 for MexG, MexC, UsaG, UsaC, RowC, respectively.

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



# 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

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

Mex=1, USA=2, ROW=3

- My approach
  - Long memory habits

$$\tilde{\mu}^*_{j_{t-1}} = \left[lnq_{j_{t-1}} + \delta_j^1 lnq_{j_{t-2}} + \delta_j^2 lnq_{j_{t-3}} + \cdots + \delta_j^m lnq_{j_{t-m-1}}\right]$$

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$$\tilde{\mu}^*_{Mex_{t-1}} = \left[lnq_{1_{t-1}} + \delta_j^1 lnq_{1_{t-2}} + \delta_j^2 lnq_{1_{t-3}} + \cdots + \delta_j^m lnq_{1_{t-m-1}}\right]$$

$$\tilde{\mu}^*_{USA_{t-1}} = \left[lnq_{2_{t-1}} + \delta_j^1 lnq_{2_{t-2}} + \delta_j^2 lnq_{t-3} + \cdots + \delta_j^m lnq_{2_{t-m-1}}\right]$$

$$\tilde{\mu}^*_{ROW_{t-1}} = \left[lnq_{3_{t-1}} + \delta_j^1 lnq_{3_{t-2}} + \delta_j^2 lnq_{3_{t-3}} + \cdots + \delta_j^m lnq_{3_{t-m-1}}\right]$$

# Comparing both Holt & Goodwin & my approach

- **H&G LR-D-NL/IAIDS**
- $w_i = \alpha_i^* + \boldsymbol{\alpha_i^{**}\tilde{\mu}_{t-1}} + \sum_j(\gamma_{ij} + \boldsymbol{\theta_{ij}\tilde{\mu}_{t-1}})Lnq_j + (\beta_i + \boldsymbol{\eta_i\tilde{\mu}_{t-1}})Ln\tilde{Q}_t^*$
  - $Ln\tilde{Q}_t^* = \alpha_0 + \sum_j(\alpha_j^* + \boldsymbol{\alpha_j^{**}\tilde{\mu}_{t-1}})Lnq_j + \frac{1}{2}\sum_i\sum_j(\gamma_{ij} + \boldsymbol{\theta_{ij}\tilde{\mu}_{t-1}})Lnq_iLnq_j$
- *They assume that: The aggregated habits and specific good habits have the same effect on the Wi*

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

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

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

# Comparing both Holt & Goodwin & my approach

- **Proposed LR-D-NL/IAIDS with Own- and cross-habit formation**
- $w_i = \alpha_i^* + \sum_j \boldsymbol{\alpha_{ij}^{**}} \boldsymbol{\tilde{\mu}_{j_{t-1}}^*} + \sum_j (\gamma_{ij} + \sum_{j_{t-1}} \boldsymbol{\theta_{ijj_{t-1}}} \boldsymbol{\tilde{\mu}_{j_{t-1}}^*}) Lnq_j + (\beta_i + \sum_j \boldsymbol{\eta_{ij}} \boldsymbol{\tilde{\mu}_{j_{t-1}}^*}) Ln\ddot{Q}_t^*$
  - $Ln\ddot{Q}_t^* = \alpha_0 + \sum_j (\alpha_j^* + \sum_j \boldsymbol{\alpha_{ij}^{**}} \boldsymbol{\tilde{\mu}_{j_{t-1}}^*}) Lnq_j + \frac{1}{2} \sum_i \sum_j (\gamma_{ij} + \sum_{j_{t-1}} \boldsymbol{\theta_{ijj_{t-1}}} \boldsymbol{\tilde{\mu}_{j_{t-1}}^*}) Lnq_i Lnq_j$
- *I assumed that the own- and cross consumption habit affect the $W_i$ in different magnitudes*

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

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

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

# Long Run Own- and Cross-price Flexibilities

- Holt & Goodwin model own- and cross-prices flexibilities are as follows:
  - $f_{ij}^{LR} = -\delta_{ij} + \left(\frac{\gamma_{ij} + \theta_{ij}\tilde{\mu}_{t-1}}{w_i}\right) + \left(\frac{\beta_i + \eta_i\tilde{\mu}_{t-1}}{w_i}\right) * \{w_j - (\beta_j + \eta_j\tilde{\mu}_{t-1})Ln\tilde{Q}_t^*\}$

- Proposed own- and cross-prices flexibilities are as follows:
  - $f_{ij}'^{LR} = -\delta_{ij} + \left(\frac{\gamma_{ij} + \sum_{j_{t-1}} \theta_{ijj_{t-1}}\tilde{\mu}^*_{j_{t-1}}}{w_i}\right) + \left(\frac{\beta_i + \sum_j \eta_{ij}\tilde{\mu}^*_{j_{t-1}}}{w_i}\right)\{w_j - (\beta_j + \eta_{ij} \sum_j \eta_{ij}\tilde{\mu}^*_{j_{t-1}})Ln\ddot{Q}_t^*\}$

# Long Run habits Flexibilities

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

- H&G model aggregated habit flexibilities are as follows:
  - $\frac{\partial f_{ij}^{LR}}{\partial \tilde{\mu}_{t-1}} = \frac{\theta_{ij}}{w_i} + \frac{\eta_i}{w_i} * \{w_j - (\beta_j + \eta_i \tilde{\mu}_{t-1}) LnQ_t^*\} + \left(\frac{\beta_i + \eta_i \tilde{\mu}_{t-1}}{w_i}\right) * \left\{\frac{\partial Ln\tilde{Q}_t^*}{\partial lnq_j} / \partial \tilde{\mu}_{t-1}\right\}$

- The proposed model own- and cross-habit flexibilities are as follows:
  - $\frac{\partial f_{ij}'^{LR}}{\partial \tilde{\mu}_{j_{t-1}}^*} = \frac{\theta_{ijj_{t-1}}}{w_i} + \frac{\eta_{ij}}{w_i} \{w_j - (\beta_j + \eta_{ij} \sum_j \eta_{ij} \tilde{\mu}_{j_{t-1}}^*) Ln\ddot{Q}_t^*\} + \left(\frac{\beta_i + \sum_j \eta_{ij} \tilde{\mu}_{j_{t-1}}^*}{w_i}\right) \left\{\frac{\partial Ln\ddot{Q}_t^*}{\partial lnq_j} / \partial \tilde{\mu}_{j_{t-1}}^*\right\}$

# 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***** | **-0.759***** | **-0.691***** | -0.135*** | -0.141*** | -0.161*** | -0.109 | -0.194 | -0.381*** |
| | **(0.024)** | **(0.061)** | **(0.034)** | (0.016) | (0.016) | (0.023) | (0.078) | (0.251) | (0.144) |
| U.S. Price | -0.175*** | -0.194*** | -0.235*** | **-0.808***** | **-0.789***** | **-0.767***** | -0.453*** | -0.489*** | -0.438** |
| | (0.026) | (0.045) | (0.034) | **(0.019)** | **(0.040)** | **(0.016)** | (0.075) | (0.087) | (0.181) |
| ROW Price | -0.016 | -0.038 | -0.080** | -0.063*** | -0.071*** | -0.064** | **-0.500***** | **-0.340**** | **-0.189** |
| | (0.012) | (0.042) | (0.031) | (0.008) | (0.008) | (0.027) | **(0.044)** | **(0.167)** | **(0.268)** |
| Scale (fi) | -0.977*** | -0.991*** | -1.006*** | -1.006*** | -1.002*** | -0.993*** | -1.063*** | -1.024*** | -1.009*** |
| | (0.046) | (0.047) | (0.019) | (0.032) | (0.047) | (0.012) | (0.114) | (0.174) | (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%Δ↑_Qmex | | 1%Δ↑ QUSA | | 1%Δ↑_QROW | |
|---|---|---|---|---|---|---|
| | *Long Run.* | *Agg-habit* | *Long Run* | *Agg-habit* | *Long Run* | *Agg-habit* |
| | *LR-D-Agg-$Q_{t-1}$* | $\Delta f_{ij}/\Delta U_{t-M}$ | *LR-D-Agg-$Q_{t-1}$* | $\Delta f_{ij}/\Delta U_{t-M}$ | *LR-D-Agg-$Q_{t-1}$* | $\Delta f_{ij}/\Delta U_{t-M}$ |
| **%Δ Mex Price** | **-0.759*** ** | **0.008*** ** | -0.141*** | -0.000 | -0.194 | -0.035*** |
| | **(0.061)** | **(0.003)** | (0.016) | (0.001) | (0.251) | (0.009) |
| **%Δ U.S. Price** | -0.194*** | -0.005 | **-0.789*** ** | **0.005** | -0.489*** | -0.012 |
| | (0.045) | (0.005) | **(0.040)** | **(0.004)** | (0.087) | (0.009) |
| **%Δ ROW Price** | -0.038 | -0.005*** | -0.071*** | 0.000 | **-0.340** ** | **0.023*** ** |
| | (0.042) | (0.001) | (0.008) | (0.000) | **(0.167)** | **(0.006)** |

# Own- and Cross-habit Flexibilities

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

| | 1%Δ↑ QMEX | Habit effects | | 1%Δ↑ QUSA | Habit effects | | 1%Δ↑ QROW | Habit effects | |
|---|---|---|---|---|---|---|---|---|---|
| | $f_{ij}^{\prime LR}$ | Agg-habit $\partial f_{ij}/\partial\tilde{\mu}_{t-M}$ | Spec-habit $\partial f_{ij}/\partial\tilde{\mu}_{jt-M}$ | $f_{ij}^{\prime LR}$ | Agg-habit $\partial f_{ij}/\partial\tilde{\mu}_{t-M}$ | Spec-habit $\partial f_{ij}/\partial\tilde{\mu}_{jt-M}$ | $f_{ij}^{\prime LR}$ | 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)**<br>**$h_{112}$= -0.045** (0.018)**<br>**$h_{113}$= -0.010 (0.012)** | *-0.161**** (0.023) | 0.001 (0.017) | $h_{211}$ -0.040*** (0.008)<br>$h_{212}$ 0.010 (0.012)<br>$h_{213}$ 0.026** (0.010) | *-0.381**** (0.144) | -0.043*** (0.077) | $h_{311}$ -0.192*** (0.036)<br>$h_{312}$ 0.142** (0.067)<br>$h_{313}$ -0.126*** (0.030) |
| %ΔP-US | -0.235*** (0.034) | -0.003 (0.029) | $h_{121}$= -0.067*** (0.015)<br>$h_{122}$= 0.030 (0.021)<br>$h_{123}$= 0.037** (0.015) | **-0.767*** (0.016)** | **0.003 (0.024)** | **$h_{221}$ 0.001 (0.012)**<br>**$h_{222}$ -0.005 (0.016)**<br>**$h_{223}$ 0.007 (0.012)** | -0.438** (0.181) | -0.010 (0.065) | $h_{321}$ 0.308*** (0.040)<br>$h_{322}$ -0.110* (0.057)<br>$h_{323}$ -0.229*** (0.058) |
| %ΔP-ROW | -0.080** (0.031) | -0.176** (0.016) | $h_{131}$ -0.040*** (0.013)<br>$h_{132}$ 0.032** (0.013)<br>$h_{133}$ -0.035*** (0.010) | -0.064** (0.027) | -0.031 (0.009) | $h_{231}$ 0.037*** (0.007)<br>$h_{232}$ -0.013 (0.008)<br>$h_{233}$ -0.035*** (0.009) | **-0.189 (0.268)** | **0.277*** (0.087)** | **$h_{331}$ -0.062 (0.049)**<br>**$h_{332}$ -0.064 (0.082)**<br>**$h_{333}$ 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