The Australian Journal of Agricultural and Resource Economics

AARES AUSTRALASIAN AGRICULTURAL & RESOURCE ECONOMICS SOCIETY

Australian Journal of Agricultural and Resource Economics, 65, pp. 222–245

Detecting origin fraud with trade data: the case of U.S. honey imports*

Peyton Michael Ferrier †

Following the 2001 U.S. imposition of antidumping tariffs on imported honey from China and Argentina, industry press noted patterns of trade suggesting that honey was being transshipped to circumvent tariffs, origin fraud that was later uncovered in criminal cases. This article presents three approaches that use trade and production data to flag countries for possible instances of origin fraud and then compares these countries with those implicated in criminal cases and media reports. In our preferred empirical method, we also find that countries with higher corruption scores are more likely to show increases in suspicious trade patterns following the tariffs.

Key words: antidumping, food fraud, honey, mismanifesting, tariff, transshipment.

1. Introduction

Honey could be the poster child for food fraud. In recent year, regular reports have detailed numerous instances of honey being diluted with added sweeteners, filtered to obscure prohibited production methods or mislabelled regarding its origins (Strayer *et al.* 2014; Evershed 2016). While the adulteration of honey is not new, the enactment of antidumping tariffs on China and Argentina in 2001 increased the incentives for some producers to evade tariffs through *origin fraud*, the intentional misrepresentation of the product's point of production. At the time of the tariff's enactment, China and Argentina supplied approximately 79 per cent of U.S. imports (or 38 per cent of U.S. domestic consumption).

Two ways producers may seek to avoid tariffs are *transshipping* and *mismanifesting*. *Transhipping*, as a general term, refers to the process of moving traded goods through a third country *en route* from its production point to its destination for consumption. While transshipping often refers to the legitimate (and legal) practice of moving goods through third countries or shipping hubs for logistical reasons (e.g. economies of scale or scope in shipping), the practice

* The author thanks the editor and the specials editors of the Food Fraud issue for helpful feedback. Any errors in the final manuscript are those of the author. This work received funding from United States Department of Agriculture's Economic Research Service.

† Peyton Michael Ferrier (email: peyton.ferrier@usda.gov) is at the Agricultural Marketing Service, United States Department of Agriculture, Washington, District of Columbia, USA.

doi: 10.1111/1467-8489.12412

becomes illegal when used to change or obscure a product's true region of origin[1]. *Mismanifesting* refers to a good being falsely declared a good of a type different from its actual identity to customs authorities upon importation. Both practices may be used to illegally avoid tariffs or trade restrictions to which the product would have been otherwise subject (Ferrier 2008).

When a food is sold with a misrepresented origin but otherwise identical product characteristics, its harm is primarily economic damage of lost tariff revenue or eroded brand value. Spink and Moyer (2011) note that such 'technical food fraud risk' does not materially affect consumer health. When such food has reduced nutritional or health characteristics, however, it represents an 'indirect food fraud risk' because consumer health may be put at risk through long-term exposure. This occurs when producers micro-filter honey to prevent inspectors from determining its fraudulent origins based on region-specific pollen markers (Strayer *et al.* 2014; Evershed 2016) because micro-filtered honey lacks the protein in pollen along with other health benefits. Moreover, a further food safety risk may arise if origin fraud allows the shipped product to avoid heightened inspection scrutiny for food safety reasons, as honey from China and elsewhere is subject to owing to past violations of antibiotic residues limits. In this case, the honey may then represent a 'direct food fraud risk' in the Spink and Meyer framework.

In this paper, we describe trade protection policies that were adopted in the early 1990s after the discontinuation of the U.S. Honey Program (see Muth *et al.* 2003) which supported prices producers received. The 2001 enactment of antidumping tariffs on China and Argentina, the two largest U.S. import sources for honey at the time, led to price increases that likely encouraged illicit trade in honey. We then describe how several criminal prosecutions uncovered shippers in various countries committing origin fraud in the importation of Chinese honey. In addition to the tariff circumvention, the motivation for origin fraud may also have stemmed from producers wanting to avoid heightened food inspection protocols.

We then discuss how countries have been implicated by inspection authorities in origin fraud and how these countries have also shown patterns of trade and production consistent with transshipment and mismanifesting. We then develop three methods of flagging countries as displaying trade patterns consistent with origin fraud. Specifically, we test for suspicious patterns of excess trade (exports exceeding production), reporting gaps (inconsistencies between volumes of origin-reported exports and destination-reported imports) and transshipping patterns (time-linked trade inflows and outflows of honey through third countries) following the imposition of U.S. antidumping tariffs on honey from China and Argentina. We then compare the flagged import sources to those that were implicated in criminal prosecutions. Following Fisman and Wei (2004), we also examine whether

[1] Circumventing antidumping tariffs by misrepresenting a product's origin is illegal under the False Claims Acts of 1863.

countries that measured higher on country-level corruption scores maintained by the World Trade Organization were more likely to be flagged by our methods. In our preferred method of detecting transshipping, seven of eight of the countries that had been implicated in origin fraud in criminal cases showed significant increases in suspicious trade patterns following implementation of the antidumping tariff on China.

2. Factors causing origin fraud with honey

As with other modern agricultural industries, honey is commonly marketed in a manner that facilitates food fraud. Honey production is highly variable in terms of annual yields. Most beekeepers are small relative to the size of the market (Daberkow *et al*. 2009). Branding is limited at the national level. Key quality attributes may be considered credence attributes that are difficult for consumers to ascertain without accurate, truthful labelling (Darby and Karni 1973). Honey is typically sold through intermediaries that may aggregate output from multiple producers. Sales to distant markets may limit the political incentives to maintain labelling integrity.

Migratory beekeeping and the modern honey industry emerged in the late 1800s as productivity advances, including as the creation of the Langstroth hive, and transportation improvements fostered the development of specialised, mobile beekeeping operations that would sell to distant urban centres (Rucker and Thurman 2010; Ferrier, Rucker and Thurman 2018). In an era of lax food safety regulation, honey was susceptible to adulteration through dilution using cheap sugar substitutes. Wilson (2008) cites an 1881 article in *Popular Science Monthly* describing how the recent availability of glucose allowed honey forgers to dilute and extend honey which they obscured by reinserting to the honey 'remnants of bees, wings, leaf, etc. to carry out the fraud'. In the 20th century, honey production grew as the emerging transportation networks allowed beekeepers to exploit better honey production zones and later earn fees from pollinating crops (Rucker *et al*. 2010). World War II caused a surge in the demand for honey and beeswax and U.S. production peaked in 1946 (Ferrier, 2019). The post-war crash lead to the 1950 creation of the Honey Program that supported minimum prices primarily through government purchases but did not otherwise restrict honey importation or production (Muth *et al*. 2003). Until 1980, low support prices limited the impacts and costs of the program. Then, program changes led to price floors substantially above market prices and government purchases rose while imports surged into the U.S. market. As costs ballooned, the program was curtailed significantly in 1986 and then eliminated entirely in 1994. Around the time of the Honey Program's elimination, the Clinton administration pursued an antidumping case against China to address industry concerns about rising low-cost honey imports. The United States won the case, but reached a voluntary export agreement in which China agreed to restrict its exports to the United States rather than imposing tariffs.

When the voluntary export agreement expired in 2000, the United States opted to impose antidumping tariffs on honey from China and, as the result of a separate antidumping case, Argentina, the two largest import sources for U.S. honey at the time. Based on preliminary estimates by the U.S. International Trade Commission (ITC), the Immigration and Customs Enforcement requires importers to post a deposit as a bond for the damages as reflected in the antidumping tariff. After any appeals by importers, the bond is paid to the U.S. Treasury after ITC makes its final determination of the damage rate. At the time of the tariff's 2001 initiation and through 2007, however, the Continued Dumping and Subsidy Offset Act (CDSOA[2]) mandated that tariff revenue be paid back to the harmed domestic producers – beekeepers.

Stating a single average tariff rate for either China or Argentina is difficult because the ITC can impose different tariff rates on different foreign producers within the same country. Unspecified producers, however, typically face a generic tariff rate[3] with all tariffs being re-evaluated every 2 to 3 years. For honey, tariff rates on China were much higher, lasted longer and collected more revenue that those on Argentina. Argentina's generic rate was initially set at 36.7 per cent in 2001 and discontinued after 2010. China's rate was set at 183.8 per cent and, with minor adjustments, remains in place currently. Based on data on revenue reimbursements through the CDSOA through 2016, total reimbursements from China at $72.8 million were 19 times those from Argentina at $3.8 million (U.S. Customs and Border Protection 2018).

As one might expect, following the imposition of tariffs in 2001, U.S. imports fell and the honey price rose. Table 1 shows that between 2002 and 2002, U.S. honey prices rose 84 per cent from 99 to 181 cents per pound. Between 2000 and 2002, imports from Argentina and China at 45 and 27 thousand MT fell to 9 and 8 thousand MT. Imports from other countries rose in this period so that total imports were slightly higher in 2002 than 2001, while the combined share of imports originating from Argentina and China fell from 80 per cent to 18 per cent. Table 1 shows that China, still restricted by its tariff, has shipped negligible amounts of honey to the United States since 2008.

Since the tariffs were enacted, the accusation that shipments of honey have entered the United States illegally through transshipment circulated regularly in the industry press, especially concerning China as an origin. High profile criminal cases prosecuted by Immigration and Customs Enforcement would later reveal the patterns of illegal trade that many industry watchers suspected. Berfield (2013) describes how two companies, Groeb Farms and

[2] The CDSOA had often been called the Byrd Amendment in reference to its legislative sponsor Sen. Robert Byrd.

[3] Based on various Federal Register documents from ITC cases #01-19348 (China) and #01-30469 (Argentina), individual producers faced rates as low as 22.1 per cent in China and 27.0 per cent in Argentina.

Table 1 U.S. honey prices, domestic production and imports of honey

Year	U.S. honey price (cents per pound)	US domestic prod (MT)	Imports (1000 metric tons)					
			Argent.	Canada/ Mexico	China	Vietnam	India	All Others
1989	98.4	81.9	4.7	15.4	11.3	–	–	3.6
1990	100.7	90.1	8.8	10.8	11.5	–	–	3.8
1991	100.1	100.2	9.3	10.0	20.3	–	–	2.3
1992	96.1	100.6	14.1	9.8	27.3	–	–	0.8
1993	91.4	104.6	16.3	7.6	34.8	–	–	1.9
1994	87.3	99.0	18.3	7.1	29.3	0.0	–	1.2
1995	110.2	95.7	12.5	14.6	12.5	0.1	–	0.5
1996	138.7	90.5	31.0	13.5	19.4	0.7	0.6	3.1
1997	114.8	89.1	48.6	10.6	11.5	0.9	1.8	2.7
1998	98.5	99.9	31.5	10.5	13.8	2.9	0.4	0.8
1999	90.4	93.1	41.5	15.5	23.1	1.5	0.0	1.1
2000	85.7	99.9	45.0	15.0	26.8	1.9	–	1.3
2001	98.7	84.1	20.5	14.8	17.7	5.8	0.0	6.9
2002	181.2	77.9	8.7	31.2	7.6	14.4	2.5	27.7
2003	185.5	82.4	4.4	19.0	22.8	8.0	4.6	32.1
2004	138.7	83.3	3.6	13.4	26.9	9.8	6.9	20.3
2005	115.2	79.3	22.8	11.7	29.4	13.6	7.6	20.6
2006	126.0	70.3	28.9	14.2	32.1	13.3	11.1	26.4
2007	127.3	67.3	20.4	17.2	17.8	15.7	7.7	27.0
2008	161.8	74.3	10.0	18.7	11.3	19.4	13.6	31.9
2009	168.3	66.4	10.9	9.9	0.1	17.4	13.1	44.0
2010	181.9	80.0	17.4	14.4	1.5	20.7	18.5	41.4
2011	192.4	67.3	33.5	10.0	1.5	27.8	26.9	31.0
2012	212.6	64.5	42.5	22.1	0.0	20.7	21.5	34.2
2013	225.2	67.8	44.2	15.0	0.1	33.6	25.9	34.3
2014	223.8	80.9	36.9	12.9	–	47.1	20.3	48.6
2015	215.4	71.0	27.1	13.6	0.1	37.0	36.1	61.4
2016	216.4	73.4	34.7	18.0	0.1	38.5	29.4	45.7
2017	215.6	67.0	35.4	20.6	0.6	36.3	45.2	65.1

Source: Sugar and Sweeteners Yearbook, ERS (2017).

Honey Holding, avoided $180 million in tariffs by transhipping honey from China to the United States via India, Malaysia, Indonesia, Russia, South Korea, Mongolia, Thailand, and Taiwan and the Philippines. In 2016, Customs and Border Protection seized 202 tons of illegally imported Chinese honey that was falsely declared as originating in India, Vietnam and Taiwan (ICE 2016a; ICE 2016b; ICE 2016c). Origin fraud (and related product tampering with an unapproved antibiotic) would lead the FDA to propose debarring of associated individuals from importation of any food goods to the United States for four years (FDA 2014). In this case, honey had been moved through India and Vietnam, the two largest current U.S. import sources. Several articles (Berfield 2013; Strayer *et al*. 2014)[4] have documented

[4] Booker (2018) also relates how honey imported to Canada from Asian countries is commonly found to be adulterated with sweeteners and that this honey is often moved into U.S. markets through transshipping.

instances of origin from different countries including Nordhaus (2011) who writes that when: 'honey imports to Australia rose by more than twenty fold ... in 2002 and most was then shipped to the United States labelled as Australian honey'.

The origin fraud concern is often coupled with food safety and quality concerns when honey is alleged to be doctored to obscure its origin (Nordhaus 2011; Phipps 2017; Scott 2018). Pollen provides important flavour and nutritional characteristics to honey and can be used to identify its origin and floral source, a field of study known as melissopalynology. In ordinary circumstances, beekeepers typically strain or coarse-filter honey to remove natural physical contaminants without removing pollen (i.e. bee parts and wax). Unlike that process, however, micro-filtering uses much finer screens, sometimes in conjunction with heating, to remove all the pollen in honey. As described by Strayer *et al.* (2014) and Evershed (2016), such 'honey laundering' prevents the identification of honey's origin based on its pollen content.

The Food and Drug Administration (FDA) regulates and inspects honey imports for food safety concerns. Food safety inspections are long and expensive to both the agency and the importers. Despite FDA having the authority to inspect all imports, it only targets inspection towards a limited percentage of imports based on a risk-targeting model that includes country of origin. In 2009, the FDA began issuing import alerts regarding the unpermitted presence of the antibiotics chloramphenicol, nitrofuran and fluoroquinolone in honey imports among specific shippers (Food and Drug Administration 2018). Initially, this alert included only firms from China, Thailand and Mongolia, but would later be expanded to include those from 12 other countries[5]. Once cited by these alerts, these importer's shipments enter the status of 'Detention without Physical Examination' in which the FDA holds the imported honey until the shipper provides further evidence documenting that it is free of violations. Such requirements and delays are extremely disruptive to supply chains and can have the practical effect of preventing imports from the affected parties. We are unaware of any similar import alert arising for Argentina or other South American firms in the same time frame.

For China, in particular, patterns of trade since the imposition of the tariff and the issuance of the import alert have raised concerns about the possibility of transshipping. In years that followed, U.S. imports would increase sporadically from countries that had not previously been noted for honey production or export (Nordhaus 2011; Schneider, 2011; Berfield 2013; Strayer *et al.* 2014).

Differences between prices of domestic and imported honey would later increase significantly, with honey from the Northern Great Plains of the United States selling for between $1.80 and $2.00 dollars per pound and honey from India or Vietnam selling for between $0.70 and $0.90 per pound in 2019 (USDA AMS 2019). Honey prices differ based on quality

[5] These twelve countries are Armenia, Egypt, Hong Kong, India, Malaysia, Mexico, Moldova, Peru, Russia, Turkey, Ukraine and Vietnam.

characteristics including colour, floral source, organic status and origin. Less expensive, lower quality honey is typically used as an ingredient in baked or prepared foods in which origin information is obscured. Table-ready honey sold in grocery stores, on the other hand, is required to have its country of origin on the label. A large agricultural economics literature has identified how consumers will pay a premium for country of origin information and how this information can act as a proxy for food quality and safety (Lewis and Grebitus 2016).

One industry response to the origin fraud problem was the 2008 creation of an origin verification program where participating producers can market honey under the True Source trademark (True Source Honey 2019). Program notes state that it was created for the specific purpose of countering the tariff circumvention, origin fraud and their attendant problems with regard to food safety. Future industry efforts may also utilise the legal instruments of the Trade Facilitation and Trade Enforcement Act of 2015 which establishes a formal process for Customs and Border Protections to investigate allegations from industry groups of evasion of antidumping orders (Customs and Border Protection Media Relations 2017). This mechanism, along with new technologies improving detection and enforcement, may further deter origin fraud.

3. Methods of detecting origin fraud through trade data

This section describes three diagnostic methods using trade and production data to detect instances in which origin fraud may be occurring through transshipping or mismanifesting. These are the transshipping method, the excess trade method and reporting gap method. These three diagnostics represent a low-cost way for regulatory authorities and industry to detect possible instances of origin fraud using readily available trade and production data. Further investigation or better enforcement mechanisms would then be required to verify and address actual tariff compliance problems. Later, we apply these methods to the honey industry to show their ability to detect origin fraud where it has been reported to have occurred based on previously mentioned criminal cases and press documents.

The import gap method leverages mirror data, the parallel recording of trade flow by both the importing and exporting country. When a shipment's value is recorded by the export country it typically omits the freight and insurance charges that are included in the reported value by the importing country. Carrere and Grigoriou (2015), however, note that differences seen on trade data are often much larger than those that may be attributed to such charges and describe several legitimate and fraudulent reasons for why these may arise[6]. Legitimate reasons include product definition and timing issues,

[6] Baldwin and Taglioni (2011) also review various causes for differences in record trade flows between data recorded by importing and exporting countries.

exchange rate conversion variation while in transit, and re-export and transshipment. Re-exports are defined by the United Nations as trade flows with goods entering the customs territory of a country then being shipped to another, without the goods having been transformed. The authors note that while the U.N. recommends that importers (at the final destination) record the country of origin (not the transiting country) as the import source and that the exporter (in the country of origin) record the last known destination in its export report. If the exporter does not know the final destination at the time of the initial shipment, a discrepancy may occur. Fraudulent reasons cause these discrepancies as well, including tariff evasion and concealing exports among other reasons[7]. In evaluating the fraud motivation, Fisman and Wei (2004, 2007) compare data on the antiquities trade as reported as origin-reported exports and destination-reported imports and leverage the differential incentives of countries to report data accurately on either side of the trade. They then test whether countries with higher corruption scores have higher rates of reporting gaps, which suggest mismanifesting. Other studies considering whether the import gap increases in the presence of a tariff include Kee and Nicita (2016), Mishra *et al*. (2008), Javorcik and Narciso (2008), Rotunno and Vézina (2012) and Vezina (2015).

The excess trade method is a relatively simple approach that addresses the possibility that transshipping is explained by trade diversion (Brenton, 2001). This method examines whether exports exceed the sum of production and imports in a manner that suggests the product has been imported into the country without declaration or under a false trade code (mismanifested) before being exported under ordinary methods. The difference between production and the sum of net export and stock changes measures product disappearance, which is occasionally reported as product consumption. Thursby *et al*. (1991), Goel (2004), and Golub and Mbaye (2009) have examined whether importation and production data indicate unrealistic consumption patterns and suggest that illicit trade is occurring with nearby regions. The Economist (2007) also described high rates of poultry import into Moldova, indicating consumption rates five times higher than neighbouring countries, as suggestive of the smuggling of poultry into the Ukraine and Russia which had restricted imports at the time. Nordhaus (2011) notes that of the top 12 honey exporters globally, seven countries (Vietnam, Malaysia, Indonesia, Taiwan, Thailand, Russia and India) export more than they produce (a pattern we do not see in our analysis)[8]. In these cases, excess trade suggests origin fraud, although the exact mechanism by which it may occur is unclear.

The transshipping approach tests whether imports into an intermediary from an origin country subject to a tariff are predictive of the exports from

[7] Specifically, gaps may also emerge if customs officials overvalue imports in order to increase tariff revenue, if companies attempt to evade taxes by shifting profits through transfer pricing or if companies overvalue exports to take advantage of export subsidies.

[8] The documentary *Rotten* (Kennedy and Kerr 2018) similarly points out this discrepancy for Malaysia.

that intermediary into the destination country. If so, this suggests that the product may have lost its true origin identity in the intermediary country before re-export, thus avoiding the tariff. Figures 1 to 4 show the basic intuition behind the transshipping approach by showing import volumes of honey both arriving from China and exported to the United States between 2001 and 2017 for Thailand, Malaysia, Indonesia and Australia, countries that have been implicated in tariff circumvention as previously discussed. While presented as annual figures, the underlying data on trade flows are published monthly. Transshipping take time so two months are added to the date the import moved into the intermediary to improve the correspondence of trade flows. The figures show that exports of honey to the United States from these countries closely followed imports of honey from China at times.

4. Data

To implement our three approaches, we combine separate data sets on monthly trade, annual production, tariffs and country-level production. The Global Trade Atlas (2018) provides monthly data on the quantity and value of traded goods. For most countries (with the notable exception of Vietnam), honey values and quantities are reported by both the importing and exporting country. We denote X_{ij} as exports from country i to country j as recorded by

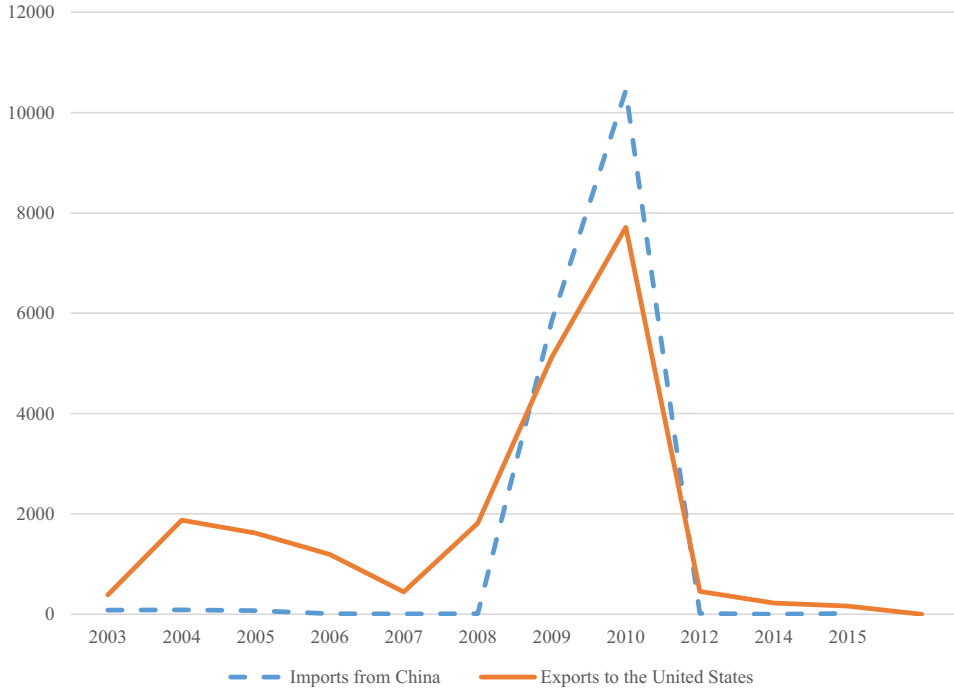

Figure 1 Indonesian honey trade in metric tons. [Colour figure can be viewed at wileyonlinelibrary.com]

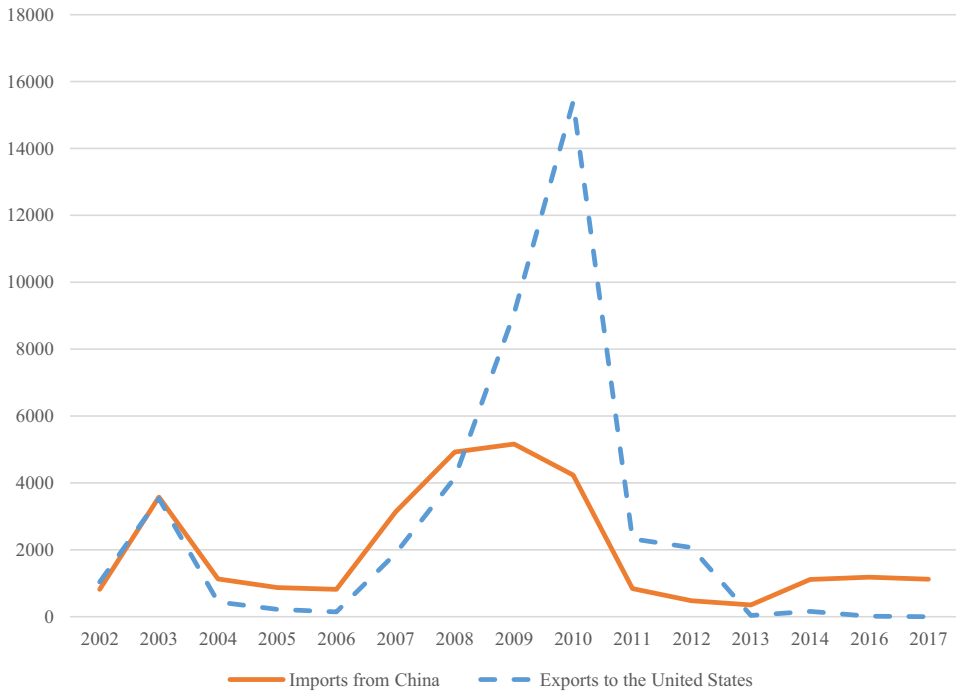

Figure 2 Malaysian honey trade in metric tons. [Colour figure can be viewed at wileyonlinelibrary.com]

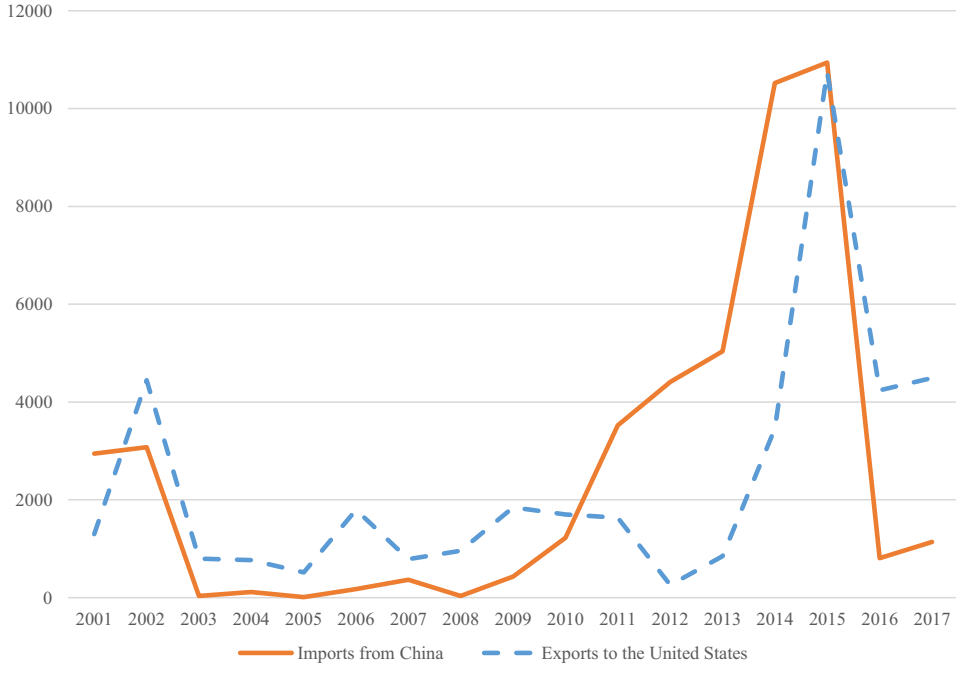

Figure 3 Thai honey trade in metric tons. [Colour figure can be viewed at wileyonlinelibrary.com]

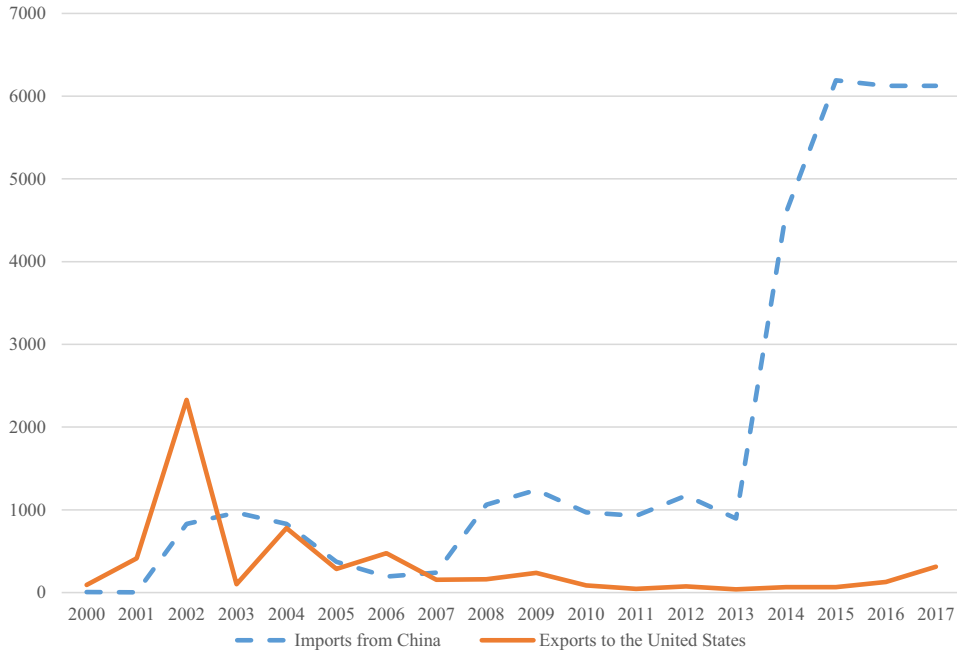

Figure 4 Australian honey trade in metric tons. [Colour figure can be viewed at wileyonlinelibrary.com]

the exporter (country *i)* and M_{ij} as imports from country *i* into country *j* as recorded by importer (country *j*.) Conceptually, the reported value of exports at the country of origin and the corresponding value of imports at the country of destination should be approximately equal. That is, X_{ij} should equal M_{ij}. We obtain our annual data on production from United Nations Food and Agricultural Organization (FAO) where y_i is the quantity (in MT) of honey produced in country *i*. Agricultural production data reported to the FAO aggregates honey production data collected across member countries, which vary in their collection methods and data quality[9].

Data on the timing of antidumping duties are obtained from U.S. Federal Register postings[10,11]. Over the period of our analysis, the generic antidumping tariff rate for honey varied relatively little from the 184 per cent level for

[9] For instance, annual production data reported by some countries to FAO may be extrapolated from smaller or less frequent surveys of farms for some countries.

[10] Data on the size of ordinary tariff are generally available through various public data sources such as the United Nations Conference on Trade and Development's Trade Analysis Information System (UNCTAD-TRAINS) or the Harmonized Tariff Schedule of the U.S. International Trade Commission (ITC). Antidumping tariffs, however, arise from adjudicated cases brought before the ITC and are not reflected in these public sources. While the World Trade Organization briefly maintained an antidumping database, it was not sufficiently detailed for our analysis.

[11] Postings specified different antidumping tariff rates across producers from the same country along with a generic rate for unnamed producers. Rates were slightly lower (a few percentage points) in nearly every case where a specific producer was named.

China and the 37 per cent level for Argentina varied. Since the tariff rate varied little while in effect, we treated it a dummy variable (called *tariff*) that was equal to 1 for China after 2000 and for Argentina after 2000 but before 2011.

Our corruption variable ($corr_j$) is the composite corruption variable for each country drawn from the World Bank Governance Indicators (2018). This variable aggregates several hundred individual underlying variables from a wide variety of existing data sources concern questions such as the frequency of bribery, trust in public officials and irregularity of government accounts. The data reflect the views on governance of survey respondents and public, private and NGO sector experts worldwide. To simplify its interpretation of variables, we follow Fisman and Wei (2007) by normalising this variable to a 0 to 5 scale where 5 is the 'most corrupt' level[12]. Since it varies little over time, we used each country's average over the data period in our estimation. Table 2 provides the corruption scores and U.S. import volumes for the 23 countries that shipped more than 1000 metric tons of honey to the U.S. in any single year between 2001 and 2016. It also indicates whether importers from that country had been implicated in a law enforcement action involving origin fraud with honey based on enforcement and press sources. Implicated countries in Table 2 had an average corruption score of 2.49, while the other countries averaged 2.15.

5. Analysis

The guidance of previous criminal litigation and investigations allow us to direct our focus to a limited number of potential trade relationships. Our analysis is threefold. First, we examine whether excess trade increases in target countries following the tariff's implementation. Second, we test whether the reporting gap between origin-reported exports and destination-reported imports increases after the tariff's imposition for individual countries and is affected by the country's corruption score. Third, we test whether transshipment increased following the tariff's imposition and varied based on the country's corruption score.

5.1 Excess trade analysis

Excess trade occurs when net exports exceed production. In trade date, natural honey is identified at the four-digit level (04.09) in the Harmonized Tariff System allowing for uniform reporting across countries. Honey is also well-defined in production data as well. This is likely to limit the potential for discrepancies in how products are classified and data are recorded across countries. Excess trade may occur due to legitimate reasons (i.e. current

[12] The original corruption score format varies from −2.5 to 2.5 with −2.5 being the most corrupt. We subtract 2.5 from that score and multiply it by −1 to get our new variable.

Table 2 U.S. honey imports and corruption scores of major trade partners

Country		Implicated in origin fraud	Corruption score	U.S. imports in 2016 (MTs)
1	Vietnam	X	3.00	38,513.8
2	Argentina		2.93	34,708.4
3	India	X	2.95	29,364.4
4	Brazil		2.66	19,062.3
5	Canada		0.56	13,487.0
6	Ukraine		3.51	11,086.1
7	Mexico		3.07	4,556.7
8	Thailand	X	2.89	4,237.6
9	New Zealand		0.20	1,857.6
10	Turkey		2.53	1,852.2
11	Uruguay		1.17	1,767.2
12	Taiwan	X	1.72	1,661.6
13	Dom. Republic		3.33	484.5
14	Myanmar		NA	427.8
15	China	X	2.89	148.0
16	Russia	X	3.49	143.4
17	Australia	X	0.59	129.0
18	Romania		2.65	55.1
19	Malaysia	X	2.29	19.2
20	South Korea	X	2.01	1.2
21	Chile		1.07	0.6
22	Indonesia	X	3.09	–
23	Mongolia	X	2.50	–
Average Implicated			2.49	NA
Average Not Implicated			2.15	NA

Source: USDA ERS Sugar and Sweeteners Year Book (2018); Worldwide Governance Indicators (2018); CBP (2016a, 2016b, 2016c).

exports being sold out of a previous year's surplus) or due to mismanifesting associated with origin fraud. When honey is imported to a country under an incorrect trade code and then re-exported (i.e. Chinese honey is shipped as syrup to Vietnam then as honey to the United States), both total exports and net exports (total exports minus total imports) may exceed production. If imported honey is transshipped but not mismanifested (i.e. a country imports honey from China and immediately exports it as honey to the United States), exports but not net exports may exceed production. While sales of stored honey that has been produced or imported in previous years may explain excess trade in individual years, this is unlikely over multiyear periods.

Define $EX1_i$ as excess exports, total exports ($\sum_j X_{ij}$) divided by production (y_i), and $EX2_i$ as excess net exports (total exports minus total imports or $\sum_j X_{ij} - \sum_k M_{ki}$) divided by production (y_i). *EX2* being greater than 100 per cent suggests that a country is exporting more than it produces and imports, a situation suggestive of the mismanifesting of imported honey and its re-export to the United States. Since the tariff on Chinese honey seems to have

Table 3 Excess exports and excess net export statistics for selected countries

Country	Date Range	Years	EX1	EX2	EX1	EX2	Imp.	Exp.	Prod.
			Percentage of years greater than 1		Average Percentage				
Vietnam	1995–2001	6	33%	33%	78%	78%	0.03	24.28	30.95
	2002–2014	12	83%	33%	123%	117%	9.08	186.30	151.36
El Salvador	1995–2001	6	33%	33%	60%	55%	0.75	10.45	17.48
	2002–2014	12	17%	8%	78%	74%	0.82	18.05	23.26
Myanmar	1995–2001	6	0%	0%	18%	16%	0.02	0.18	1.03
	2002–2014	12	25%	25%	88%	88%	0.03	13.29	15.06
Argentina	1995–2001	6	0%	0%	92%	92%	0.43	441.60	478.00
	2002–2014	12	8%	8%	96%	96%	1.24	901.74	942.50
Cuba	1995–2001	6	0%	0%	83%	47%	0.00	29.66	35.60
	2002–2014	12	8%	8%	80%	80%	0.03	57.45	71.47
Uruguay	1995–2001	6	0%	0%	91%	90%	0.05	42.55	47.00
	2002–2014	12	8%	8%	79%	79%	0.01	128.31	163.03
Thailand	1995–2001	6	17%	0%	76%	54%	4.29	14.48	19.00
	2002–2014	12	33%	0%	93%	55%	28.82	70.58	75.99
Taiwan	1995–2001	6	0%	0%	3%	−44%	13.05	0.82	27.50
	2002–2014	12	8%	0%	27%	−3%	27.63	24.53	89.84
Average			3%	1%	24%	−1%	51.5	196.5	617.3
			4%	0%	24%	−1%	109.1	514.1	2,150.5

Source: Global Trade Atlas (2018), Food and Agricultural Organization (2018).

played a more significant role than the tariff on Argentinian honey, we divide the statistics into the six-year period between 1995 and 2001 before the tariff and the 12-year post-tariff period between 2002 and 2014 after the tariff. Table 3 provides these measures of excess exports and excess net exports for honey for countries that traded with the United States before and after the tariff period and for which *EX1* and *EX2* were large[13]. Average values for *EX1*, *EX2*, exports, imports and production are provided as well.

The count data in Table 3 suggests that excess trade in honey has been a regular occurrence in Vietnam since 2001 since net exports exceeded production (*EX2* > *1*) in four (33%) of the 12 tariff years and average *EX2* increased 39 percentage points to average more than 117 per cent in the tariff period. Myanmar had net exports exceed production (*EX2* > 1) in 3 of 12 post-tariff years. While El Salvador, Argentina, Cuba and Uruguay all have a single year in which net exports exceeded production, there does not seem to be a clear pattern of increased excess trade for these countries in the post-tariff period. The increase in EX1 in Taiwan, Thailand and El Salvador in the post-tariff period may suggest that these countries use mismanifesting in

[13] Countries of the European Union owing to trade data within that customs union showing a large degree of cross-border movement and both Belize and Saudi Arabia owing to their relatively small size of production.

conjunction with transshipping. In general, however, the only country clearly flagged for origin fraud in this method was Vietnam, a country also implicated in origin fraud investigations.

5.2 Reporting gap analysis

Mismanifesting goods may also occur by shipping the product under a trade code that is different from the one subject to a tariff. Fisman and Wei (2007) note that incentives to report trade codes falsely may differ between the origin and destination. In the case of tariff evasion, mismanifesting may result in the exporting country recording a greater volume of trade than the import country that is levying the tariff.

Define the reporting gap, GAP_{ij}, as the percentage difference between exports (quantities) reported in origin country i and imports recorded in destination country j, or $\left(X_{ij}-M_{ij}\right)/\left(0.5\left(X_{ij}+M_{ij}\right)\right)$. If GAP_{ij} is positive, a larger quantity of traded goods is being recorded by the exporting country than the importing country. Carrere and Grigoriou (2015) note that differences in prices of shipments between exporting and importing countries differ due to freight and insurance charges and that the difference is often used as a proxy for transport costs, which are often assumed to be an *ad valorem* cost. However, before discussing possible reasons for discrepancies, they write 'in a 'perfect world' with no discrepancy in reported volumes by trade partners', so that we should have X_{ij} equal to M_{ij}.

Define tar_{ij} as a dummy variable equal to 1 when an antidumping duty is in place between the origin and destination country. This variable equals one after 2001 for China and from 2002 through 2010 for Argentina. $Corr_j$ is the corruption score at the intermediate country (j); The variables *year* and $country_j$ are fixed effect dummy variables for year and country. Equation (1) estimates the effect of tariffs on reporting gaps arising by country while controlling for the fixed effects. When trade partners act to circumvent tariffs, then the tariff years will have a positive effect on the reporting gap, GAP_{ij}.

$$GAP_{ih,t}=\beta_t*year_t+\beta_h*country_h+\beta_{tarij}*country_h*tar_{ij,t} \quad (1)$$

$$GAP_{hj,t}=\beta_t*year_t+\beta_h*country_h+\beta_{tarij}*country_h*tar_{ij,t} \quad (2)$$

Table 4 reports the estimates of the country–tariff interaction effects $\left(\beta_{tarij}\right)$ in Equations (1) and (2) using SAS 9.4 Proc SurveyReg function with clustered errors specified for year and country for both China and Argentina. Because the model's specification requires that trade partners be active before and after the tariff period to identify the interaction term, the estimation only includes countries that traded in both the post- and pre-tariff period. For the estimations with China, this eliminated some key countries implicated in origin fraud in Table 2. The β_tar_{ij} term was significant for both Chinese

Table 4 Reporting gap regression estimation with country–tariff interaction effects

Dep. Var.	$Gap_{ih,t}$	$Gap_{hj,t}$	*Dep. Var.*	$Gap_{ih,t}$	$Gap_{hj,t}$
Equation	(1)	(2)	Equation	(1)	(2)
Origin	China	Various	Origin	Argentina	Various
Destination	Various	USA	Destination	Various	USA
Tariff period	2002–16	2002–16	Tariff period	2002–10	2002–10
Parameter of interest (β_tar_i)			Parameter of interest (β_tar_i)		
Canada	−0.3097	−2.2488	Australia	0.0407	−0.197
	(0.1574)	(0.1274)		(0.2719)	(0.2649)
Czech	−0.3491	−0.8139	Austria	0.1985	−0.0904
Republic	(0.1447*)	(0.2287***)		(0.5191)	(0.2388)
Germany	−0.3491	−2.4726	Belgium	0.0915	0.9279
	(0.1447*)	(0.2779***)		(0.3356)	(0.479)
Spain	0.5395	−1.9721	Bolivia	−0.0314	0.9448
	(0.1961**)	(0.1984)		(0.2505)	(0.1667***)
France	0.5395	−1.8094	Brazil	−0.1333	−0.7043
	(0.1961**)	(0.2821***)		(0.2855)	(1.0875)
Great Britain	−1.957	−1.328	Canada	−0.0093	−0.1723
	(0.2449***)	(0.2212***)		(0.2897)	(0.1658)
Greece	−1.957	−1.6508	Switzerland	0.0775	−0.063
	(0.2449***)	(0.1964***)		(0.3062)	(0.2304)
Hong Kong	−0.1653	−0.7253	China	1.5797	−1.9436
	(0.2275)	(0.7459)		(0.2603***)	(0.1733)
Italy	−0.1653	−1.7251	Colombia	0.3186	0.6128
	(0.2275)	(0.2261***)		(0.2586)	(0.1712***)
Mexico	0.9785	−2.0172	Czech	0.5562	−0.318
	(0.119***)	(0.2119)	Republic	(0.3351)	(0.3613)
Poland	0.9785	−1.2229	Germany	0.0762	0.2453
	(0.119***)	(0.2312***)		(0.244)	(0.2797)
Taiwan	0.8236	−3.0626	Denmark	0.0997	−0.3791
	(0.3307*)	(0.3605***)		(0.5737)	(0.1733*)
			Ecuador	0.1427	−1.1433
				(0.2505)	(0.1667***)
			Spain	0.051	−0.1125
				(0.2492)	(0.2037)
			Finland	0.1738	
				(0.2584)	
			France	−0.003	−0.3188
				(0.3593)	(0.2188)
			Great Britain	0.1482	−0.1441
				(0.2645)	(0.2837)
			Indonesia	1.9983	1.6519
				(0.2562***)	(0.4652***)
			Ireland	−0.002	
				(0.2559)	
			Italy	0.1166	0.3796
				(0.248)	(0.24)
			Japan	0.4905	3.0901
				(0.2942)	(0.181)
			Malaysia	0.3486	0.1069
				(0.3097)	(0.1822)
			Poland	−0.0636	0.7995
				(0.378)	(0.2769**)
			Taiwan	0.124	0.4442
				(0.3481)	(0.2529)

Table 4 (*Continued*)

Dep. Var.	$Gap_{ih,t}$	$Gap_{hj,t}$	*Dep. Var.*	$Gap_{ih.t}$	$Gap_{hj,t}$
Equation	(1)	(2)	Equation	(1)	(2)
Origin	China	Various	Origin	Argentina	Various
Destination	Various	USA	Destination	Various	USA
Tariff period	2002–16	2002–16	Tariff period	2002–10	2002–10
Fixed effect controls			Fixed effect controls		
Year	Yes	Yes	Year	Yes	Yes
Country	Yes	Yes	Country	Yes	Yes
Fit statistics			Fit statistics		
R-Square	0.7461	0.4731	R-Square	0.8816	0.9052
Root MSE	0.2366	0.1479	Root MSE	0.1690	0.1369
Observations	180	270	Observations	181	251

Note: "*", "**", and "***" indicates statistical significance at the alpha levels of 0.05, 0.01, and 0.001, respectively.

exports to and U.S. imports from Taiwan, a country implicated in origin fraud. In other cases involving European countries (Czech Republic, Germany, Great Britain, France, Greece, Italy, Poland), the significance of the β_{tarij} parameters may be explained by the frequent transshipping of food goods across countries in the European Union. These countries also ship relatively little honey to the United States. For Argentina, the β_{tarij} was significant for Argentina's exports to China and for U.S. imports from Bolivia, Colombia, Ecuador and Poland. Most notably, the β_{tarij} term was significant for both Argentine exports and U.S. imports from Indonesia, another country implicated in origin fraud.

Since a country's tendency to commit origin fraud is thought to be related to its institutional corruption, Equations (3) and (4) are estimated with a similar framework to Equation (1) but with the country's corruption score–tariff interaction $(corr_h * tar_{ij})$ replacing the country–tariff interaction effect $(country_h * tar_{ij})$.

$$GAP_{ih,t} = \beta_t * year_t + \beta_h * country_h + \beta_{corr} * corr_h * tar_{ij} \quad (3)$$

$$GAP_{hj,t} = \beta_t * year_t + \beta_h * country_h + \beta_{corr} * corr_h * tar_{ij} \quad (4)$$

Table 5 shows the regression results for Equations (3) and (4) for China and Argentina as the origin. For China, the tariff–corruption interaction value did not have a significant effect on the reporting gap for honey exported from China to intermediaries or honey imported from those intermediaries to the United States. The p-value on the β_{corr} term for exports from China to various countries is 0.091, suggesting that the tariff may have had a weak negative effect, consistent with increased discrepancies of reported exports from China to countries with higher corruption score in the tariff period. For

Table 5 Reporting gap regression estimation with corruption–tariff interaction effects

Dep. Var.	$Gap_{ih,t}$	$Gap_{hj,t}$	*Dep. Var.*	$Gap_{ih,t}$	$Gap_{hj,t}$
Equation	(3)	(4)	Equation	(3)	(4)
Origin	China	Various	Origin	Argentina	Various
Destination	Various	USA	Destination	Various	USA
Tariff period	2002–16	2002–16	Tariff period	2002–10	2002–10
Parameters of Interest			Parameters of Interest		
β_corr	−0.2002	0.0974	β_corr	0.0171	0.3118
	(0.1176)	(0.0623)		(0.0307)	(0.1415*)
Fixed effect controls			Fixed effect controls		
Year	Yes	Yes	Year	Yes	Yes
Country	Yes	Yes	Country	Yes	Yes
Fit statistics			Fit statistics		
R-Square	0.7311	0.8770	R-Square	0.4528	0.8563
Root MSE	0.2341	0.1656	Root MSE	0.1428	0.1598
Observations	180	181	Observations	270	251

Note: Standard errors are in parentheses below parameter estimates. The '***' denotes significance at the α-level of 0.001, '**' at the α-level of 0.01 and '*' at the α-level of 0.05.

Argentina, the β_{corr} is not significant for Argentina exporting to various countries but is significantly positive for the United States importing from various countries. In this case, discrepancies between U.S. recorded imports and imports reported from other countries increased in period of the Argentine tariff from 2002 through 2010. Since this time period overlapped with the Chinese tariff period, it is likely that this estimate embeds some of the effect of both tariffs.

The reporting gap method seems to have the drawback of having a strong potential for false positives, a result likely stemming from the widespread use of legitimate transshipping for logistical reasons in many countries. This complication suggests the need for circumspection and outside cross-validation of suspicious trade patterns only suggested by this method alone. It is worth noting, however, that both Indonesia and Taiwan were identified as having trade data discrepancies in both imports and exports and both countries were implicated in legal actions involve circumvention of the honey tariff.

5.3 Transshipping analysis

To consider whether honey is being transshipped, we estimate the following two equations.

$$\log M_{hj,t} = \beta_t year_t + \beta_h country_h + \beta_{trans_h} * country_h * \log X_{ih,t} * tar_{ij,t} \quad (5)$$

$$\log M_{hj,t} = \beta_t year_t + \beta_h country_h + \beta_{corr} * corr_h * \log X_{ih,t} * tar_{ij,t} \quad (6)$$

After controlling for year and country fixed effects, Equation (5) estimates the effect of logged exports from origin i to intermediary $h(\log X_{ih,t})$ on logged

Table 6 Transshipping analysis regression estimation

Dep. Var.		M_{hj}	Dep. Var.		M_{hj}	Dep. Var.		M_{hj}	Dep. Var.		M_{hj}
Equation		(5)	Equation		(5)	Equation		(6)	Equation		(6)
Origin		China	Origin		Argentina	Origin		China	Origin		Argentina
Destination		USA	Destination		USA	Destination		USA	Destination		USA
Tariff period		2002-16	Tariff Period		2002-10	Tariff Period		2002-16	Tariff Period		2002-10
Param.(β_trans_h)	Est.	Std. Err.	Param.(β_trans_h)	Est.	Std. Err.	Param.	Est.	Std. Err.	Param.	Est.	Std. Err.
Australia	0.3957	(0.1993*)	Australia	0.5429	(0.1549***)	β_{cor}	0.3323	(0.0314***)	β_{cor}	0.5000	(0.1384***)
Belgium	0.0456	(0.0707)	Belgium	0.2076	(0.1065)						
Canada	0.0677	(0.0791)	Brazil	1.7938	(0.3597***)						
Great Britain	0.0745	(0.0747)	Canada	0.0919	(0.1015)						
Hong Kong	0.0828	(0.1148)	Chile	0.9159	(0.6032)						
Indonesia	1.1163	(0.1766***)	China	4.3534	(1.1164***)						
India	1.0004	(0.2571***)	Great Britain	0.0676	(0.0927)						
Mexico	0.8506	(0.1468***)	Hong Kong	0.8164	(0.2298***)						
Mongolia	1.3911	(0.124***)	Indonesia	1.8039	(0.3785***)						
Malaysia	0.8818	(0.0984***)	India	2.4063	(0.4777***)						
Thailand	0.5705	(0.1777**)	Mexico	0.5848	(1.397)						
Taiwan	1.0894	(1.5115)	Malaysia	1.9479	(0.4159***)						
Vietnam	1.3570	(0.0872***)	Taiwan	4.5728	(0.9378***)						
			Uruguay	0.8624	(0.3287**)						
R-Square		0.9016	R-Square		0.7616	R-Square		0.8887	R-Square		0.7343
Root MSE		2.9728	Root MSE		4.1291	Root MSE		3.0815	Root MSE		4.2468
Observations		277	Observations		291	Observations		277	Observations		291

Note: Standard errors are in parentheses below parameter estimates. The '***' denotes significance at the α-level of 0.001, '**' at the α-level of 0.01 and '*' at the α-level of 0.05.

imports from intermediary h to destination $j(\log M_{hj,t})$ while the tariff between i and $j(tar_{ij,t})$ is in place[14]. If imports to country i are only intended to satisfy domestic consumption while a portion of domestic production is exported to the United States, then no significant relationship should exist between those exports and either Chinese or Argentine imports.

Table 6 provides parameter estimates for the interaction terms – β_{trans_h} in Equation (5) and β_{corr} in Equation (6) – are our key variables of interest. Estimates are provided for both Argentina and China as origins and the United States as destination using the Proc Surveyreg function in SAS 9.4 with clustered errors for the year and country.

In Equation (5) for exports from China, the parameter for the country–-tariff interaction term (β_{trans_h}) is positive and statistically significant for Australia, Indonesia, India, Mexico, Malaysia, Vietnam and Mongolia. Aside from Mexico, all of these countries were implicated in press reports for origin fraud. For exports from Argentina, this term is positive and significant for Australia, Brazil, China, Hong Kong, Indonesia, India, Mexico, Malaysia, Taiwan and Uruguay. Of these countries, Australia, Indonesia, India, Malaysia and Taiwan had been implicated in origin fraud. Specifications had a good fit across estimates with R-squared values of .9 for China and .76 for Argentina. In Equation (6), the parameter for the corruption–tariff interaction term (β_{corr}) is positive and significant for both exports from China and from Argentina. The lower number of explanatory variables in Equation (6) compared to Equation (5) reduced the model fit only slightly with R-squared values falling to .89 for China and .73 for Argentina.

Across the three methods, the excess trade method flagged only a single country, Vietnam, a country implicated in origin fraud; the reporting gap method flagged numerous countries including Taiwan and Indonesia, countries implicated in origin fraud. In this method, the corruption–tariff interaction variable was only significant for the 2001 to 2010 tariff periods for imports to the United States. The transshipping method flagged eight countries, seven of which were implicated in origin fraud, for China trade. For Argentina, the method flagged nine countries. While five of these countries had been implicated in origin fraud in connection with China, there is no comparable record of countries likely to have committed origin fraud with Argentina.

6. Conclusion

Fraud seeks to evade detection. For this reason, it is difficult, if not impossible, to know the full extent of tariff evasion and origin fraud with honey. Based on previous criminal prosecutions and industry concerns, we know the practice was widespread after antidumping tariffs were imposed in

[14] Logged values for imports and exports are used so as to make the difference in their values be a percentage difference rather than a absolute difference.

2001 on China. In recent years, the formation of a labelling program to differentiate source-verified honey underscores the continued severity of the concern, especially as substantial differences in price have emerged between domestic and imported honey.

We describe and assess three methods of detecting suspicious patterns of trade and production that are consistent with countries illicitly transshipping or mismanifesting honey to avoid tariffs. Each method has certain drawbacks. The excess trade method suggested relatively few countries with trade patterns consistent with origin fraud despite the large number of countries implicated in the practice. On the other hand, the reporting gap method seemed to have a large number of countries flagged for suspicious trade patterns where there is little record of some of those countries being implicated in the practice. Given our limitations in knowing the true pattern of origin fraud, the transshipping method, however, seems to strike the best balance, at least in the case of origin fraud originating in China, of flagging countries that were implicated in origin fraud schemes (7 of 8) while avoiding flagging countries that were not (one). We also find that countries with higher corruption scores were more likely to display the increases in suspicious trade data patterns that our transshipping method flags.

It is important, however, to emphasise that our method does not provide proof that origin fraud has or has not occurred for any specific country. Any origin fraud our methods suggest must be corroborated using legal resources. While our inclusion of fixed effects addresses controls for time invariant effects including proximity or cultural connections that might affect the likelihood of transshipping, the inclusion of additional control variables such as bilateral changes in GDP or inspections outcomes affecting deterrence of origin fraud may improve the fit of the model. Leveraging readily available trade and production data to reveal patterns of illicit trade and food fraud offers the potential to improve enforcement by shrinking the universe of potential targets for more costly inspection and forensic analysis. Such investigations can then occur with access to detailed cargo manifest data for flagged countries or other tools.

The antidumping tariff on honey from China represented a particularly high trade barrier on a major import source of a storable commodity that has little distinguishing brand or origin characteristics that the consumer might recognise. These market characteristics presented a particularly high incentive for shippers to commit origin fraud to evade the tariff. The effects of such tariff circumvention, however, should not be minimised as only affecting prices and tariff revenue. With consumers placing a high premium on information about food's origin and production processes, increased origin fraud food can harm consumer confidence and possibly public health as well.

Disclaimer

The views and opinions expressed in this article are those of the author and do not reflect that the United States Department of Agriculture or the Agricultural Marketing Service.

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

References

Baldwin, R. and Taglioni, D. (2011) *Gravity Chains: Estimating Bilateral Trade Flows When Parts and Components Trade is Important*. NBER Working Paper #16672, National Bureau of Economic Research, Cambridge, MA.

Berfield, S. (2013). The Honey Launderers: Uncovering the Largest Food Fraud in U.S. History, Bloomberg News.

Brenton, P. (2001). Antidumping policies in the EU and trade diversion, *European Journal of Political Economy* 17, 593–607.

Carrere, C. and Grigoriou, C. (2015) Can mirror data help to capture informal international trade? Policy Issues in International Trade and Commodities Research Studies Series No. 65, United Nations Conference on Trade and Development, Geneva, Switzerland.

Customs and Border Protection Media Relations (2017). CBP Establishes New Procedures to Investigate Trade Related Allegations. Available from URL: https://www.cbp.gov/newsroom/national-media-release/cbp-establishes-new-procedures-investigate-trade-related-allegations [accessed June 1, 2019].

Daberkow, S., Korb, P. and Hoff, F. (2009). Structure of the US beekeeping industry: 1982–2002, *Journal of Economic Entomology* 102, 868–886.

Darby, M.R. and Karni, E. (1973). Free competition and the optimal amount of fraud, *Journal of Law and Economics* 16, 67–88.

Economic Research Service (2017). *Sugar and Sweeteners Yearbook*. United States Department of Agriculture, Washington, DC. Accessible at https://www.ers.usda.gov/data-products/sugar-and-sweeteners-yearbook-tables/

Evershed, R. and Temple, N. (2016). *Sorting the Beef from the Bull: The Science of Food Fraud Forensics*. London, UK: Bloomsbury Publishing.

Ferrier, P. (2008). Illicit agricultural trade, *Agricultural and Resource Economics Review* 37, 273–287.

Ferrier, P. (2019). The evolution of federal programs for beekeepers and pollinator data, *Choices, the magazine of Agricultural and Applied Economics Associate* 34, 1–7.

Ferrier, P., Rucker, R., Thurman, W. and Burgett, M. (2018). Economic effects and responses to changes in honey bee health. Economic Research Report #246, Economic Research Service, USDA, Washington, DC.

Fisman, R. and Wei, S.J. (2004). Tax rates and tax evasion: evidence from 'Missing Imports' in China, *The Journal of Political Economy* 112, 471–496.

Fisman, R. and Wei, S.J. (2007). The Smuggling of Art, and the Art of Smuggling: Uncovering the Illicit Trade in Cultural Property and Antiques. National Bureau of Economic Research Working Paper Series No. 13446.

Food and Drug Administration (2009). Public Meeting; Request for Comment [Docket No. FDA-2009-N-0166] [Electronic Version]. Federal Register, 74, 15497.

Food and Drug Administration (2014) Proposal to Debar - Notice of Opportunity for Hearing. Docket Number FDA-2014-N-0964.
Food and Drug Administration (2018). *Import Alert 36–04: Detention without Physical Examination of Honey and Blended Syrup due to Unsafe Drug Residues*. Food and Drug Administration, Rockville, MD.
Global Trade Atlas. (2018). *Global Import Export Data & Commodity Trade Data*. IHS Markit, London, UK.
Goel, R.K. (2004). Cigarette demand in Canada and the US-Canadian cigarette smuggling, *Applied Economics Letters* 11, 537–540.
Golub, S.S. and Mbaye, A.A. (2009). National trade policies and smuggling in Africa: the case of the Gambia and Senegal, *World Development* 37, 595–606.
Immigration and Customs Enforcement Service (2016a) HSI Chicago Seizes Nearly 60 tons of Honey Illegally Imported from China, U.S. Department of Homeland Security Press Release dated June 30, 2016.
Immigration and Customs Enforcement Service (2016b) HSI Chicago Seizes Nearly 60 tons of Honey Illegally Imported from China, U.S. Department of Homeland Security Press Release dated May 5, 2016.
Immigration and Customs Enforcement Service (2016c) To Bee or Not To Bee: CBP and Partners Seized 132 Drums of Honey, U.S. Department of Homeland Security Press Release dated September 14, 2016.
Javorcik, B.S. and Narciso, G. (2008). Differentiated products and evasion of import tariffs, *Journal of International Economics* 76, 208–222.
Kee, H.L. and Nicita, A. (2016). *Trade Frauds, Trade Elasticities and Non-Tariff Measures*. 5th IMF-World Bank-WTO Trade Research Workshop, Washington, DC.
Kennedy, L. and Kerr, B. (Executive Producers). (2018) Rotten (Episode #1, Lawyers, Guns, and Honey), Netflix, Singapore.
Lewis, K.E. and Grebitus, C. (2016). Why U.S. consumers support country of origin labeling: examining the impact of ethnocentrism and food safety, *Journal of International Food and Agribusiness Marketing* 28, 254–270.
Mishra, P., Subramanian, A. and Topalova, P. (2008). Tariffs, enforcement, and customs evasion: Evidence from India, *Journal of Public Economics* 92, 1907–1925.
Muth, M.K., Rucker, R.R., Thurman, W.N. and Chuang, C.T. (2003). The fable of the bees revisited: causes and consequences of the U.S. honey program, *Journal of Law and Economics* 46, 479–516.
Nordhaus, H. (2011). *The Beekeeper's Lament: How One Man and Half a Billion Bees Help Feed America*. Harper/Perennial, New York.
Phipps, R. (2017). International Honey Markets (Honey Fraud), *American Bee Journal* 156, 597–604.
Rotunno, L. and Vézina, P.L. (2012). Chinese networks and tariff evasion, *The World Economy* 35, 1772–1794.
Rucker, R.R. and Thurman, W.N. (2010) Contracting for Pollination Services: Birds Do it, Bees Do It... Let's Specialize and Exchange. Paper presented at Contracting for Ecosystem Services, a conference in Chapel Hill, NC on November 8-10, 2010, sponsored by the Property and Environment Research Center. Chapel Hill, NC.
Schneider, A. (2011) Tests show most store honey isn't honey. Food Safety News, Nov 07, 2011.
Scott, H. (2018). Props for Beekeepers. *American Bee Journal* 185, 163–165.
Spink, J. and Moyer, D. C. (2011). Defining the Public Health Threat of Food Fraud, *Journal of Food Science* 76(9), 157–163.
Strayer, S.E., Everstine, K. and Kennedy, S. (2014). Economically motivated adulteration of honey: quality control vulnerabilities in the international honey market, *Food Protection Trends* 34, 8–14.

Thursby, M., Jensen, R. and Thursby, J. (1991). Smuggling, Camouflaging, and Market Structure, *The Quarterly Journal of Economics* 106, 789–814.

True Source Honey (2019) True Source Honey - Ethically Sourced, Perfectly Delicious. Available from URL: http://www.truesourcehoney.com [accessed May 1, 2019].

U.S. Customs and Border Protection (2018) Continued Dumping and Subsidy Offset Act of 2000. Department of Homeland Security. Available from URL: https://www.cbp.gov/trade/priority-issues/adcvd/continued-dumping-and-subsidy-offset-act-cdsoa-2000 [accessed June 1, 2018].

Vézina, P.L. (2015). Illegal trade in natural resources: Evidence from missing exports, *International Economics* 142, 152–160.

Wilson, B. (2008). *Swindled: The Dark History of Food Fraud, From Poisoned Candy to Counterfeit Coffee*. Princeton University Press, Princeton.

Worldwide Governance Indicators (2018) Control of Corruption Statistics, World Bank. Available from URL: http://info.worldbank.org/governance/wgi/#home [accessed 1 June 2018].