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# Evolving U.S. Fruit Markets and Seasonal Grower Price Patterns

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## Abstract

This paper analyzes seasonal patterns in grower prices for five major U.S. fresh fruit markets between 1980 and 2012. Seasonality (the regular pattern of price change occurring within a year) has been recognized as an important determinant of price in fresh produce. Major adjustments in fruit markets over the past 30 years include changes in production, storage, import patterns, and demand. Unique commodity and market conditions for each of these five fruit products, arising from a combination of these adjustments, have been hypothesized to affect seasonal price patterns. Several changes in seasonal price patterns are observed after grouping monthly price data into four periods (1980-89, 1990-99, 2000-09, and 2010-12). A distinct seasonal pattern is observed in fresh strawberry prices even as expanded geographical and varietal diversity has smoothed seasonal price effects. Seasonality also continues to be noticeable in fresh grape and peach prices even as imports have increased in volume and number of supplying regions. The range of monthly prices has increased for less storable produce (e.g., strawberries and peaches) relative to produce that can be stored for longer periods (e.g., apples and oranges). In several cases, the timing of high and low prices within the year has shifted.

Keywords: U.S. fresh fruit, seasonality, grower prices, production, storage, imports, demand, apples, oranges, strawberries, grapes, peaches

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Approved by USDA's  
World Agricultural  
Outlook Board

## Introduction

There have been major changes in U.S. fresh fruit markets over the past 30 years. Strong growth in domestic and export demand for U.S. fresh fruit has encouraged significant expansion in domestic production and imports. The average fresh-market<sup>1</sup> fruit volume produced in the United States grew 25 percent between 1980-89 and 2010-12 (to 23.2 billion pounds) at the same time that the import share of U.S. fresh fruit use (excluding bananas<sup>2</sup>) quadrupled to 33 percent (USDA-ERS, 2013). As fresh fruit supplies and the choices of fruit and varieties available to consumers expanded, so did the potential for changes in the seasonal price patterns faced by U.S. growers.

The U.S. produce sector is comprised of a wide array of individual commodity markets with different supply conditions, marketing needs, demand trends, and global linkages. Seasonality is the regular pattern of price change occurring within a year; it is the result of uneven demand, supply, or movement to market when either production or use (or both) is concentrated during particular months (Tomek and Robinson, 2003). For example, crops harvested throughout the year often exhibit less seasonality in their prices than crops harvested only once a year. Demand surges for particular foods, often associated with a holiday, typically exacerbate seasonality in those markets. Storage or imports can enable a more even distribution of supplies during the year, smoothing seasonal price effects. Shifts in grower price patterns for a specific market could reflect adjustments in domestic production, storage, import patterns, or demand.<sup>3</sup> Knowledge of seasonal price behavior—the typical timing and levels of seasonal highs and lows within a year and their reliability—is important in understanding these commodity markets. Keeping informed of changes in seasonal price behavior may serve as a tool in forming accurate analysis and market projections, effective marketing strategies, and sound policy decisions.

This paper examines changes in seasonal grower price patterns in five major U.S. fresh fruit markets between 1980 and 2012. Fresh strawberries, apples, oranges, peaches, and grapes are the commodities selected for analysis based on the ranking of U.S. fresh-market value of production and the availability of monthly price data. Monthly grower price data reported by the U.S. Department of Agriculture's (USDA) National Agricultural Statistics Service (NASS) are used to address three fundamental economic questions:

- What are the factors that may have influenced seasonal patterns of grower prices, and is there evidence of differences among these fresh fruit markets?
- Have there been adjustments in the timing of high and low grower prices throughout the year?
- Have there been shifts in the magnitude of seasonal changes in grower prices?

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<sup>1</sup>Fresh market refers to the portion of production directed for fresh use, with the remaining balance used for processing.

<sup>2</sup>Imports account for virtually all U.S. banana supplies, with annual volumes almost half of total fresh fruit imports in the United States.

<sup>3</sup>Consumer prices are not explicit in this analysis, but relatively short fresh-fruit supply chains suggest that grower prices may be more closely correlated with consumer prices in these markets than they would be for more processed food products.

## Transitions In U.S. Fresh Fruit Markets

There have been many changes in fresh fruit markets over the past 30 years that may have influenced shifts in seasonal price patterns, including adjustments in imports, production, storage, and demand. Unique commodity and market conditions lead impacts from each of these factors to vary over time and between markets. Fruit that can be supplied evenly throughout the year, either through domestic production or imports, is less likely to demonstrate strong seasonality. Demand, either domestic or export, that is more evenly distributed over time can also smooth seasonal price patterns.

### *Domestic Production*

Domestic production practices for many crops have changed to distribute supplies more evenly throughout the year, including increased production volume (strawberries, grapes), greater intensity of production (apples, oranges), extended domestic growing areas (strawberries), and adoption of new varieties (strawberries, apples). These changes were targeted, at least in part, to take advantage of higher prices and/or extend seasons.

Fresh domestic strawberry supplies have expanded over the last three decades. Annual production exceeded 2.0 billion pounds in every year since 2003, more than double the average production levels from the 1980s (fig. 1). Strawberries are grown throughout the United States, but commercial acreage and production is concentrated in California (almost 90 percent of the total U.S. crop between 2003 and 2012). Production in Florida accounts for an additional 8 percent, which is supplied during the winter months.<sup>4</sup> Growers in both Florida and California extended their production seasons during the 1990s and 2000s through a mix of new varieties and expanded planting regions. Prior to 1990, strawberry varieties in commercial production were primarily developed by the University of California to ripen in March and April under West Coast conditions (Chandler, 2003). In 1992, the Sweet Charlie variety was developed specifically for Florida's growing conditions, producing higher yields during winter months and enabling Florida to build a market presence during the seasonal high-price period.

California strawberry producers also invested in new varieties and expanded production across the State to extend the growing season. Diverse growing regions enable 12-month production in California, even as the majority of the State's volume is harvested between February and October. Increased acreage planted in California's Salinas-Watsonville growing district in the north expanded spring and summer production. Varieties better adapted to cold weather were also introduced to California's southern growing districts, allowing harvest several weeks earlier and increasing volume during January and February. In 1994, a second planting and harvest season was implemented in the southern growing districts, adding supply in September through early November (Han et al., 1999).

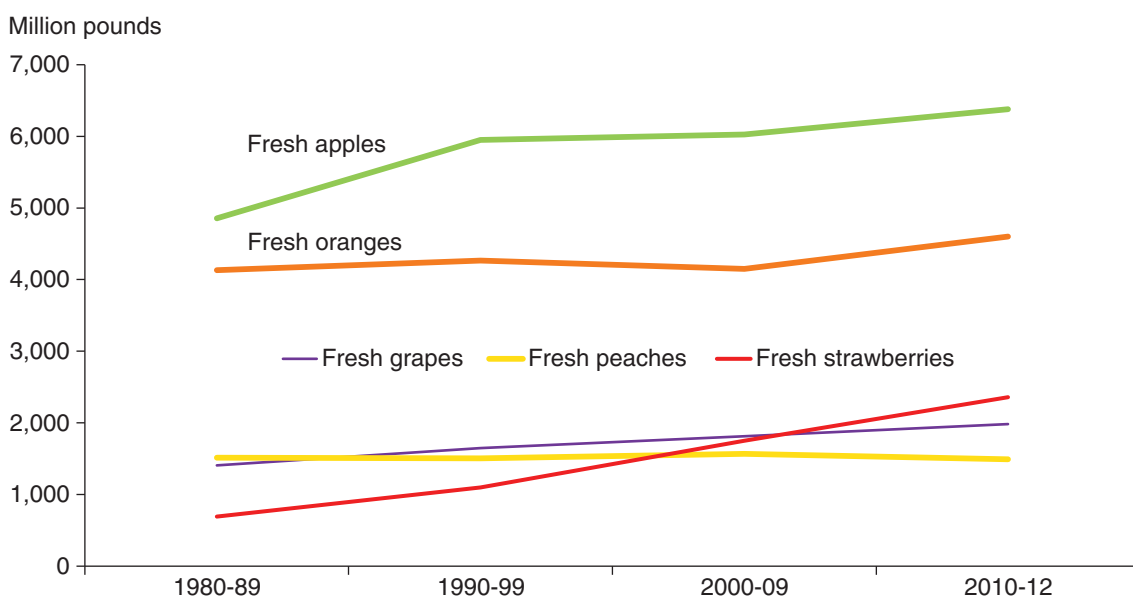
Over the same period, the U.S. apple industry increased the volume and intensity of production and diversified both its varietal profile and products (e.g., introduction of fresh sliced apples). Despite some annual fluctuations, fresh-market production increased from 4.9 billion pounds in 1980-81 to a

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<sup>4</sup>Many smaller U.S. production areas (e.g., North Carolina, Oregon, and Michigan) harvest in late spring and early summer. While these additional production areas are not large contributors to the total domestic supply, they can displace some sales from California during May and June (Woods et al., 2006).

Figure 1

**Averaged utilized production of selected fresh fruit, 1980-2012**



Note: Utilized production is the amount of the crop sold plus the quantities used at home or held in storage.  
 Source: USDA, Economic Research Service, *Fruit and Tree Nuts Yearbook Tables*, 2013.

record 6.6 billion pounds in 2004-05.<sup>5</sup> Production has since remained at or above 6.0 billion pounds each year as growers moved to highly intensive production systems. Planted acreage decreased over time, but trees per acre increased with the use of smaller trees for easier harvest. On average across all varieties, plantings in Washington State increased from slightly less than 200 trees per acre in 1986 to approximately 262 trees per acre in 1993, 434 trees per acre in 2006, and 562 trees per acre in 2011 (USDA-NASS, Washington Field Office, 2006 and 2011).<sup>6</sup>

U.S. apple growers began planting new varieties in the 1980s and made significant shifts in the varietal mix by the mid-1990s.<sup>7</sup> Red Delicious, a traditional apple variety, is still the most widely produced apple (i.e., greatest annual volume) in the United States, but its share of total production has declined dramatically. Gala apples have superseded Golden Delicious as the second most widely produced apple variety in the country, and Fuji now ranks fourth. Domestic production of Fuji and Gala was initially intended to enhance export opportunities, especially in East Asia where these two varieties are popular. More recently, a combination of varietal diversification and new strategy

<sup>5</sup>Marketing years for each fruit commodity are different: strawberries and peaches follow a calendar year (January-December), apples are marketed August-July, grapes are marketed May-April, and oranges are marketed November-October.

<sup>6</sup>Apples are grown widely throughout the United States, but Washington State is the leading domestic source of fresh apples (approximately 70 percent of the national crop).

<sup>7</sup>For example, in 2011, 26 percent of Washington State’s apple acreage was Red Delicious, but this acreage accounted for only 15 percent of the trees (USDA-NASS, Washington Field Office, 2011). Over 50 percent of the Red Delicious acreage was planted prior to 1991, with only 4 percent planted in 2006 or later. In the same year, 20 percent of Washington’s apple acreage and 22.5 percent of the trees were planted to Gala. Over 25 percent of the Gala acreage was planted between 1996 and 2000, and 16 percent was planted after 2005. Likewise, 16.5 percent of the acreage and 23 percent of the trees were planted to Fuji, with 27 percent of the plantings between 1991 and 1995 and an additional 29 percent in 2006 or later.

in supply management was introduced in the form of club varieties (which are patent protected). Producers with exclusive license to grow a specific apple variety (e.g., Ambrosia, Jazz™, Pacific Rose™) control the quality, quantity, and uniqueness of the variety to capture premium prices (Brown and Maloney, 2013; Carew et al., 2012).

Except for occasional weather-induced crop losses, U.S. fresh orange supplies have remained relatively stable since 1980 even as acreage declined and production area became more concentrated. Overall, domestic orange acreage fell by 21 percent between 2002 and 2007 (USDA-NASS, 2007). Across all States, the conversion of some orange acreage to specialty citrus varieties, competition for available land from urban development and large-scale water projects, and disease outbreaks have all put pressure on U.S. acreage planted to oranges (U.S. ITC, 2006; Johnston and McCalla, 2004).<sup>8</sup> At the same time, orchard concentration has increased to incorporate high-density, high-yield plantings, improved orchard management, and greater irrigation efficiency. Thus, production has declined at a slower rate than planted acreage (U.S. ITC, 2006).<sup>9</sup>

U.S. production of oranges is limited to California and Florida, with small additional amounts in Arizona and Texas, due to freeze intolerance. California is the main producer of fresh oranges with 85 to 90 percent of U.S. navel orange production (USDA-NASS, Citrus Fruits, 1979-2013). Historically, the California orange industry was concentrated in Southern California, with 80 percent of production in the region in 1950 (Johnston and McCalla, 2004). Prior to 1980, fresh orange production moved northward to the eastern San Joaquin Valley, where acreage rose by 85,000 acres between 1950 and 1975. In 2000, 82 percent of California's harvested acreage was located in the San Joaquin Valley and, by 2012, the San Joaquin Valley's Tulare County accounted for 51 percent of total State bearing acreage (Johnston and McCalla, 2004; California Department of Food and Agriculture, 2012). In contrast, Orange County, located in Southern California, had over 60,000 acres of oranges in 1950, but only 115 acres remained by 2000.

Though fresh grapes are grown throughout the United States, 99 percent of commercial volume is produced in California.<sup>10</sup> Domestic fresh grape production has increased from 1.4 billion pounds during the 1980s to an average of almost 2.0 billion pounds between 2010 and 2012. Like strawberries, grapes are produced in California in multiple growing regions. Harvest begins in May in the desert areas, which supply the early-season market through mid-July. Harvesting from California's main production region (the San Joaquin Valley) begins in July and lasts through mid-December. Supplies from other States generally enter the market between August and October. National supply volume is noticeably heaviest from July through November, slowing down in December as the domestic harvest ends.

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<sup>8</sup>For example, in contrast to declining orange consumption, tangerine per capita use reached a record 3.97 pounds per person in 2010-11 as production more than doubled since 1980. An example of pressure on available acreage is the development of the Delta-Mendota Canal in the Central Valley of California. Developing production risks from disease outbreaks have been highly visible (Kuchment, 2013). Citrus greening (Huanglongbing, HLB) is a devastating bacterial disease spread by the Asian citrus psyllid with no cure identified. While all commercial citrus acreage in Florida was reported to be infected in 2013, only the psyllid (not the disease) had been reported in California as of July 2013.

<sup>9</sup>Fresh orange utilized production was at 4,033 million pounds in the 1980-81 marketing year (November – October), peaked at 5,366 million pounds in 1997-98, and then declined to 4,635 million pounds in 2011-12.

<sup>10</sup>Table grapes make up about 80 percent of California's fresh crop, with the remainder sold for wine and raisin production. Washington, New York, Pennsylvania, and Michigan are relatively important grape-producing States that primarily serve the juice- and wine-processing markets.

Domestic peach production for the fresh market has remained consistent at about 1.1 million pounds since 1980, and there has been little change in the timing of harvest. Production is concentrated in California, with approximately 75 percent of the national peach crop each year. The harvest of California’s fresh-market peaches begins as early as mid-April, but volumes are quite limited until mid-May and are often too low to establish a price. South Carolina, Georgia, and New Jersey follow with a combined production share of about 15 percent, supplying primarily the fresh fruit market. Unlike for some other fruit commodities, these three States have been able to establish a location identity for fresh peaches, with consumers displaying a strong sense of regional recognition (Raper et al., 2009). Since 1980, over 70 percent of annual domestic shipments have occurred between June and August. Shipment volume drops rapidly in September and continues to average 5 percent or less of the annual total through October and November.

### *Storage*

While storage periods have likely been extended since 1980 for all fruits through the use of more advanced atmospheric control systems in storage and transport facilities and varietal innovations, notable differences remain (table 1). Perishability varies significantly among fresh fruit commodities, and those with relatively shorter shelf lives tend to demonstrate stronger seasonal price patterns (e.g., strawberries). Among the five fruit commodities in this report, post-harvest cold storage shelf-life varies from 5-10 days for strawberries to 2-7 months for apples (USDA-AMS, 2004). Advancements in storage technology have impacted the year-round supply distribution for apples and oranges the most.

U.S. apples are harvested between August and November, but the ability to store apples for a long period allows an evenly sustained release of supplies to market (which mitigates seasonal price variability). Packing and shipping commences as soon as harvest begins; as harvest volumes increase, fruit is typically placed in storage and the fruit is continually brought to market (Schotzko and Granatstein, 2004). The average volume of apples in storage has increased in each decade since the 1980s even as the seasonal pattern of storage volume, driven by production seasons and shelf life, has remained consistent (fig. 2). Although varietal differences exist, the aggregate post-harvest storage life of apples is estimated to be 2-7 months, and minimal fruit is carried forward into the next marketing year. The combination of new varieties with later harvest dates and the increased use of more sophisticated storage technology have enabled the industry to move apples later in the marketing season.

Table 1

**Approximate post-harvest cold storage for selected fresh fruit commodities**

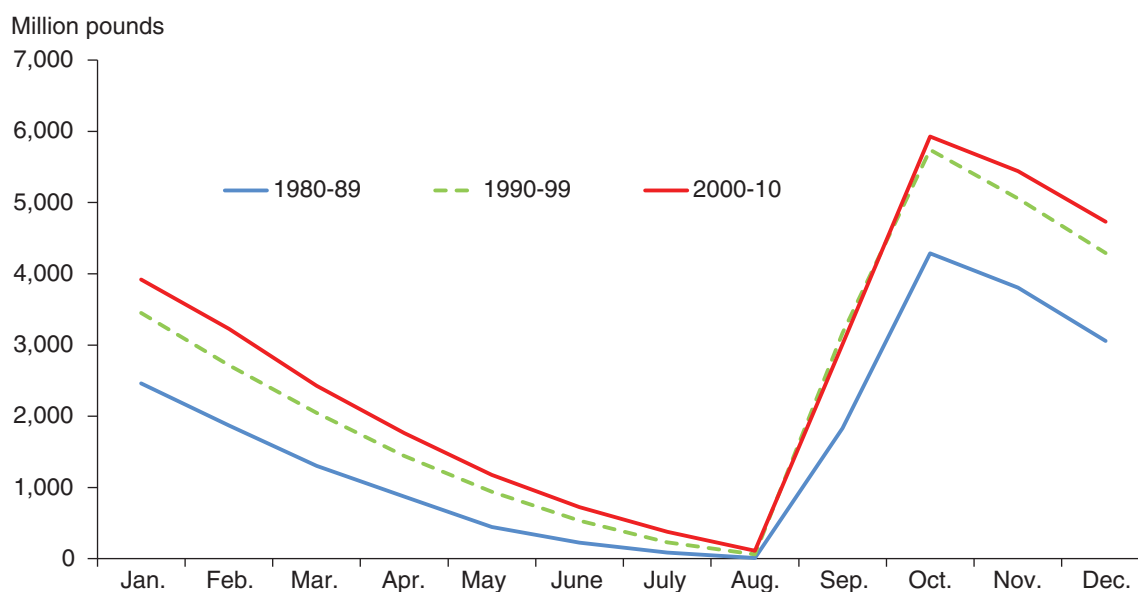
Fruit	Time period
Strawberry	5-10 days
Peach	2-4 weeks
Orange	2-6 weeks
Grape (American)	3-8 weeks
Apple	2-7 months

Notes: Oranges have on-tree storage potential of several months; storage time cited is specific to California oranges. American grapes are table grapes which have shorter storage time than wine grapes.

Source: USDA Agricultural Marketing Service, *Agricultural Export Transportation Handbook 700*, 2004.



Figure 2  
**U.S. average apple volume in storage, 1980-2010**



Note: Estimates discontinued in 2011.

Source: USDA, National Agricultural Statistics Service, *Cold Storage Annual*, 1980-2010.

Advances in cold storage and transport have increased post-harvest shelf life for fresh oranges, but the fruit can generally withstand only 6-12 weeks of cold storage before degrading (Ladaniya, 2008). Approximate post-harvest storage for oranges primarily targeted to the fresh market is even shorter at 2-6 weeks. Among the commodities in this report, on-tree storage is unique to oranges. The fruit can be left on tree up to several months, ripening slowly, and will not soften or abscise because it is non-climacteric.<sup>11</sup> At times, either growers themselves or prorated delivery schedules within citrus cooperatives will use on-tree storage to manage the harvest and flow of the product to the market (Jacobs, 1994).

### *Import Patterns*

Imports, which have increased in volume and changed supply regions over time, have helped bolster the year-round availability of fresh fruit in the United States. U.S. imports of all fresh fruit commodities (excluding bananas) increased from 7.6 percent of domestic use in the 1980s to over 33 percent of domestic use between 2010 and 2012 (USDA-ERS, 2013). Imports are counter-seasonal for many fresh produce commodities, often filling gaps in domestic supply and reducing price fluctuations during periods when domestic supplies are not available (Huang, 2013). Since 1980, import penetration has increased notably in grapes and strawberries; however, the average share of imports remains below 10 percent for strawberries, apples, and peaches after 2010 (table 2). Although the

<sup>11</sup>Fruits, vegetables, and nuts are classified as climacteric or non-climacteric. Climacteric fruits will ripen after harvest (i.e., apples) due to the expiration of ethylene gas, while non-climacteric fruits respire little or no ethylene gas. Thus, non-climacteric fruits mature slowly and only while attached to the plant; the fruit does not ripen after harvest.

Table 2

**Average monthly and annual share of domestic and import shipment volumes in the United States**

Period	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average annual share of total volume
<i>Percent of annual volume</i>													<i>Percent</i>
<b>Fresh strawberries</b>													
Domestic													
1980-89	1.7	3.6	11.8	24.7	24.5	13.2	7.8	5.5	3.7	1.8	0.7	0.9	96.8
1990-99	2.5	4.1	10.2	19.2	19.2	13.6	11.0	7.5	5.8	4.1	1.5	1.4	95.4
2000-09	3.7	5.1	11.0	15.3	16.9	14.0	11.1	8.2	5.9	4.6	2.2	1.9	93.4
2010-12	3.1	5.5	10.2	13.0	15.0	14.0	11.9	9.4	7.7	5.3	2.5	2.4	90.8
Imports from Mexico <sup>1</sup>													
1980-89	9.6	10.0	13.4	21.7	15.4	9.6	2.8	2.3	1.0	1.2	5.3	7.4	3.2
1990-99	7.5	10.4	22.2	24.1	16.3	10.9	2.8	0.0	0.0	0.2	1.8	3.8	4.6
2000-09	13.2	14.4	21.8	19.9	9.4	6.7	3.2	0.1	0.1	1.1	3.8	6.3	6.6
2010-12	18.1	20.0	21.4	17.0	3.9	0.1	0.0	0.0	0.0	2.4	6.6	10.4	9.2
<b>Fresh apples</b>													
Domestic													
1980-89	10.0	9.4	10.0	9.2	7.4	4.6	3.8	4.1	7.2	11.5	10.9	11.8	93.1
1990-99	9.4	9.1	9.8	8.5	8.0	5.8	5.3	5.5	7.4	10.5	10.3	10.4	93.4
2000-09	9.6	9.1	10.6	8.6	7.8	5.7	4.6	5.4	8.0	10.2	10.1	10.2	92.8
2010-12	10.7	9.1	9.7	8.5	7.6	5.6	4.7	4.3	7.8	11.2	9.8	11.0	93.2
Imports													
1980-89	5.0	5.1	9.5	14.3	18.5	15.2	9.4	2.9	2.6	4.9	6.8	5.6	6.9
1990-99	3.4	3.6	8.4	14.6	19.7	14.1	8.5	5.1	4.4	8.7	5.7	3.7	6.6
2000-09	2.6	2.5	7.8	12.6	18.9	19.4	18.3	7.3	1.9	2.8	3.4	2.6	7.2
2010-12	1.2	1.1	4.2	9.3	14.3	22.9	27.1	13.0	1.6	1.9	1.8	1.5	6.8
<b>Fresh oranges<sup>2</sup></b>													
Domestic													
1980-89	9.9	9.7	11.7	12.0	10.8	6.3	4.8	4.2	4.2	4.9	8.5	12.8	99.1
1990-99	10.1	10.2	11.8	11.4	10.8	6.5	3.4	2.9	3.5	5.9	9.2	14.4	97.0
2000-09	12.1	10.0	10.8	10.0	8.4	5.6	1.7	1.5	2.0	7.6	12.9	17.5	83.2
2010-12	12.1	10.6	12.2	10.8	8.2	6.0	2.0	1.5	2.1	6.2	12.6	15.5	78.8
Imports													
1980-89	13.8	16.6	12.7	10.8	7.0	6.2	3.1	2.6	1.5	5.5	7.2	12.8	0.9
1990-99	6.4	9.5	11.6	15.0	10.3	5.7	12.5	18.6	3.7	1.4	1.2	3.9	3.0
2000-09	3.1	3.5	6.9	5.7	3.9	4.0	20.4	24.5	15.9	9.4	0.7	2.0	16.8
2010-12	2.8	2.3	2.4	1.8	2.5	3.2	17.1	32.0	18.7	14.3	1.6	1.3	21.2

Continued—



Table 2

**Average monthly and annual share of domestic and import shipment volumes in the United States—continued**

Period	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average annual share of total volume
<i>Percent of annual volume</i>													<i>Percent</i>
<b>Fresh peaches</b>													
Domestic													
1980-89	---	---	---	0.1	9.6	24.2	27.8	25.3	12.1	0.8	0.0	---	93.1
1990-99	---	---	---	0.4	11.5	23.2	26.6	25.2	11.3	1.6	0.1	---	87.9
2000-09	---	---	---	0.2	9.8	22.0	25.6	25.6	13.8	2.8	0.1	---	90.5
2010-12	---	---	---	---	8.0	22.1	26.8	24.1	13.7	5.2	0.0	---	92.6
Imports													
1980-89	22.7	31.9	23.1	8.1	2.1	0.2	0.0	0.4	0.5	0.1	0.2	10.6	6.9
1990-99	35.8	32.2	15.1	0.4	0.0	0.0	0.0	0.7	0.7	0.0	1.2	13.8	12.1
2000-09	31.6	24.3	20.8	2.0	0.9	0.9	0.8	1.3	1.5	0.7	2.4	12.7	9.5
2010-12	30.9	35.5	18.2	3.1	1.8	0.0	0.1	0.9	0.6	0.0	0.1	8.8	7.4
<b>Fresh grapes</b>													
Domestic													
1980-89	2.4	0.7	0.3	0.1	2.9	10.2	14.3	20.4	18.0	13.3	10.4	6.9	75.0
1990-99	0.7	0.1	0.0	0.0	3.5	9.1	13.6	20.6	18.6	15.5	12.6	5.6	64.2
2000-09	0.6	0.1	0.0	0.2	2.8	6.1	13.6	21.0	19.4	17.0	13.0	6.1	55.0
2010-12	0.6	0.1	0.0	0.0	1.6	4.2	9.4	19.6	21.2	19.8	15.8	7.8	35.6
Imports													
1980-89	5.9	15.7	22.3	26.0	13.6	9.7	1.9	0.0	2.0	0.8	0.1	2.0	25.0
1990-99	15.9	22.4	23.8	13.5	7.1	9.0	0.9	0.1	0.4	0.3	0.2	6.3	35.8
2000-09	15.4	19.1	21.9	14.8	8.0	12.6	0.9	0.0	0.4	0.9	0.8	5.2	45.0
2010-12	16.9	17.6	25.5	17.5	6.3	6.6	0.6	0.1	0.3	1.4	2.0	5.4	64.4

-- Zero shipments reported.

<sup>1</sup>Comprise virtually all U.S. strawberry import volume.

<sup>2</sup>Beginning in 1994, California Citrus Mutual stopped reporting fresh orange shipment volumes to Agricultural Marketing Services Market News, resulting in the decline in reported domestic shipment volumes despite relatively stable fresh production.

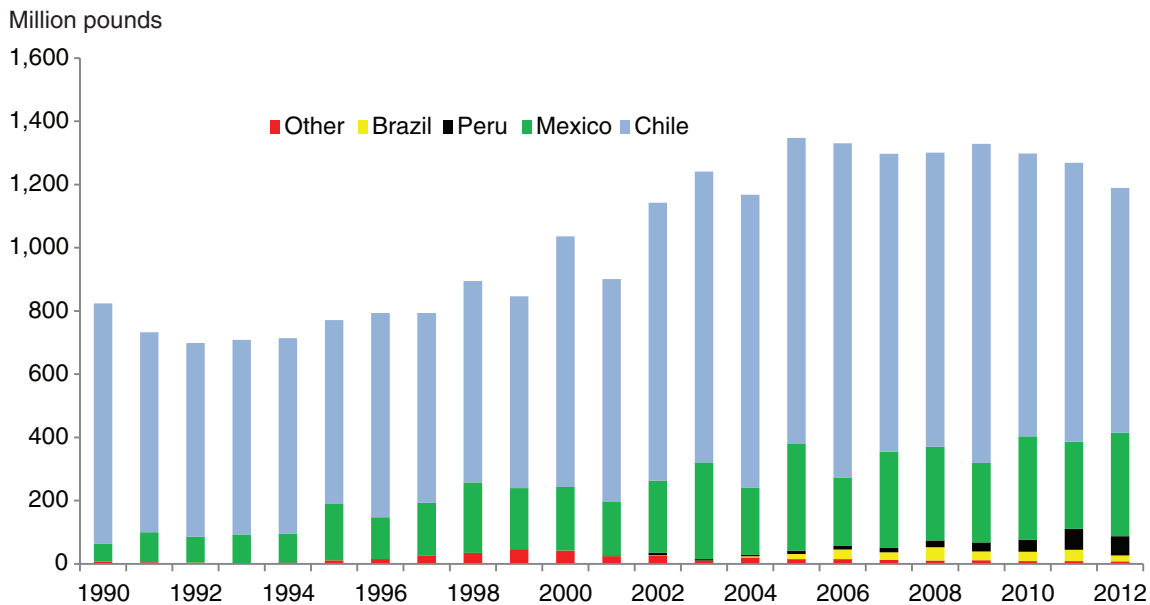
Source: USDA, Agricultural Marketing Service, *Fresh Fruit and Vegetable Shipments, by Commodities, States and Months, 1980-2012*.

import share remains low for fresh apples and oranges,<sup>12</sup> a change in supply regions has shifted the timing of their entry into U.S. markets.

The market share of fresh grape imports to the United States has grown notably, from less than 10 percent of domestic use in the 1970s to over 40 percent since the 2000s (USDA-ERS, 2013). Imports primarily supplement domestic supplies during the off-season, with over 70 percent of total U.S. fresh grape import volume occurring counter-seasonally from January through April.<sup>13</sup> The majority (75 percent) of fresh grape imports come from Chile (fig. 3), where exports to the United States rose from over 600 million pounds per year in the 1990s to over 900 million pounds since 2000. Since the implementation of the North American Free Trade Agreement (NAFTA) in the mid-1990s, Mexico has also increased fresh grape exports to the United States, with supplies entering during the early months of the domestic marketing season (May-June). In years when Chile has a big crop or late harvest, supplies overlap with imports from Mexico. Although imports during May and June may be reduced relative to the off-season, higher-than-normal supplies during peak domestic production periods (June-August) can reduce grower prices.

While imports are important to the U.S. market for fresh grapes, they remain a small (but growing) part of fresh strawberry use in the United States, with import volume concentrated in the winter and early spring. Approximately 32 million pounds of strawberries were imported in 1990, rising to

Figure 3  
**U.S. fresh grape imports, 1990-2012**



Source: USDA, Economic Research Service calculations using data from U.S. Department of Commerce, Census Bureau, 2014.

<sup>12</sup>Import shares for oranges are overestimated in table 2 due to domestic shipments being underestimated since 1994—a California grower association stopped reporting shipment volumes to AMS, reducing total reported domestic shipment volumes.

<sup>13</sup>In general, fresh grape imports enter the United States tariff free from the end of the marketing year (in April) through June.

just over 350 million pounds in 2012; however, this is still only 14 percent of all fresh strawberries available for domestic use in the United States (USDA-ERS, 2013). Mexico has been the primary source of fresh strawberries since 1989 and has supplied virtually all U.S. imports since 2000. Fresh strawberries from Mexico typically enter the United States between December and June, with peak volume in March and April. Since 2010, these imports have been somewhat less seasonally concentrated as shipments became stronger from October to April (compared with the previous three decades). At the same time, import shipments were down in the peak domestic summer months (May and June).

Similarly, imports play a minor (but still growing) role in total domestic apple consumption. Less than 10 percent of the U.S. fresh apple supply was imported between 2010 and 2012, but import volumes increased from over 100 million pounds in the early 1980s to a record 473 million pounds in 2003-04, with succeeding-year volumes in the range of 300 million to 400 million pounds (U.S. Census Bureau, 2014). There has also been a shift in the supply source even as imports remain largely counter-seasonal to domestic production. In the 1990s, Canada and New Zealand were the primary suppliers of U.S. imports, while the Chilean share was only about 20 percent. During this period, Chilean apple imports entered the United States mostly in April and May. Chile's fruit industry matured in the 1990s, however, with production and varieties heavily oriented towards meeting the growing demand for off-season fruit in the Northern Hemisphere. Chile currently supplies approximately 60 percent of imported fresh apples to the United States, and New Zealand, Canada, and Argentina provide most of the remaining 40 percent. As the Chilean varietal mix shifted, June and July import volumes increased (World Apple Review, 2004) and the peak period for all U.S. fresh apple imports moved to later in the season (May to July).

While still accounting for less than 5 percent of total utilized domestic production, fresh orange imports increased from 26 million pounds in 1989-90 to a record 263 million pounds in 2011-12 and, like apples, the source of supply shifted (USDA-ERS, 2013). Increased use of controlled atmospheric storage, advancements in post-harvest treatment, and improved transportation technology supported the increase in fresh orange imports (U.S. ITC, 2006). In the 1980s, import volumes were heaviest from December through April, and Mexico, the Dominican Republic, and other small producers located near the United States were the primary suppliers. By the 1990s, domestic firms entered into multiple agreements with international suppliers to maintain year-round orange supplies. South Africa, Australia, and Chile became major suppliers and import volumes moved later into the domestic off-season to capture higher prices. In the 1990s, imports peaked in August; by the 2000s, the majority of import volume entered from July through September.

Of the five fruit commodities covered, import patterns have exhibited the least change in peaches. Import share remains low, at less than 9 percent of total supply (on average) since 1980 (table 2), although volume has increased from an average 50 million pounds in the 1980s to over 120 million pounds during the 2000s (USDA-ERS, 2013). Over 95 percent of fresh peach imports come from Chile, where production is counter-seasonal to the United States. Though imports and domestic supply overlap at the beginning and end of the U.S. production season, volume in these periods remains thin relative to demand. Only limited amounts of imported fresh peaches are available through the summer months.<sup>14</sup> Since the mid-1990s, there have also been slight increases in peach imports from Canada, Mexico, and a few other Central and South American countries.

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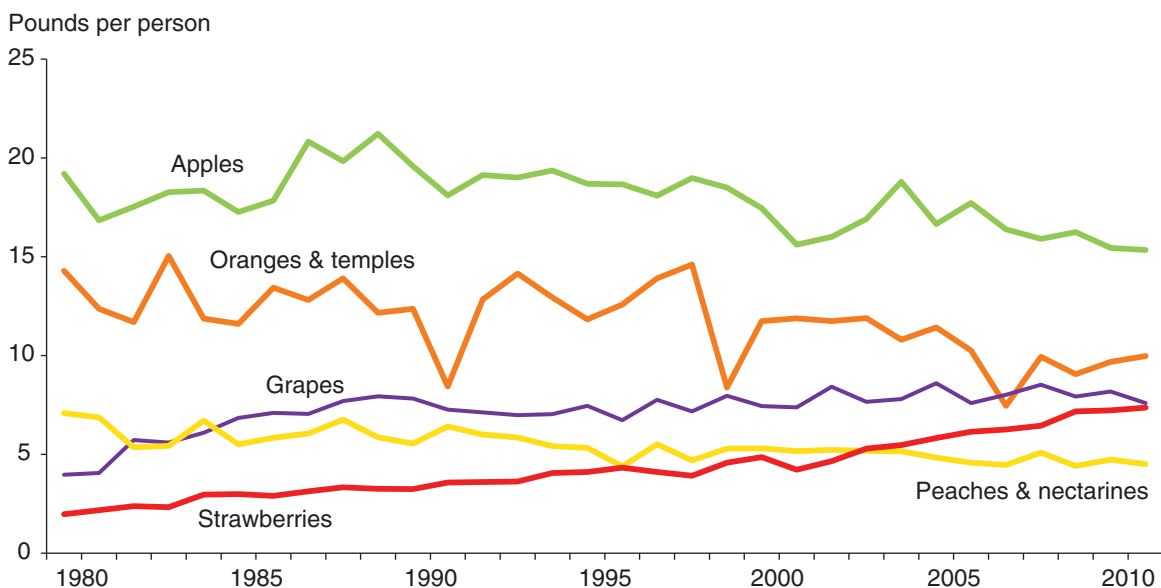
<sup>14</sup>Beginning in 2002, a seasonal import tariff of 0.2 cents per kilogram for fresh peaches was imposed from June 1 to November 30, corresponding with the U.S. peach harvest season.

## Demand

Seasonal grower price patterns are also influenced by domestic and global demand. Demand surges for particular foods, often associated with a holiday, typically exacerbate seasonality in those markets. While not a direct measure of month-to-month consumption, increasing annual per capita use does signal greater total domestic use over the course of a year. For example, per capita fresh strawberry use in the United States grew from 1.97 pounds in 1980 to 7.86 pounds in 2011-12—a 300-percent increase (fig. 4). Demand for U.S. fresh grapes has also trended up over time even as the average annual rate of growth has slowed since the 1990s. In the 1980s, annual increases in per capita domestic fresh grape use averaged 9 percent, declining to less than 1 percent since the 1990s. In contrast, per capita use of peaches, apples, and oranges has trended downward—per capita consumption of fresh peaches and nectarines was 5.20 pounds in the 1970s, reached a high of 7.08 pounds in 1980, and has since declined. Per capita consumption of fresh apples was 19.2 pounds in the 1980-81 marketing year, rose to a high of 21.2 in 1989-90, and fell to 15.3 pounds per person by 2011-12.<sup>15</sup> Domestic per capita consumption of fresh oranges has also waned, bottoming out at 7.5 pounds in 2006 from a high of 15 pounds in 1982.

The presence of alternative outlets (i.e., exports, processing) can act to smooth domestic demand patterns for fresh produce. With the exception of strawberries, exports are a growing outlet for the fruit commodities in this report. On average, close to 40 percent of the domestic fresh grape crop

Figure 4  
**U.S. per capita use of fresh fruit commodities, 1980-2012**



Note: Oranges and temples are grouped together in production data; peaches and nectarines are grouped together in most trade and production data.

Source: USDA, Economic Research Service, *Fruit and Tree Nuts Yearbook Tables*, 2013.

<sup>15</sup>In comparison, per capita use of processed apple products from domestic and imported sources (converted to a fresh-weight basis) was approximately 24, 28, and 30 pounds per capita in the 1980s, 1990s, and 2000s, respectively. Market conditions and price trends for processed apple products vary, with growth in per capita consumption of some products (e.g., juice, cider, apple slices), decline in consumption of other products (e.g., canned, frozen), and a significant increase in the share of imports.

has been exported annually since 2000—an increase from the relatively steady average share of 30 percent between 1970 and 1999. Approximately 90 percent of total export volume is shipped between July and December (during peak U.S. harvest). Use of fresh U.S. apples in international markets has also increased. International markets absorbed 28 percent of domestic fresh apple production on average between 2007-08 and 2011-12, up from slightly over 10 percent during the 1980s. Exports of fresh peaches increased more gradually; on average, 15 percent of utilized production was exported annually between 2000 and 2012, compared to only 7 percent in the 1980s and 11 percent in the 1990s. The share of fresh orange exports increased very gradually, from an average of 28 percent in the 1980s to 33 percent since 2007-08. Like domestic availability, exports are tied to U.S. production patterns and are highly seasonal.

Processed product markets are an additional outlet for some commodities. The presence of a large processed-product market for apples (e.g., juice, canned, dried, frozen) helped absorb the increased availability of domestic production and imports since the 1980s.<sup>16</sup> Grapes for fresh use account for only about 13 percent of total U.S. utilized production, but fresh grape grower prices are typically higher than those for processing use (Boriss et al., 2011). Unlike for apples and oranges, the processed product market does not provide a large outlet for peaches, and utilization in the canned peach market has steadily declined.<sup>17</sup> Likewise, while a large juice market exists for oranges, some varieties of oranges (e.g., navel oranges) are targeted to the fresh market and some (e.g., Valencia oranges) are targeted to the processed markets, and these markets are largely distinct.<sup>18</sup>

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<sup>16</sup>Over half of U.S. apple production is utilized in the fresh market (56 percent, 57 percent, and 65 percent on average during the 1980s, 1990s, and 2000s, respectively). Although declining in total share over the past three decades, processed products still account for over 33 percent of U.S. apple utilization.

<sup>17</sup>Peach varieties are broadly classified by how firmly the flesh attaches to the pit. In freestone peach varieties, the pit is more easily pulled away from the fruit flesh. Clingstone peaches are typically firmer varieties, where the flesh inside the peach tends to cling to the pit. Typically, freestone peach varieties enter the fresh market while clingstone varieties are targeted for the processing market.

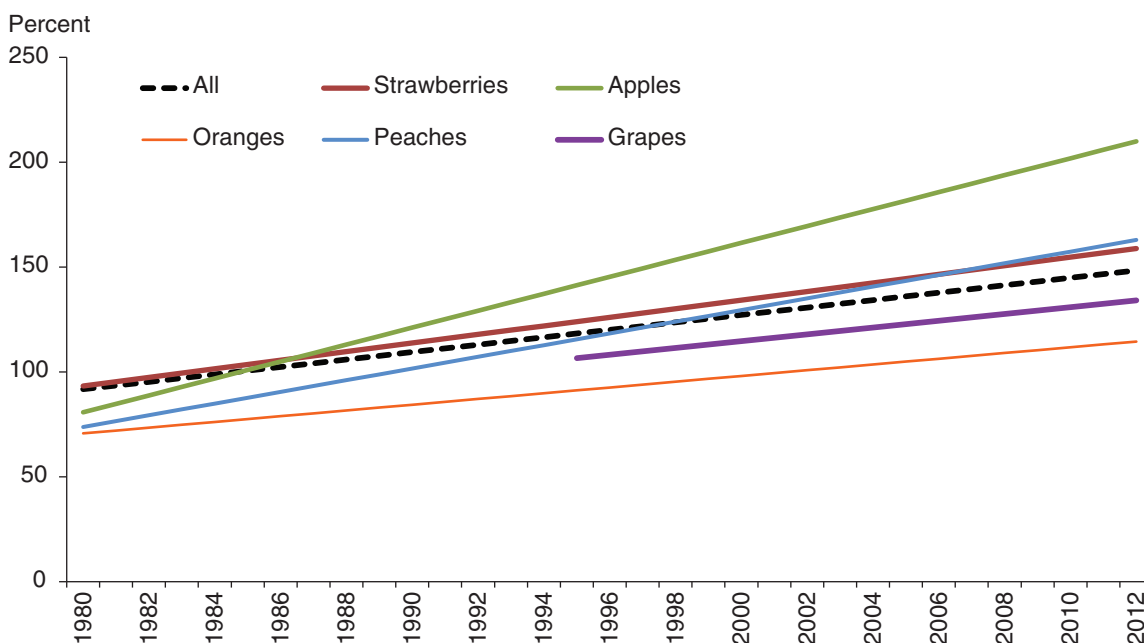
<sup>18</sup>Navel oranges are primarily consumed fresh due to sweetness and ease of peeling. They are rarely used for juicing as the fruit develops bitterness during processing and is less juicy than other varieties. Valencia oranges have the high juice content and flavor profile preferred by the juice market, but are also consumed fresh in smaller volumes.

## Data and Methods

Simple statistical techniques and graphical analysis are used in this paper to evaluate adjustments in seasonal price patterns based on nominal monthly grower price data from 1979 to 2012.<sup>19</sup>

In addition to seasonality, additional random (stochastic) and nonrandom factors influence observed produce prices (Tomek and Robinson, 2003). Price trends showing upward movement over time are evident for fruit commodities (fig. 5). Price cycles are typically related to lags between the decision to enter or leave a market and the actual change in output levels (Rosen et al., 1994; Dieci and Westerhoff, 2010). Four of the five fruit commodities included in this report are perennial crops with multi-year production lags that have the potential to generate price cycles. Further, random price movements result from stochastic shifts in supply and demand, which are influenced by weather or other shocks (e.g., a food safety scare).

Figure 5  
Trend in Producer Price Index, 1980-2012



Notes: All includes fresh fruit and melons, fresh and dried vegetables, and tree nuts. The Producer Price Index (PPI) is a weighted index of prices measured at the wholesale or producer level. Trend in PPI is significant at the 1-percent level for the aggregate index as well as for strawberries, apples, and peaches. PPI trend is significant at the 5-percent level for oranges and insignificant for the shorter fresh grape time series. The time series is a data series of values of a quantity obtained at successive times, often with equal intervals between them.

Source: USDA, Economic Research Service calculations using data from U.S. Department of Labor, Bureau of Labor Statistics, 2013.

<sup>19</sup>Monthly prices used for each of the commodities reflect the all-fresh-fruit grower price (USDA-NASS, Agricultural Prices, 1979-2013). U.S.-level prices are used for all fruits except for fresh orange grower prices, which represent the fresh-on-tree-equivalent price in California (supplier of 88 percent of U.S. fresh-market oranges). The fruit prices reflect a weighted U.S. average for nonorganic fruit. NASS reports fresh peach grower prices only for the months of May through September and fresh grape grower prices only for the months of May through December. Fresh-market grapes include mostly table grapes but also wine and raisin grapes sold for fresh use. Grower prices for grapes are only available from 1995 to 2012.



In order to disentangle seasonal price effects from trend, cyclical, and random price movements, a monthly grower price index for each commodity is calculated following the method established by Houck (1974) and Buxton (1988). In this approach, monthly nominal grower prices are divided by the corresponding centered moving average commodity price to create a monthly price index value for each period.<sup>20</sup> By construction, the mean will approach 100 when monthly index values are averaged for a given year (in contrast to averaging values for the same month across years). The difference between maximum and minimum index values within the year (i.e., the range) represents the magnitude of yearly price changes. For example, in 1980, the fresh strawberry grower price index varied between 75 (minimum in April) and 120 (maximum in February) for a price index swing of 45. In 2012, the price index varied between 66 and 175 for a difference of 109.

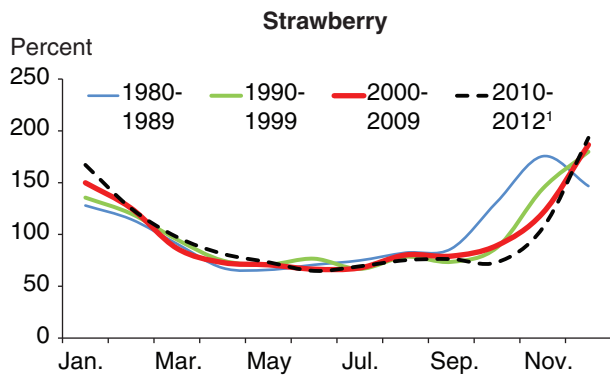
Monthly price index values are averaged by decade (i.e., January 1980-99, 1990-99, 2000-09, and 2010-12) and serve as the basis for the graphs in fig. 6 of seasonal price patterns. Annual maximum and minimum price index values are also averaged by decade. The resulting range provides an indication of magnitude for seasonal grower price fluctuation in each of the four periods. T-tests are used to assess statistical significance of the observed differences across the four periods.

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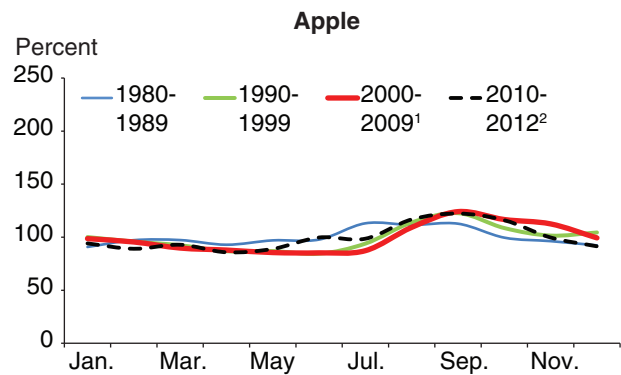
<sup>20</sup>See appendix for a sample calculation of the price index.

Figure 6

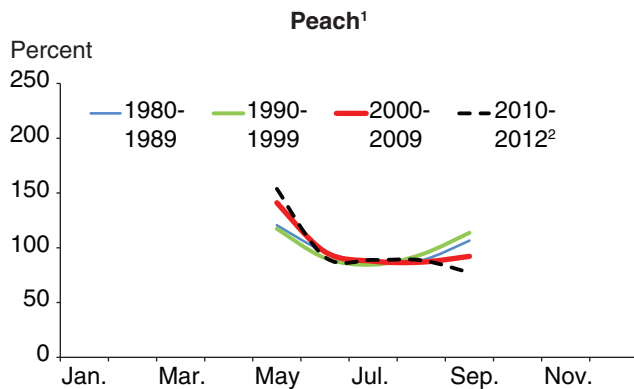
**Monthly seasonal patterns in grower price index for strawberries, apples, peaches, oranges, and grapes, 1980-2012**



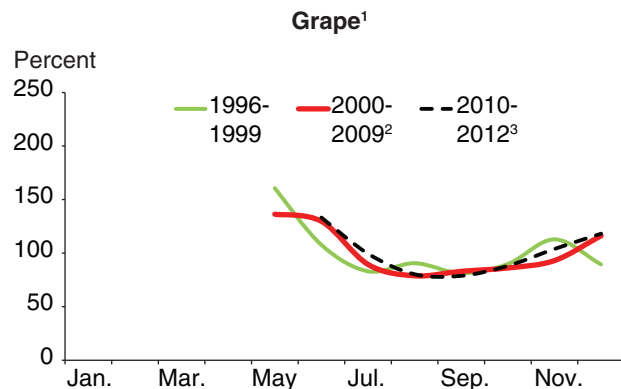
<sup>1</sup>Maximum statistically different from 2000-09 (10%); minimum statistically different from 1990-99 (10%) and 2000-09 (1%); range statistically different from 1980-89 and 1990-99 (5%) and from 2000-09.



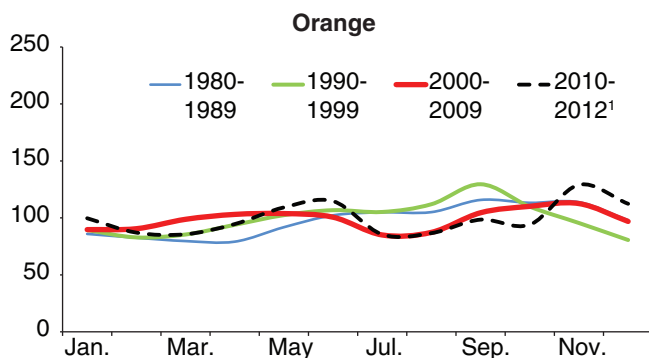
<sup>1</sup>Range statistically different from 1980-89 (5%).  
<sup>2</sup>Maximum statistically different from 1980-89 (1%), 1990-99, and 2000-09 (5%); minimum statistically different than 1980-89 (5%), 1990-99, and 2000-09 (1%); range statistically different than 1980-89, 1990-99, and 2000-09.



<sup>1</sup>Peach grower prices are only reported from May through September.  
<sup>2</sup>Maximum statistically different from 2000-09 (10%); range statistically different from 1980-89 (1%) and from 1990-99 and 2000-09 (5%).



<sup>1</sup>Grape grower prices only for the months of May through December and are only available from 1995 to 2012. During May in 2010-12 period, insufficient number of reports to establish a price.  
<sup>2</sup>Minimum statistically different from 1990-99 (10%); range statistically different from 1990-99 (5%).  
<sup>3</sup>Maximum statistically different from 2000-09 (5%); minimum statistically different from 1990-99 (10%) and 2000-09 (1%); range statistically different from 2000-09 (5%).



<sup>1</sup>Maximum statistically different from 1980-89 (5%), 1990-99, and 2000-09 (1%); minimum and range statistically different from 1980-89, 1990-99, and 2000-09 (1%).

Source: USDA, Economic Research Service calculations based on USDA, National Agricultural Statistics Service, *Agricultural Prices*, 1979-2013.

## Findings

### *Similarities in seasonal grower price patterns across markets and changes over time*

The presence of seasonal grower price patterns in fresh produce has been well documented in the literature (Anonymous, 1958; USDA-AMS, 1961; Houck, 1974; Buxton, 1988; Canova and Hansen, 1995; Arnade et al., 2005; Huang and Huang, 2012). Strawberry, peach, and grape grower prices demonstrate a classic seasonal pattern for fresh produce, with the high prices occurring at the beginning and/or ending of the year or marketing season (fig. 6). In comparison, fresh apples and oranges exhibit weak seasonal price patterns.

In general, strawberry grower prices tend to decrease through the first 4 months of the year, stabilize at low levels from May through August, and rise in the last 4 months (except during the 1980s, when prices dropped notably in December).<sup>21</sup> However, there have been some significant changes in the months when low and high fresh strawberry prices are realized. In the 1980s, the average monthly price index was at its lowest point in May, when shipment volumes were near peak levels for the year (approximately 25 percent of annual supply). By the 2000s, the low price point had moved later in the year to June, and the timing of high grower prices had also moved to later in the year. The highest monthly price index in the 1980s occurs in November, when shipment volumes are lowest (approximately 1 percent of annual supply). By the 1990s, the share of annual supply shipped in November began to increase gradually, and high prices had shifted to December.<sup>22</sup>

Fresh peach and grape grower prices also exhibit the classic pattern of seasonal highs and lows, with high prices early in the U.S. harvest season when supplies are tight, declines through the peak production months, and increases towards the end of the harvest season. In the peach market, prices peak in May, when only around 10 percent of the annual supply volume is in the market. Prices bottom out in July or August, when at least 25 percent of the annual supply volume is available. Overall patterns during the 1980s and 1990s are very similar, but there are indications of change since 2000; early season prices have been higher than the two previous decades and show little price increase or even a decline at the end of the season. Though overall domestic production has remained fairly steady since the 1980s, plantings of late-season varieties have contributed to slightly higher supplies for the late summer and early fall market during the 2000s than in the previous decades. Domestic shipment volume in September rose from 11 to 12 percent of annual volume in the 1980s and 1990s to 14 percent during the 2000s; similarly, volume in October rose from around 1 to 2 percent to 3 to 5 percent.

Grower prices bottom out in the fresh grapes market from July through September, then increase again from October through December. When compared across time, prices in the 1990s declined more sharply from the early-season peak than they did in the 2000s. Prices also declined in December during the mid-to-late 1990s in contrast to end-of-season price increases after 2000. Between 1996 and 1999, markets were very thin in December with fewer grower prices reported, often not having sufficient production volume to establish a price. During 2010-12, fresh grape

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<sup>21</sup>Volume or movement of fresh strawberries was too low to establish a price in 5 of 10 years between 1980 and 1989.

<sup>22</sup>T-tests confirm the 2010-12 June price index is statistically different than 1990-99 at the 10-percent level. With data for only 3 years available, it is not known if this shift will be sustained through 2019. The 1980s December price index is statistically different from the 1990s (5-percent level) and from the 2000s (1-percent level).

prices were not reported in May (again due to thin markets) and the grower price index peaks in June, a month behind the previous decades.

Fresh apples exhibit fairly weak seasonal grower price patterns. Although apple prices typically increase slightly at the beginning of a new marketing year (August-September) then decline as harvest volume rises, a comparison of monthly grower prices throughout the year shows only narrow differences in values. Comparison of apple price patterns between decades shows little difference between 1990-99 and 2000-09 but some shifts from 1980-89 and 2010-12. During the 1980s, average price peaked at the end of the marketing season (July) when supplies were low, before gradually declining as the new crop entered both the market and cold storage facilities. In the subsequent two decades, prices did not peak until September and then mostly declined through the remainder of the year. During 2010-12, grower prices reached their low point in April, 2 months earlier than in the previous decades.

Like apples, fresh orange prices have a relatively flat seasonal pattern. In general, grower prices decline during the heaviest navel-harvest months in the beginning of the year. As navel production decreases and the Valencia harvest increases, grower prices typically rise; however, there are noticeable differences in the seasonal price patterns between decades. The mean grower price index during the 2000s was at its lowest point in July, 3 months after the last large shipment volume. In the 1980s, the mean price index value was lowest in April, when shipments were the second highest of the year.

### *Magnitude of seasonal price changes*

When annual maximum and minimum grower price index values are averaged by decade, the resulting range provides a measure of average magnitude for the seasonal price fluctuation in each of the four periods. In the strawberry example, the 1980s price index (1980-89) varied between 61 and 180 for a difference of 120 and the 2010s price index (2010-12) varied between 62 and 200 for a difference of 139 (table 3). The difference in range between these two periods is 19 points. The observed magnitude of change is even more pronounced in peaches at 33 (from an average range of approximately 44 points in the 1980s to 76 points between 2010 and 2012).

Marked differences in the magnitude of seasonal price fluctuations signal more obvious shifts in price patterns over time, and differences among fresh fruit markets are discernable. Over the 33-year period, changes in average magnitude are not significant for strawberries or apples. In contrast, U.S. fresh peach, grape, and orange grower prices do show significant change.

Most notable are the statistically significant decreases in the magnitude of seasonal grower price change for grapes and oranges in 2010-12, although it is too soon to know if this example will be sustained through 2019. Peach prices have experienced an increase in magnitude and the average maximum price index as growers try to capture early season prices (when the fruit is more susceptible to loss or damage from late-season freezes).

In the strawberry and peach markets, there has been relatively more stability in the minimum prices over time than in maximum prices. Even in individual years, the fresh strawberry grower price index value has rarely fallen below 50 in any single year, while more variability is observed in the high values. Between 1980 and 2012, high prices have been as much as 147 percentage points above the mean (2010) and as little as 20 percentage points above the mean (1980). Average maximum values for the fresh peach grower price index since 2000 are significantly higher than they were between 1980 and 1999.

Table 3

**Descriptive statistics in within-season fresh grower price index**

	1980-89	1990-99*	2000-09	2010-12
<b>Strawberry</b>				
Avg. Max.	180.47	185.32	193.75	200.45
Avg. Min.	60.51	58.40	59.14	61.82
Range	119.96	126.92	134.60	138.63
<b>Peaches</b>				
Avg. Max.	125.00 <sup>1</sup>	124.58 <sup>1</sup>	138.74	153.77
Avg. Min.	81.45	78.54	72.03	77.28
Range	43.55	46.04	66.71	76.49
<b>Grapes</b>				
Avg. Max.		153.45	162.88 <sup>2</sup>	133.85
Avg. Min.		71.16	64.98	74.36
Range		82.29	97.89 <sup>2</sup>	59.48
<b>Apple</b>				
Avg. Max.	130.77	130.19	129.87	125.78
Avg. Min.	80.15	78.81	79.98	84.04
Range	50.62	51.38	49.88	41.74
<b>Orange</b>				
Avg. Max.	138.30	143.37	137.48	129.04
Avg. Min.	70.66	68.82	71.69	81.10 <sup>3</sup>
Range	67.64	74.55	65.79	47.94 <sup>4</sup>

\* 1996-99 for grapes.

1/ Statistically different than 2000-09 and 2010-12 at the 10-percent level.

2/ Statistically different than 2010-12 at the 5-percent level.

3/ Statistically different than 1980-89, 1990-99, and 2000-09 at the 5-percent level.

4/ Statistically different than 1980-89 at the 10-percent level and 1990-99 and 2000-09 at the 5-percent level.

Source: USDA, Economic Research Service calculations using USDA, National Agricultural Statistics Service, *Agricultural Prices*, 1979-2013.

The fresh orange market is an exception—the average minimum grower price index has risen in the most recent period (2010-12) even as the average maximum price index value shows no significant change. The range in the fresh grape price index moved from 82 in the 1990s, to 98 in the 2000s, and to 59 from 2010-12. In contrast, the average range for apple price indices has been relatively steady since 1980. Even when individual years are evaluated, the range in the apple price index varied only as little as 15 (2004) and as much as 96 (1988).

## Summary of Findings

Market conditions unique to each commodity influence the impacts of changing supply and demand factors on the seasonality of grower prices. Products that are supplied and demanded evenly throughout the year are less likely to demonstrate strong seasonality. Over time, fresh fruit suppliers have extended the period various fruits are available in the U.S. market through imports, increased domestic output, expanded planting regions, and/or enhanced storage. Domestic use for some products has increased, potentially spreading sales across a greater number of months. In addition, global demand for U.S. products and, in some cases, growth in alternative markets for processing has influenced the timing of sales. Grouping monthly price data into four periods, 1980-89, 1990-99, 2000-09 and 2010-12, reveals several changes in the seasonal price patterns.

Some shifts have occurred in the magnitude of price change within a season even when averaged by decade, such as for grapes and oranges. When month-to-month price patterns are evaluated, shifts in range are also noted in strawberries, peaches, and apples. The range of monthly prices has increased for less storable produce (e.g., strawberries and peaches) relative to produce that can be stored for longer periods (e.g., apples and oranges). In several cases, notably strawberries and oranges, the timing of high and low prices within the year has also shifted.

A distinct seasonal pattern is observed in fresh strawberry prices even as expanded geographical and varietal diversity have smoothed seasonal price effects (particularly since 2000). Fresh peach and grape markets also continue to demonstrate seasonality, with high price windows at the start and end of the domestic harvest season. Fresh peach supply, demand, and trade trends have not undergone major changes but, while seasonal price patterns remained similar during the 1980s and 1990s, there are indications of change since 2000 with higher early-season prices and little price increase or decline at the end of the season. With little growth in domestic utilization of fresh grapes, increases in production, fluctuations in imports from major and emerging trading partners, and growth in exports have influenced price patterns over time.

Fresh apples and oranges are more storable fruit commodities that fail to demonstrate deep seasonal price swings within a given year, although the timing of high and low prices has shifted. Though the apple harvest occurs largely in the fall, storability, increased domestic production, and counter-seasonal import availability permit more even distribution throughout the year. While the post-harvest shelf-life for oranges is shorter than that for apples, there is a much wider harvest window, allowing for greater on-tree control over when the fruit comes to market.



## Looking Ahead: Policy Issues That May Alter Future Seasonal Price Patterns

Several prevalent policy issues are likely to influence how seasonal price behavior in fresh fruit markets will evolve in the future. Market and policy changes in immigration and labor, food safety, diet and health, growth in organic markets, and the sustainability and growth of local and regional food systems will alter available fresh fruit supplies and needs in the United States. Immigration reform has the potential to significantly affect U.S. crop agriculture, as more than half of the hired workers in this sector are believed to be unauthorized immigrants (Calvin and Martin, 2010). Lack of farm labor to maintain and harvest crops is an increasing concern among U.S. fruit growers—labor is the leading expense item for fruit and tree nut growers and is most intensively used in fresh-market production (Perez and Ali, 2009). Further constraints on labor availability or significantly increased costs could reduce the production of some fruit crops, potentially encouraging those markets to further rely on imports and expand supply sources beyond those already established.

In addition to the food safety systems individual producers already have in place, the Food Safety Modernization Act (FSMA) was enacted in January 2011 to ensure the safety of the U.S. food supply by shifting the focus of Federal regulators from outbreak response to prevention. FSMA is composed of a number of rules implementing mandatory microbial food safety practices for produce growers and handlers. The rules establish science-based minimum standards for the safe production and harvesting of fruits and vegetables that are raw agricultural commodities where the U.S. Food and Drug Administration (FDA) has determined such standards will minimize the risk of serious adverse health consequences or death. As the rules continue to be released and implemented, compliance has the potential to shift both supply regions and demand for fresh produce commodities. Several high-profile outbreaks of food-borne illness have been associated with fresh produce since the mid-1990s. Market reaction to these outbreaks varies by the characteristics of the commodity and by the information that consumers receive, but it can include random price spikes or shifts among commodities purchased (Arnade et al., 2009).

Increased awareness of the growing obesity problem in the United States has strengthened the emphasis on diet and health in policymaking. Some U.S. fruit industries are promoting the benefits of healthy eating and nutrition associated with their products, hoping to stimulate increased consumption of U.S. fruit both here and abroad. Similar to food safety initiatives, efforts to improve diet quality have the potential to boost demand in fresh fruit markets and yield further expansion in domestic production, imports, and exports, with the possibility of further shifts in supply and demand regions with the associated adjustments in price.

Organic retail sales have spread far beyond the natural products market niche and into mainstream retail venues (Green et al., 2009). In trying to keep pace with growing consumer demand, organic production has expanded rapidly in the United States since the late 1990s. Fresh produce is still the top seller in the organic retail food sales category (Greene, 2014), commanding a price premium over conventionally produced counterparts. As USDA continues to expand programs and services for organic producers and handlers, increased participation in the organic market could alter supply conditions in the fresh produce sector, signaling potential adjustments in price. Increased Federal funding in the 2014 Farm Act for economic data collection efforts in the organic sector will facilitate further investigation of price adjustments in this market as more market data become available.

Local foods are a small but growing segment of U.S. agriculture (Martinez, 2010). The 2014 Farm Act provides appropriations for both specialty crops and local/regional food initiatives to promote development of local and regional food systems. While the diffusion of wide-scale commercial fruit production into more States and regions seems implausible, surges in local production and sourcing, and consumer shifts to the consumption of more seasonal foods, may affect seasonal price patterns. Seasonal prices might be exacerbated in local markets with preference-based supply limitations. As more data become available on local foods, there will be opportunities to assess the influence of local and regional food markets on seasonal price patterns across U.S. fresh fruit markets.

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## Appendix: Monthly Commodity Price Index Construction

Monthly grower price for fresh strawberries		
Year	Month	Reported price (cents/pound)
1987	September	68.1
	October	116.0
	November	146.0
	December	130.0
1988	January	80.0
	February	76.3
	March	58.8
	April	40.9
	May	49.9
	June	45.4
	July	50.4
	August	55.0

Source: U.S. Department of Agriculture, National Agricultural Statistics Service, *Agricultural Prices*, 1979-2013.

First, calculate a centered moving average for each month. In our example, the

*February 1988 Nominal Monthly Grower Price = 76.3 cents/pound*

$$\begin{aligned}
 \text{Centered Moving Average} &= \left( \frac{12 \text{ month grower price sum}}{\text{number of observations within 12 month sum}} \right) \\
 &= \left( \frac{68.1 + 116 + 146 + 130 + 80 + 76.3 + 58.8 + 40.9 + 49.9 + 45.4 + 50.4 + 55}{12} \right) = 76.4 \\
 &= \text{February 1988 Centered Moving Average Price}
 \end{aligned}$$

Values used in the calculation roll forward every month. For example, the centered moving average for March 1988 will include prices reported from October 1987 through September 1988. When fewer than 12 consecutive months of prices are reported, the number of values included in the calculation is reduced. For example, peach prices are only reported for 5 months a year so the 12-month grower price sum is divided by 5; the other months are non-observation months and have been left blank.

The index is created by dividing the monthly nominal grower price by the corresponding centered moving average and multiplying by 100:

$$\text{Monthly Price Index} = \left( \frac{\text{Nominal Monthly Grower Price}}{\text{Centered Moving Average}} \right) \times 100$$

In our example,

$$\left( \frac{76.3}{76.4} \right) \times 100 = 99.9 = \text{February 1988 Monthly Fresh Strawberry Price Index}$$